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ECON3350 - Applied Econometrics for Macroeconomics and Finance

Week 13 – Final Exam prep

Tutor: Francisco Tavares Garcia

Final Exam – 12 June

Assessment

Assessment summary

Category	Assessment task	Weight	Due date
Paper/ Report/ Annotation	Research Report 1	20%	11/04/2025 1:00 pm
Paper/ Report/ Annotation	Research Report 2	30%	9/05/2025 1:00 pm
Examination	Final Exam Identity Verified In-person	50%	End of Semester Exam Period 7/06/2025 - 21/06/2025

No hurdle!

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Final Exam – 12 June

Exam details

Planning time	10 minutes
Duration	120 minutes
Calculator options	(In person) Casio FX82 series only or UQ approved and labelled calculator
Open/closed book	Closed Book examination - specified written materials permitted
Materials	One A4 sheet of handwritten or typed notes, double sided, is permitted A bilingual dictionary is permitted for the final exam.
Exam platform	Paper based
Invigilation	Invigilated in person

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Applied Econometrics for Macroeconomics and Finance

Students

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2022 - Online Quiz 1

Question 1

Consider the following ARMA model for $\{y_t\}$:

$$y_t = a_0 + \sum_{j=1}^{p} a_j y_{t-j} + \varepsilon_t + \sum_{l=1}^{q} b_l \varepsilon_{t-l}$$

where $\{\varepsilon_t\}$ is the residual.

Which of the following assumption(s) on the residuals $\{\varepsilon_t\}$ is needed to enable forecasting with this model in practice?

Answers:

a. ε_t is normally distributed.

b. ε_t is mean-independent of $y_{t-1}, y_{t-2}, \ldots$ and $\varepsilon_{t-1}, \varepsilon_{t-2}, \ldots$.

c. ε_t and ε_s are stochastically independent for all $t \neq s$.

d. All of the above.

2022 - Online Quiz 1

Question 2

How can the validity of the assumption(s) identified in Question 1 be examined in practice?

Answers:

a. Use the Breusch-Pagan test, where the null hypothesis is that the distribution is normal.

b. Use the Ljung-Box test, where the null hypothesis is that the first *K* autocorrelations are zero.

c. Examine the SACF and SPACF of the estimated residuals $\widehat{\varepsilon}_t$.

d. Both (b) and (c).

2022 - Online Quiz 1

Question 3

What conditions on the parameters $a_0, a_1, \ldots, a_p, b_1, \ldots, b_q$ are necessary for the process to be stable?

Answers:

a. $a_1 = \ldots = a_p = 0.$

b. $a(z) \neq 0$ for all $|z| \leq 1$, where $a(L) = 1 + a_1 L + \ldots + a_p L^p$.

c. $b(z) \neq 0$ for all $|z| \leq 1$, where $b(L) = 1 + b_1 L + \ldots + b_q L^q$.

d. Both (b) and (c).

2022 - Online Quiz 1

Question 4

Consider the 2-period ahead forecast $\hat{y}_{T+2} = E(y_{T+2} \mid y_1,\ldots,y_T)$. Which of the following statements is ***not*** true?

Answers:

a. If the ARMA(p,q) is invertible, then $\hat{y}_{T+2}$ can be reasonably approximated by a linear function of $y_1,\ldots,y_T$.

b. The forecast error variance $\sigma^2_{\hat{y},T+2} \equiv Var(y_{T+2} - \hat{y}_{T+2})$ is finite only if the ARMA(p,q) is stable.

c. Predictive intervals for $\hat{y}_{T+2}$ account for uncertainty due to unobserved ε_{T+1}, ε_{T+2} as well as parameter estimation.

d. All of the above are true.

2022 - Online Quiz 1

Question 5

Consider the following information for a set of three ARMA models: ARMA(1,0), ARMA(1,1) and ARMA(3,2).

p	*q*	AIC
1	0	-4.204
1	1	-6.819
3	2	-6.847

Based on this, how would you proceed with model specification?

Answers:

a. Eliminate the ARMA(1,0) because it has a clearly inferior fit versus parsimony tradeoff according to the AIC.

b. Choose the ARMA(3,2) only because it has the best fit versus parsimony tradeoff according to the AIC.

c. Choose the ARMA(1,1) only because it has a better fit than the ARMA(1,0) but it is more parsimonious than the ARMA(3,2).

