

ECON 4115/5115

Midterm Exam Review

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➤ Chapter 1. Getting Started

- Time Series vs. Econometric Models
- Five Steps of Forecasting
- Notation

➤ Chapter 2. Time Series Graphics

- Three patterns: trend, seasonality and cycles
- “tsibble” object and *autoplot()*
- Types: regular, seasonal subseries, scatter, lag, correlogram

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➤ Chapter 3. Time Series Decomposition

- Three components: trend (T) + seasonality (S) + remainder (R)
- Transformations & Adjustments: populations, inflation, logarithms, Box-Cox, etc.

➤ Chapter 4. Time Series Features

- The “features” package can calculate various statistics
- Mean, minimum, maximum, ACF, PACF, F_T , F_S , white noise test statistics, etc.

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➤ Chapter 5. The Forecaster's Toolbox

- Forecasting steps: (1) prepare data, (2) plot data, (3) pick model, (4) estimate parameters, (5) check in-sample fit and residual diagnostics, (6) generate forecasts & confidence intervals
- Simple forecasting methods: average, naïve and seasonal naïve methods
- Evaluate forecasts: use *accuracy()* function & training/test samples

➤ Chapter 6. Judgmental Forecasts

- Not explicitly covered in class
- Read the chapter, possible exam questions

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➤ Chapter 7. Time Series Regression Models

- Econometric model: $y_t = \beta_0 + \beta_1 x_{1,t} + \beta_2 x_{2,t} + \varepsilon_t$
- Use *TSLM()* function to estimate
- Diagnostics: Use R^2 and \bar{R}^2 for goodness of fit. Plot residuals vs. regressors/fitted values.
- Useful predictors: Linear trend and dummy variables
- Model selection: AIC, BIC, and \bar{R}^2 statistics. Use *glance()* function. Correlated regressors are okay.
- Ex-ante (genuine) vs ex-post forecasts

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➤ Chapter 8. Exponential Smoothing

➤ Weighted average of past observations

➤ SES: $\hat{y}_{T+h|T} = \alpha y_T + \alpha(1 - \alpha)^1 y_{T-1} + \alpha(1 - \alpha)^2 y_{T-2} + \dots$

➤ α is the smoothing parameter, $0 \leq \alpha \leq 1$

➤ Variants: Holt's model (trend) and Holt-Winters model (trend & seasonality)

➤ ETS($\bullet, \bullet, \bullet$) = ETS(Error, Trend, Seasonal) = ETS($\{A, M\}$, $\{N, A, A_d\}$, $\{N, A, M\}$)

➤ Forecasting equation: $\hat{y}_{t+h|t} = [\ell_t + (\phi + \phi^2 + \phi^h)b_t]s_{t+h-m(k+1)}$

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➤ Chapter 9. ARIMA Models

- Step #1. Determine whether the time series is stationary or non-stationary.
- Step #2. If non-stationary, take differences until stationary.
- Step #3. Identify order of the ARIMA process using *ARIMA()* or manually with ACF & PACF.
- Step #4. Optionally write the model with backshift operator:
 - $(1 - \phi_1 B - \dots - \phi_p B^p)(1 - B^d)y_t = c + (1 + \theta_1 B + \dots + \theta_q B^q)\varepsilon_t$
- Step #5. Estimate parameters using maximum likelihood.
- Step #6. Check the properties of the in-sample residuals.
- Step #7. Forecast the future using *forecast()* and provide confidence intervals.