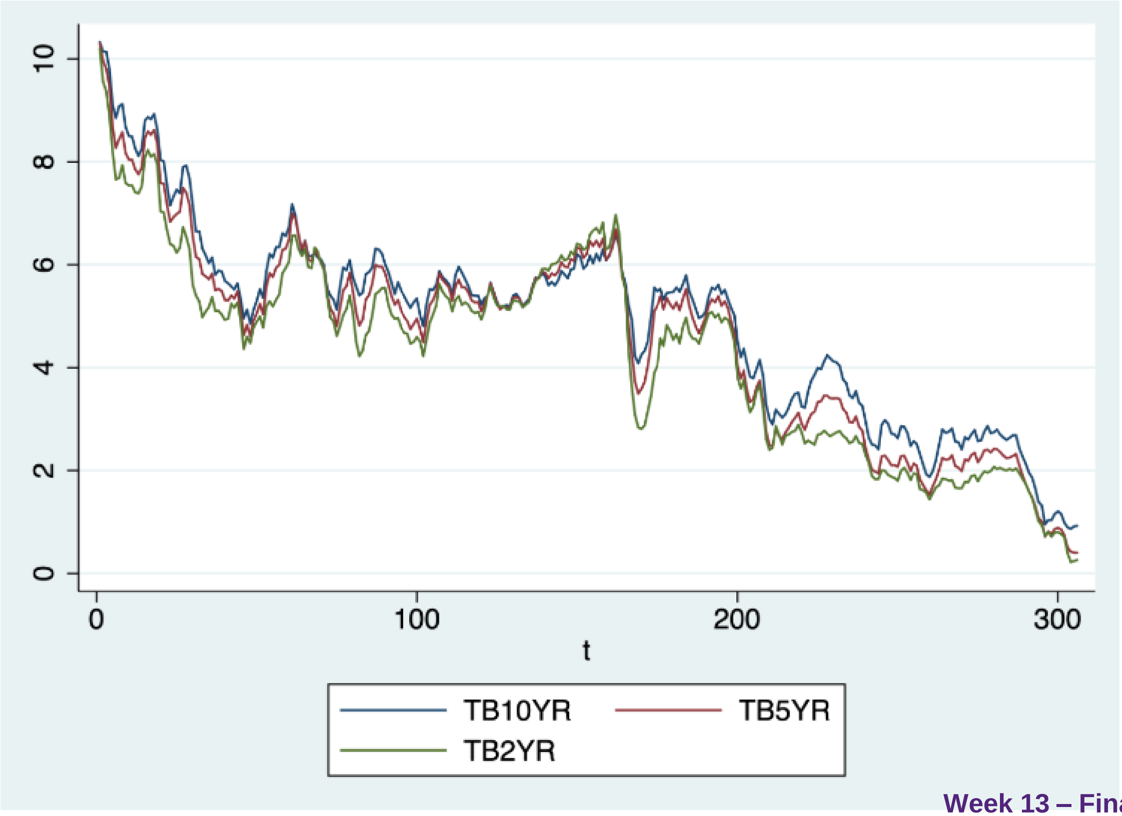
d. Eliminate all the models in this set because they have a negative AIC value.

2022 - Online Quiz 2

Question 1

In your role as a data analyst with a financial consultant, you are provided monthly interest rates (Commmonwealth government bonds with 2 years, 5 years and 10 years maturities) for the period January 1995-June 2020 (T = 306). The three series are plotted in Figure 1.

Figure 1: Monthly Commonwealth Bond Yields from January 1995 to June 2020



Let y_t denote the 10 year bond series, x_t the 5 year bond series, and z_t the 2 year bond series. You use statistical software to estimate the following equations (t-statistics in parentheses):

$$\Delta z_t = \underset{(1.07)}{0.033} - \underset{(-1.86)}{0.012} \times z_{t-1} + \underset{(6.54)}{0.347} \times \Delta z_{t-1} + \hat{\eta}_{z,t}$$

$$\Delta^2 z_t = -\underset{(-1.45)}{0.019} - \underset{(-9.58)}{0.627} \times \Delta z_{t-1} - \underset{(0.506)}{0.038} \times \Delta^2 z_{t-1} + \hat{\eta}_{\Delta z,t}$$

$$\Delta y_t = \underset{(1.29)}{0.028} - \underset{(-5.69)}{0.100} \times \left(y_{t-1} - \underset{(-23.1)}{1.340} \times x_t + \underset{(11.6)}{0.400} \times z_t \right) + \hat{u}_t$$

$$y_t = \underset{(1.29)}{0.028} + \underset{(39.8)}{0.900} \times y_{t-1} + \underset{(42.6)}{1.515} \times x_t - \underset{(-29.2)}{1.381} \times x_{t-1} - \underset{(-18.1)}{0.620} \times z_t + \underset{(16.7)}{0.580} \times z_{t-1} + \hat{v}_t$$

Please use the above results only to answer the following questions.

What inference can be drawn on the order of integration for the stochastic process $\{z_t\}$?

Answers:

a. $\{z_t\}$ is stationary.

b. $\{z_t\}$ has a unit root.

c. $\{z_t\}$ is not empirically distinguishable from a hypothetical I(1) process.

d. None of the above.

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2022 - Online Quiz 2

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Question 2

What inference can be drawn on the order of integration for the stochastic process $\{y_t\}$?

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Question 3

Consider the effect of an un-anticipated 1 basis point increase in the 5 year bond rate (x_t) at time t, which persists at t+1, t+2, ... Assuming the 2 year bond rate (z_t) does not change, and no other shocks occur at any horizon, what is the most appropriate inference regarding the change in the 10 year bond rate (y_t) on impact (i.e., at time t)?

Answers:

a. The 10 year bond rate increases by 1.515 on impact.

b. The 10 year bond rate decreases by 0.0175 on impact.

c. The change in the 10 year bond rate on impact is between 1.4453 and 1.5847 with 95% confidence.

d. The change in the 10 year bond rate on impact is contained in a 95% confidence interval centred at -0.0175.

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2022 - Online Quiz 2

Let y_t denote the 10 year bond series, x_t the 5 year bond series, and z_t the 2 year bond series. You use statistical software to estimate the following equations (t-statistics in parentheses):

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Question 4

Consider the effect of an un-anticipated 1 basis point increase in the 5 year bond rate (x_t) at time t, which persists at t+1, t+2, ... Assuming the 2 year bond rate (z_t) does not change, and no other shocks occur at any horizon, what is the most appropriate inference regarding the change in the 10 year bond rate (y_t) one month (t+1) after impact?

Answers:

a. The 10 year bond rate increases by 1.515 one month after impact.

b. The 10 year bond rate decreases by 0.0175 one month after impact.

c. The change in the 10 year bond rate one month after impact is between 1.4453 and 1.5847 with 95% confidence.

d. The change in the 10 year bond rate one month after impact is contained in a 95% confidence interval centred at -0.0175.

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2022 - Online Quiz 2

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Question 5

Consider the effect of an un-anticipated 1 basis point increase in the 5 year bond rate (x_t) at time t, which persists at t+1, t+2, ... Assuming the 2 year bond rate (z_t) does not change, and no other shocks occur at any horizon, what is the most appropriate inference regarding the change in the 10 year bond rate (y_t) in the long run (i.e., infinite horizon)?

Answers:

a. The 10 year bond rate increases by 1.34 in the long-run.

b. The long-run change in the 10 year bond rate is between 1.2263 and 1.4537 with 95% confidence.

c. The 10 year bond rate is not significantly affected by the increase in the 5 year bond rate.

d. The effect cannot be computed because the data is not stationary.

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2022 - Online Quiz 3

Question 1

You develop the following model designed to forecast the volatility of the weekly AUD/GBP exchange rate (denoted by z_t):

$$\Delta z_t = a_0 + a_1 \Delta z_{t-1} + \cdots + a_p \Delta z_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \cdots + \theta_q \varepsilon_{t-q},$$

$$\varepsilon_t = v_t \sqrt{h_t},$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \cdots + \alpha_r \varepsilon_{t-r}^2 + \lambda \delta_{t-1} \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \cdots + \beta_s h_{t-s}.$$

In this model, $\delta_t = 1$ if $\varepsilon_t < 0$ and $\delta_t = 0$ otherwise. Using statistical software, you fit the model to the data and obtain the following results. A residuals analysis for each specification in Table 1 *did not* detect substantial evidence of autocorrelation.

Table 1: Estimated Information Criteria for Alternative Specifications

p	*q*	*r*	*s*	λ	AIC	BIC
1	0	0	0	0	-2819.5	-2805.9
1	1	0	0	0	-2817.9	-2799.7
0	0	1	0	0	-2930.5	-2916.9
1	1	1	1	0	-2970.8	-2943.6
1	0	1	1	unrestricted	-2975.1	-2947.8
1	1	1	1	unrestricted	-2973.6	-2941.8

Subsequently, one of the specifications you estimated produced the following results (*t*-statistics in parentheses):

$$\Delta z_t = \underset{(0.22)}{0.0002} - \underset{(-0.52)}{0.0228} \times \Delta z_{t-1} + \varepsilon_t,$$

$$h_t = \underset{(3.97)}{0.0001} + \underset{(3.10)}{0.1027} \times \varepsilon_{t-1}^2 + \underset{(3.33)}{0.1230} \times \delta_{t-1} \varepsilon_{t-1}^2 + \underset{(15.45)}{0.7375} \times h_{t-1}.$$

Please use the above information only to answer the following questions.

What is the most appropriate name for the specification estimated in (1)-(2)?

Answers:

a. ARMA(1, 1) with homoscedastic errors.

b. AR(1) with TGARCH(1, 1) errors.

c. AR(1) with EGARCH(1, 1) errors.

d. None of the above.

2022 - Online Quiz 3

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$$h_t = \underset{(3.97)}{0.0001} + \underset{(3.10)}{0.1027} \times \varepsilon_{t-1}^2 + \underset{(3.33)}{0.1230} \times \delta_{t-1}\varepsilon_{t-1}^2 + \underset{(15.45)}{0.7375} \times h_{t-1}.$$

Question 2

What is a valid justification for including the specification estimated in (1)-(2) in the adequate set of models?

Answers:

a. It provides the best trade-off between fit and parsimony of all the specifications considered in Table 1.

b. The residuals are confirmed to be white noise by the Ljung-Box test.

c. $\{z_t\}$ is not empirically distinguishable from a hypothetical I(1) process.

d. All of the above.

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Question 3

Consider a test for the presence of heteroscedasticity using the specification estimated in (1)-(2). Which of the following statements are valid?

Answers:

a. We reject $H_0: \alpha_0 = 0$ in favour of $H_1: \alpha_0 \neq 0$ at the 5% significance level, where α_0 is the intercept in (2), and conclude there is evidence of heteroscedasticity.

b. We fail to reject $H_0: \alpha_1 = 0$ in favour of $H_1: \alpha_1 \neq 0$ at the 5% significance level, where α_1 is the coefficient on ε_{t-1}^2 in (2), and conclude there is evidence of homoscedasticity.

c. We reject the $H_0: \lambda_1 = 0$ in favour of $H_1: \lambda_1 > 0$ at the 5% significance level, where λ_1 is the coefficient on $\delta_{t-1}\varepsilon_{t-1}^2$ in (2), and conclude there is evidence of heteroscedasticity.

d. None of the above.

2022 - Online Quiz 3

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Subsequently, one of the specifications you estimated produced the following results (t-statistics in parentheses):

$$\Delta z_t = \underset{(0.22)}{0.0002} - \underset{(-0.52)}{0.0228} \times \Delta z_{t-1} + \varepsilon_t,$$

$$h_t = \underset{(3.97)}{0.0001} + \underset{(3.10)}{0.1027} \times \varepsilon_{t-1}^2 + \underset{(3.33)}{0.1230} \times \delta_{t-1}\varepsilon_{t-1}^2 + \underset{(15.45)}{0.7375} \times h_{t-1}.$$

Question 4

Consider a test for the presence of leverage effects using the specification estimated in (1)-(2). Which of the following statements are valid?

Answers:

a. We reject $H_0 : \alpha_0 = 0$ in favour of $H_1 : \alpha_0 \neq 0$ at the 5% significance level, where α_0 is the intercept in (2), and conclude there is evidence of leverage effects.

b. We fail to reject $H_0 : \alpha_1 = 0$ in favour of $H_1 : \alpha_1 \neq 0$ at the 5% significance level, where α_1 is the coefficient on ε_{t-1}^2 in (2), and conclude there is evidence of no leverage effects.

c. We reject the $H_0 : \lambda_1 = 0$ in favour of $H_1 : \lambda_1 > 0$ at the 5% significance level, where λ_1 is the coefficient on $\delta_{t-1}\varepsilon_{t-1}^2$ in (2), and conclude there is evidence of leverage effects.

d. None of the above.

2022 - Online Quiz 3

Subsequently, one of the specifications you estimated produced the following results (t-statistics in parentheses):

$$\Delta z_t = \underset{(0.22)}{0.0002} - \underset{(-0.52)}{0.0228} \times \Delta z_{t-1} + \varepsilon_t,$$

$$h_t = \underset{(3.97)}{0.0001} + \underset{(3.10)}{0.1027} \times \varepsilon_{t-1}^2 + \underset{(3.33)}{0.1230} \times \delta_{t-1}\varepsilon_{t-1}^2 + \underset{(15.45)}{0.7375} \times h_{t-1}.$$

Question 5

In addition to the results provided by the estimated equation, you also know that $\hat{\varepsilon}_T = -0.0129$, and $\hat{h}_T = 7.8754 \times 10^{-4}$, where $1 \times 10^{-4} = 0.0001$. Using this information, what is the most appropriate forecast of volatility one week following the end of the sample?

Answers:

a. $h_{T+1} = 0.0001$.

b. $h_{T+1} = 7.1837 \times 10^{-4}$

c. There is not enough information to compute the forecast because Δz_T is not given.

d. $\hat{h}_{T+1} = 7.1837 \times 10^{-4}$ but there is not enough information to compute the predictive interval for h_{T+1}.

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2022 - Online Quiz 4

Question 1

Suppose $\{y_t\}$ denotes the process generating the weekly AUD/USD exchange rates, and $\{z_t\}$ denotes the process generating the weekly AUD/GBP exchange rates. Let $\mathbf{x}_t = (y_t, z_t)'$ be a 2×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{x}_t\}$:

$$\mathbf{x}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \cdots + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0, \boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\Sigma(\mathbf{B}^{-1})'$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Representation A

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.1737 & 0.1064 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1119 & -0.0853 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0.0005 \\ 0.0005 & 0.0010 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0014 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.0064 & -0.0686 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1728 & -0.1315 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0 \\ 0 & 0.0006 \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ z_t \\ y_{t-1} \\ z_{t-1} \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \\ y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \\ 0 \\ 0 \end{pmatrix}.$$

$$\widetilde{\mathbf{A}}_1 = \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^2 = \begin{pmatrix} -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \\ -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \end{pmatrix},$$

$$\widetilde{\mathbf{A}}_1^3 = \begin{pmatrix} 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \\ -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^4 = \begin{pmatrix} 0.0073 & -0.0028 & -0.0061 & 0.0047 \\ -0.0224 & 0.0182 & -0.0019 & 0.0015 \\ 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \end{pmatrix},$$

$$\mathbf{B} = \begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}, \quad \mathbf{B}^{-1} = \begin{pmatrix} 1 & 0 \\ 0.9401 & 1 \end{pmatrix},$$

and

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{0.01, 0.02, 0.41\}.$$

Using the above information, what is the lag length of the realised VAR model?

Answers:

a. $p = 1$

b. $p \geq 2$

c. $p = 2$

d. There is not enough information to determine the lag length.

2022 - Online Quiz 4

Suppose $\{y_t\}$ denotes the process generating the weekly AUD/USD exchange rates, and $\{z_t\}$ denotes the process generating the weekly AUD/GBP exchange rates. Let $\mathbf{x}_t = (y_t, z_t)'$ be a 2×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{x}_t\}$:

$$\mathbf{x}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \cdots + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0, \Omega), \quad \Omega = \mathbf{B}^{-1}\Sigma(\mathbf{B}^{-1})'$$

where $\mathbf{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Question 2

What best describes Representation B of the realised VAR model?

Answers:

a. Reduced form VAR

b. Reduced form ARDL

c. Structural VAR

d. VAR companion form

Representation A

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.1737 & 0.1064 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1119 & -0.0853 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0.0005 \\ 0.0005 & 0.0010 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix} \begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0014 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.0064 & -0.0686 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1728 & -0.1315 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0 \\ 0 & 0.0006 \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ z_t \\ y_{t-1} \\ z_{t-1} \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ z_{t-1} \\ y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \\ 0 \\ 0 \end{pmatrix}.$$

$$\widetilde{\mathbf{A}}_1 = \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^2 = \begin{pmatrix} -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \\ -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \end{pmatrix},$$

$$\widetilde{\mathbf{A}}_1^3 = \begin{pmatrix} 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \\ -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^4 = \begin{pmatrix} 0.0073 & -0.0028 & -0.0061 & 0.0047 \\ -0.0224 & 0.0182 & -0.0019 & 0.0015 \\ 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \end{pmatrix},$$

$$\mathbf{B} = \begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}, \quad \mathbf{B}^{-1} = \begin{pmatrix} 1 & 0 \\ 0.9401 & 1 \end{pmatrix},$$

and

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{0.01, 0.02, 0.41\}.$$

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

2022 - Online Quiz 4

Suppose $\{y_t\}$ denotes the process generating the weekly AUD/USD exchange rates, and $\{z_t\}$ denotes the process generating the weekly AUD/GBP exchange rates. Let $\mathbf{x}_t = (y_t, z_t)'$ be a 2×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{x}_t\}$:

$$\mathbf{x}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \cdots + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0, \Omega), \quad \Omega = \mathbf{B}^{-1}\Sigma(\mathbf{B}^{-1})'$$

where Σ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Question 3

What best describes the stability of the realised VAR model?

Answers:

a. The VAR is stable because all roots of det $\mathbf{A}(z)$ are greater than one in absolute value.

b. The VAR is stable because all roots of det $\mathbf{A}(z)$ are smaller than one in absolute value.

c. The VAR is stable because the Var($\mathbf{e}_t$) is positive-definite.

d. There is not enough information to determine the stability of the realised VAR.

Representation A

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.1737 & 0.1064 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1119 & -0.0853 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0.0005 \\ 0.0005 & 0.0010 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0014 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.0064 & -0.0686 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1728 & -0.1315 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0 \\ 0 & 0.0006 \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ z_t \\ y_{t-1} \\ z_{t-1} \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \\ y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \\ 0 \\ 0 \end{pmatrix}.$$

$$\widetilde{\mathbf{A}}_1 = \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^2 = \begin{pmatrix} -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \\ -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \end{pmatrix},$$

$$\widetilde{\mathbf{A}}_1^3 = \begin{pmatrix} 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \\ -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^4 = \begin{pmatrix} 0.0073 & -0.0028 & -0.0061 & 0.0047 \\ -0.0224 & 0.0182 & -0.0019 & 0.0015 \\ 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \end{pmatrix},$$

$$\mathbf{B} = \begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}, \quad \mathbf{B}^{-1} = \begin{pmatrix} 1 & 0 \\ 0.9401 & 1 \end{pmatrix},$$

and

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{0.01, 0.02, 0.41\}.$$

The University Of Queensland Australia

2022 - Online Quiz 4

Suppose $\{y_t\}$ denotes the process generating the weekly AUD/USD exchange rates, and $\{z_t\}$ denotes the process generating the weekly AUD/GBP exchange rates. Let $\mathbf{x}_t = (y_t, z_t)'$ be a 2×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{x}_t\}$:

$$\mathbf{x}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \cdots + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim N(0, \boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\boldsymbol{\Sigma}(\mathbf{B}^{-1})'$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Question 4

Which ARDL equation is implied by the realised VAR model?

Answers:

a. $z_t = -0.0010 - 0.1737\ y_{t-1} + 0.1064\ z_{t-1} + 0.1119\ y_{t-2} - 0.0853\ z_{t-2} + e_{zt}$

b. $z_t = -0.0014 + 0.9401\ y_t - 0.0064\ y_{t-1} - 0.0686\ z_{t-1} + 0.1728\ y_{t-2} - 0.1315\ z_{t-2} + \varepsilon_{zt}$

c. Both (a) and (b).

d. None of the above.

Representation A

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.1737 & 0.1064 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1119 & -0.0853 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0.0005 \\ 0.0005 & 0.0010 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0014 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.0064 & -0.0686 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1728 & -0.1315 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix}, \quad \mathrm{Var}\begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0 \\ 0 & 0.0006 \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ z_t \\ y_{t-1} \\ z_{t-1} \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \\ y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \\ 0 \\ 0 \end{pmatrix}.$$

$$\widetilde{\mathbf{A}}_1 = \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^2 = \begin{pmatrix} -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \\ -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \end{pmatrix},$$

$$\widetilde{\mathbf{A}}_1^3 = \begin{pmatrix} 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \\ -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^4 = \begin{pmatrix} 0.0073 & -0.0028 & -0.0061 & 0.0047 \\ -0.0224 & 0.0182 & -0.0019 & 0.0015 \\ 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \end{pmatrix},$$

$$\mathbf{B} = \begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}, \quad \mathbf{B}^{-1} = \begin{pmatrix} 1 & 0 \\ 0.9401 & 1 \end{pmatrix},$$

and

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{0.01, 0.02, 0.41\}.$$

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

2022 - Online Quiz 4

Suppose $\{y_t\}$ denotes the process generating the weekly AUD/USD exchange rates, and $\{z_t\}$ denotes the process generating the weekly AUD/GBP exchange rates. Let $\mathbf{x}_t = (y_t, z_t)'$ be a 2×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{x}_t\}$:

$$\mathbf{x}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{x}_{t-1} + \cdots + \mathbf{A}_p\mathbf{x}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim N(0, \Omega), \quad \Omega = \mathbf{B}^{-1}\Sigma(\mathbf{B}^{-1})'$$

where Σ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Question 5

Consider the effect of an un-anticipated 10 cents increase in the AUD/GBP rate at time t. Assuming no other shocks occur at any horizon, what is the response of the AUD/USD rate one week ($t + 1$) after impact?

Answers:

a. The AUD/USD increases by 1.86 cents.

b. The AUD/USD increases by 3.59 cents.

c. The AUD/USD decreases by 0.94 cents.

d. None of the above.

Representation A

$$\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.1737 & 0.1064 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1119 & -0.0853 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix}, \quad \text{Var}\begin{pmatrix} e_{yt} \\ e_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0.0005 \\ 0.0005 & 0.0010 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}\begin{pmatrix} y_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0014 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 \\ -0.0064 & -0.0686 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.0648 & 0.0429 \\ 0.1728 & -0.1315 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix}, \quad \text{Var}\begin{pmatrix} \epsilon_{yt} \\ \epsilon_{zt} \end{pmatrix} = \begin{pmatrix} 0.0005 & 0 \\ 0 & 0.0006 \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ z_t \\ y_{t-1} \\ z_{t-1} \end{pmatrix} = \begin{pmatrix} 0.0005 \\ -0.0010 \\ 0 \\ 0 \end{pmatrix} + \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ z_{t-1} \\ y_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} e_{yt} \\ e_{zt} \\ 0 \\ 0 \end{pmatrix}.$$

$$\widetilde{\mathbf{A}}_1 = \begin{pmatrix} -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^2 = \begin{pmatrix} -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \\ -0.1780 & 0.1861 & -0.0648 & 0.0492 \\ -0.1737 & 0.1064 & 0.1119 & -0.0853 \end{pmatrix},$$

$$\widetilde{\mathbf{A}}_1^3 = \begin{pmatrix} 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \\ -0.0655 & 0.0359 & 0.0324 & -0.0246 \\ 0.1244 & -0.1063 & 0.0232 & -0.0176 \end{pmatrix}, \quad \widetilde{\mathbf{A}}_1^4 = \begin{pmatrix} 0.0073 & -0.0028 & -0.0061 & 0.0047 \\ -0.0224 & 0.0182 & -0.0019 & 0.0015 \\ 0.0378 & -0.0330 & 0.0083 & -0.0063 \\ 0.0195 & -0.0058 & -0.200 & 0.0152 \end{pmatrix},$$

$$\mathbf{B} = \begin{pmatrix} 1 & 0 \\ -0.9401 & 1 \end{pmatrix}, \quad \mathbf{B}^{-1} = \begin{pmatrix} 1 & 0 \\ 0.9401 & 1 \end{pmatrix},$$

and

$$\text{abs}(\text{eig}(\widetilde{\mathbf{A}}_1)) = \{0.01, 0.02, 0.41\}.$$

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

2022 - Online Quiz 5

Question 1

Suppose $\{y_t\}$ denotes the process generating the monthly 10 year bond rates, $\{x_t\}$ denotes the process generating the monthly 5 year bond rates, and $\{z_t\}$ denotes the process generating the monthly 2 year bond rates. Let $\mathbf{w}_t = (y_t, x_t, z_t)'$ be a 3×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{w}_t\}$:

$$\mathbf{w}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{w}_{t-1} + \cdots + \mathbf{A}_p\mathbf{w}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim N(0, \boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\boldsymbol{\Sigma}(\mathbf{B}^{-1})',$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Representation A

$$\begin{pmatrix} y_t \\ x_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.724 & 0.750 & -0.207 \\ -0.400 & 1.944 & -0.241 \\ -0.556 & 0.970 & 0.884 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} 0.243 & -0.702 & 0.192 \\ 0.375 & -0.865 & 0.184 \\ 0.487 & -0.769 & -0.022 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \hat{e}_{y,t} \\ \hat{e}_{x,t} \\ \hat{e}_{z,t} \end{pmatrix},$$

$$\widehat{\mathrm{Var}} \begin{pmatrix} e_{y,t} \\ e_{x,t} \\ e_{z,t} \end{pmatrix} = \begin{pmatrix} 0.0416 & 0.0404 & 0.0357 \\ 0.0404 & 0.0437 & 0.0422 \\ 0.0357 & 0.0422 & 0.0462 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} \Delta y_t \\ \Delta x_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} -0.033 & 0.048 \\ -0.024 & 0.079 \\ -0.069 & 0.201 \end{pmatrix} \begin{pmatrix} 1 & 0 & -1.108 \\ 0 & 1 & -1.061 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix}$$
$$+ \begin{pmatrix} -0.243 & 0.702 & -0.192 \\ -0.375 & 0.865 & -0.184 \\ -0.487 & 0.769 & 0.022 \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \\ \Delta z_{t-1} \end{pmatrix} + \begin{pmatrix} \hat{e}_{y,t} \\ \hat{e}_{x,t} \\ \hat{e}_{z,t} \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ x_t \\ z_t \\ y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} = \underbrace{\begin{pmatrix} 0.724 & 0.750 & -0.207 & 0.243 & -0.702 & 0.192 \\ -0.400 & 1.944 & -0.241 & 0.375 & -0.865 & 0.184 \\ -0.556 & 0.970 & 0.884 & 0.487 & -0.769 & -0.022 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix}}_{\widetilde{\mathbf{A}}_1} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \\ y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \hat{e}_{y,t} \\ \hat{e}_{x,t} \\ \hat{e}_{z,t} \\ 0 \\ 0 \\ 0 \end{pmatrix},$$

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{1.000, 0.938, 0.355, 0.272, 0.051\}.$$

Let $\mathbf{A}(L)$ be the polynomial matrix constructed from the coefficients of the reduced from VAR. Using the above information, what is the rank r of $\mathbf{A}(1)$?

Answers:

a. $r = 1$.

b. $r \geq 2$.

c. $r = 2$.

d. There is not enough information to determine the rank r.

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2022 - Online Quiz 5

Suppose $\{y_t\}$ denotes the process generating the monthly 10 year bond rates, $\{x_t\}$ denotes the process generating the monthly 5 year bond rates, and $\{z_t\}$ denotes the process generating the monthly 2 year bond rates. Let $\mathbf{w}_t = (y_t, x_t, z_t)'$ be a 3×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{w}_t\}$:

$$\mathbf{w}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{w}_{t-1} + \cdots + \mathbf{A}_p\mathbf{w}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0,\boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\boldsymbol{\Sigma}(\mathbf{B}^{-1})',$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Representation A

$$\begin{pmatrix} y_t \\ x_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.724 & 0.750 & -0.207 \\ -0.400 & 1.944 & -0.241 \\ -0.556 & 0.970 & 0.884 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} 0.243 & -0.702 & 0.192 \\ 0.375 & -0.865 & 0.184 \\ 0.487 & -0.769 & -0.022 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix},$$

$$\widehat{\mathrm{Var}} \begin{pmatrix} e_{y,t} \\ e_{x,t} \\ e_{z,t} \end{pmatrix} = \begin{pmatrix} 0.0416 & 0.0404 & 0.0357 \\ 0.0404 & 0.0437 & 0.0422 \\ 0.0357 & 0.0422 & 0.0462 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} \Delta y_t \\ \Delta x_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} -0.033 & 0.048 \\ -0.024 & 0.079 \\ -0.069 & 0.201 \end{pmatrix} \begin{pmatrix} 1 & 0 & -1.108 \\ 0 & 1 & -1.061 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.243 & 0.702 & -0.192 \\ -0.375 & 0.865 & -0.184 \\ -0.487 & 0.769 & 0.022 \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \\ \Delta z_{t-1} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ x_t \\ z_t \\ y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} = \underbrace{\begin{pmatrix} 0.724 & 0.750 & -0.207 & 0.243 & -0.702 & 0.192 \\ -0.400 & 1.944 & -0.241 & 0.375 & -0.865 & 0.184 \\ -0.556 & 0.970 & 0.884 & 0.487 & -0.769 & -0.022 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix}}_{\widetilde{\mathbf{A}}_1} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \\ y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \\ 0 \\ 0 \\ 0 \end{pmatrix},$$

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{1.000, 0.938, 0.355, 0.272, 0.051\}.$$

Question 2

According to the realisation of the VAR presented above, how many stochastic trends are present in the DGP for $\{\mathbf{w}_t\}$?

Answers:

a. There are no stochastic trends.

b. There is exactly one stochastic trend.

c. There are exactly two stochastic trends.

d. There is not enough information to determine the number of stochastic trends.

2022 - Online Quiz 5

Suppose $\{y_t\}$ denotes the process generating the monthly 10 year bond rates, $\{x_t\}$ denotes the process generating the monthly 5 year bond rates, and $\{z_t\}$ denotes the process generating the monthly 2 year bond rates. Let $\mathbf{w}_t = (y_t, x_t, z_t)'$ be a 3×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{w}_t\}$:

$$\mathbf{w}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{w}_{t-1} + \cdots + \mathbf{A}_p\mathbf{w}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0, \boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\boldsymbol{\Sigma}(\mathbf{B}^{-1})',$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Question 3

According to the realisation of the VAR presented above, how many cointegrating relations are present in the DGP for $\{\mathbf{w}_t\}$?

Answers:

a. There are no cointegrating relations.

b. There is exactly one cointegrating relation.

c. There are exactly two cointegrating relations.

d. There is not enough information to determine the number of cointegrating relations.

Representation A

$$\begin{pmatrix} y_t \\ x_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.724 & 0.750 & -0.207 \\ -0.400 & 1.944 & -0.241 \\ -0.556 & 0.970 & 0.884 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} 0.243 & -0.702 & 0.192 \\ 0.375 & -0.865 & 0.184 \\ 0.487 & -0.769 & -0.022 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix},$$

$$\widehat{\mathrm{Var}} \begin{pmatrix} e_{y,t} \\ e_{x,t} \\ e_{z,t} \end{pmatrix} = \begin{pmatrix} 0.0416 & 0.0404 & 0.0357 \\ 0.0404 & 0.0437 & 0.0422 \\ 0.0357 & 0.0422 & 0.0462 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} \Delta y_t \\ \Delta x_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} -0.033 & 0.048 \\ -0.024 & 0.079 \\ -0.069 & 0.201 \end{pmatrix} \begin{pmatrix} 1 & 0 & -1.108 \\ 0 & 1 & -1.061 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.243 & 0.702 & -0.192 \\ -0.375 & 0.865 & -0.184 \\ -0.487 & 0.769 & 0.022 \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \\ \Delta z_{t-1} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ x_t \\ z_t \\ y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} = \underbrace{\begin{pmatrix} 0.724 & 0.750 & -0.207 & 0.243 & -0.702 & 0.192 \\ -0.400 & 1.944 & -0.241 & 0.375 & -0.865 & 0.184 \\ -0.556 & 0.970 & 0.884 & 0.487 & -0.769 & -0.022 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix}}_{\widetilde{\mathbf{A}}_1} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \\ y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \\ 0 \\ 0 \\ 0 \end{pmatrix},$$

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{1.000, 0.938, 0.355, 0.272, 0.051\}.$$

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

2022 - Online Quiz 5

Suppose $\{y_t\}$ denotes the process generating the monthly 10 year bond rates, $\{x_t\}$ denotes the process generating the monthly 5 year bond rates, and $\{z_t\}$ denotes the process generating the monthly 2 year bond rates. Let $\mathbf{w}_t = (y_t, x_t, z_t)'$ be a 3×1 vector and consider the following vector autoregressive (VAR) model of $\{\mathbf{w}_t\}$:

$$\mathbf{w}_t = \mathbf{a}_0 + \mathbf{A}_1 \mathbf{w}_{t-1} + \cdots + \mathbf{A}_p \mathbf{w}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0, \boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\boldsymbol{\Sigma}(\mathbf{B}^{-1})',$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Representation A

$$\begin{pmatrix} y_t \\ x_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.724 & 0.750 & -0.207 \\ -0.400 & 1.944 & -0.241 \\ -0.556 & 0.970 & 0.884 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} 0.243 & -0.702 & 0.192 \\ 0.375 & -0.865 & 0.184 \\ 0.487 & -0.769 & -0.022 \end{pmatrix} \begin{pmatrix} y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix},$$

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Representation B

$$\begin{pmatrix} \Delta y_t \\ \Delta x_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} -0.033 & 0.048 \\ -0.024 & 0.079 \\ -0.069 & 0.201 \end{pmatrix} \begin{pmatrix} 1 & 0 & -1.108 \\ 0 & 1 & -1.061 \end{pmatrix} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.243 & 0.702 & -0.192 \\ -0.375 & 0.865 & -0.184 \\ -0.487 & 0.769 & 0.022 \end{pmatrix} \begin{pmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \\ \Delta z_{t-1} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ x_t \\ z_t \\ y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} = \underbrace{\begin{pmatrix} 0.724 & 0.750 & -0.207 & 0.243 & -0.702 & 0.192 \\ -0.400 & 1.944 & -0.241 & 0.375 & -0.865 & 0.184 \\ -0.556 & 0.970 & 0.884 & 0.487 & -0.769 & -0.022 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix}}_{\widetilde{\mathbf{A}}_1} \begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \\ y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \\ 0 \\ 0 \\ 0 \end{pmatrix},$$

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{1.000, 0.938, 0.355, 0.272, 0.051\}.$$

Question 4

Based on the realised VAR model presented above, which of the following is *not* true?

Answers:

a. The multivariate process $\{\mathbf{w}_t\}$ is stable.

b. At least one of the processes $\{y_t\}$, $\{x_t\}$ or $\{z_t\}$ is I(1).

c. The equilibrium error $u_{yz,t} = y_t - 1.108 z_t$ forms a stable process.

d. The equilibrium error $u_{xz,t} = x_t - 1.061 z_t$ forms a stable process.

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2022 - Online Quiz 5

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$$\mathbf{w}_t = \mathbf{a}_0 + \mathbf{A}_1\mathbf{w}_{t-1} + \cdots + \mathbf{A}_p\mathbf{w}_{t-p} + \mathbf{e}_t, \quad \mathbf{e}_t \sim \mathrm{N}(0,\boldsymbol{\Omega}), \quad \boldsymbol{\Omega} = \mathbf{B}^{-1}\boldsymbol{\Sigma}(\mathbf{B}^{-1})',$$

where $\boldsymbol{\Sigma}$ is a diagonal matrix with strictly positive diagonal elements. Consider the following realisation of the VAR above.

Question 5

According to the realisation of the VAR presented above, what is the speed of adjustment in y_{t+1} to a one unit rise in x_t above its equilibrium level relative to z_t, such that $u_{xz,t} = x_t - 1.061z_t = 1$?

Answers:

a. y_{t+1} decreases by 0.033.

b. y_{t+1} increases by 0.750.

c. y_{t+1} increases by 0.048.

d. None of the above.

Representation A

$$\begin{pmatrix} y_t \\ x_t \\ z_t \end{pmatrix} = \begin{pmatrix} 0.724 & 0.750 & -0.207 \\ -0.400 & 1.944 & -0.241 \\ -0.556 & 0.970 & 0.884 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} 0.243 & -0.702 & 0.192 \\ 0.375 & -0.865 & 0.184 \\ 0.487 & -0.769 & -0.022 \end{pmatrix}\begin{pmatrix} y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix},$$

$$\widehat{\mathrm{Var}}\begin{pmatrix} e_{y,t} \\ e_{x,t} \\ e_{z,t} \end{pmatrix} = \begin{pmatrix} 0.0416 & 0.0404 & 0.0357 \\ 0.0404 & 0.0437 & 0.0422 \\ 0.0357 & 0.0422 & 0.0462 \end{pmatrix};$$

Representation B

$$\begin{pmatrix} \Delta y_t \\ \Delta x_t \\ \Delta z_t \end{pmatrix} = \begin{pmatrix} -0.033 & 0.048 \\ -0.024 & 0.079 \\ -0.069 & 0.201 \end{pmatrix}\begin{pmatrix} 1 & 0 & -1.108 \\ 0 & 1 & -1.061 \end{pmatrix}\begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} + \begin{pmatrix} -0.243 & 0.702 & -0.192 \\ -0.375 & 0.865 & -0.184 \\ -0.487 & 0.769 & 0.022 \end{pmatrix}\begin{pmatrix} \Delta y_{t-1} \\ \Delta x_{t-1} \\ \Delta z_{t-1} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \end{pmatrix};$$

Representation C

$$\begin{pmatrix} y_t \\ x_t \\ z_t \\ y_{t-1} \\ x_{t-1} \\ z_{t-1} \end{pmatrix} = \underbrace{\begin{pmatrix} 0.724 & 0.750 & -0.207 & 0.243 & -0.702 & 0.192 \\ -0.400 & 1.944 & -0.241 & 0.375 & -0.865 & 0.184 \\ -0.556 & 0.970 & 0.884 & 0.487 & -0.769 & -0.022 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \end{pmatrix}}_{\widetilde{\mathbf{A}}_1}\begin{pmatrix} y_{t-1} \\ x_{t-1} \\ z_{t-1} \\ y_{t-2} \\ x_{t-2} \\ z_{t-2} \end{pmatrix} + \begin{pmatrix} \widehat{e}_{y,t} \\ \widehat{e}_{x,t} \\ \widehat{e}_{z,t} \\ 0 \\ 0 \\ 0 \end{pmatrix},$$

$$\mathrm{abs}(\mathrm{eig}(\widetilde{\mathbf{A}}_1)) = \{1.000, 0.938, 0.355, 0.272, 0.051\}.$$

Answers

Quiz 1 – 1 (b), 2 (d), 3 (b), 4 (b), 5 (a).
Quiz 2 – 1 (c), 2 (c), 3 (c), 4 (d), 5 (b).
Quiz 3 – 1 (b), 2 (a), 3 (c), 4 (c), 5 (d).
Quiz 4 – 1 (c), 2 (c), 3 (a), 4 (b), 5 (a).
Quiz 5 – 1 (c), 2 (b), 3 (d), 4 (a), 5 (c).

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Thank you

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Reference

Tsay, R. (2010). Analysis of Financial Time Series, 3rd Edition, John Wiley & Sons.