Stockholms universitet

OBS! Läs noga igenom anvisningarna i tentamen, t.ex. hur du ska skriva svaren. Det är ditt ansvar som student att följa de anvisningar som ges.

NOTE! Read the examination instructions carefully, e.g. how to write the answers. It is your responsibility as a student to follow the given instructions.

Skriv din anonymiseringskod och dagens datum på allt material du lämnar in.
(*Enter your anonymization code and todays date on all submitted materials*)

Anonymiseringskod (*Anonymization code*)	3	1	1	-	0	0	1	5	-	J	P	0

Datum (*Date* YYYY-MM-DD)	2022-01-13	Plats nr. (*Seat No.*)	21

Kurs/Kurskod (*Course/Course code*)	ST223G
Kursmoment (*Course component*)	

Fylls i av tentamensvärd (*To be filled in by invigilator*)

Direkt i skrivning: (kryss)		Svarsblankett: (kryss)		Lösa svarsblad: (antal)	6
Lämnat in blankt: (kryss)		Dator: (kryss)			

Inlämningstid: 12 : 14 Signatur tentamensvärd: [signature]

Fylls i av lärare/examinator (*To be filled in by teacher/examinator*)

Betyg:	B	Poäng:	78

Signatur rättande lärare/examinator: [signature]

Regler i skrivsalen

- Följ tentamensvärds anvisningar.
- Väskor och ytterkläder ska placeras på anvisad plats.
- Placera ID-handling väl synlig på bordet framför dig.
- Ingen student får lämna skrivsalen under de första 30 minuterna.
- Endast en student i taget får besöka toaletten. Vid toalettbesök skriv ditt namn och klockslag på avsedd lista. Efter toalettbesöket ska du åter ange klockslag på listan.
- Elektronisk utrustning som mobiltelefon eller Smartwatch ska vara avstängd och placerad på anvisad plats.
- Under tentamen gäller tystnad – det är förbjudet att prata, eller på annat sätt kommunicera, med andra studenter under pågående tentamen.
- Innan tentamenshandlingarna lämnas in; skriv sidnummer, anonymiseringskod och datum på alla inlämnade papper.

Om något är oklart – fråga gärna tentamensvärden. Lycka till!

Rules in the examination hall

- Follow the invigilator's instructions.
- Bags and outerwear must be placed at the designated place.
- Place your ID document clearly visible on the table in front of you.
- No student may leave the examination hall for the first 30 minutes.
- Only one student at a time may visit the toilet. Before visiting the toilet, write your name and time on the intended list. After the toilet visit, enter the time on the list again.
- Electronic equipment such as a mobile phone or Smartwatch must be switched off and placed at the designated place.
- During the exam, silence applies – you are not allowed to talk, or otherwise communicate, with other students during the exam.
- Before submitting the examination documents; remember to write the page number, anonymization code, and date on all papers.

Please do not hesitate to ask the invigilator if anything is unclear. Good luck!

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Datum: 2022-01-13
(Date YYYY-MM-DD)

Kurs/Kurskod: ST223G
(Course/Course code)

Sidnr.: (Page no.) 1

Anonymiseringskod (Anonymization code): 311-0015-JP0

Uppg.nr.: (Task no.) 1

Lärarens kommentar: (Teacher's note)

1. (b) an ARMA (3,2) R

2. (b) test if one time series has a causal (ceteris paribus) effect on another —

3. (c) independent of t —

4. (d) implies that adding more lagged values of either x or y will not improve the forecasting performance R

5. (c) Random effects should be used when the unobserved variable is uncorrelated with the observed variables. R

tot: 12/20

Poäng: (Points)

Tentamensservice/SU/typ_a

Uppg.nr.:
(*Task no.*)

Lärarens kommentar:
(*Teacher's note*)

Poäng:
(*Points*)

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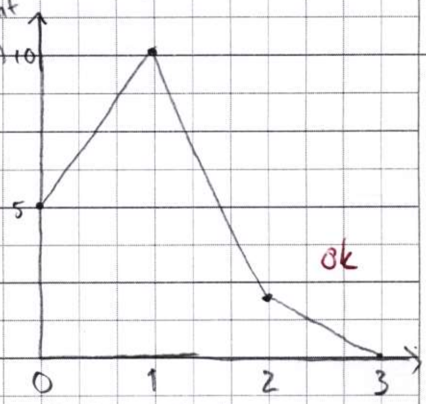
Uppg.nr.: (Task no.) 2

Lärarens kommentar: (Teacher's note)

a) $y_t = \beta_0 + \beta_1 x_t + \beta_2 x_{t-1} + \beta_3 x_{t-2} + u_t$ is a finite distributed lag model (FDL) 3

x_t measured in thousands ~~1000-tals spel~~



b) 1st year: $\hat{Y}_1 = 10 + 5 \cdot 1000 + 10 \cdot 0 + 2 \cdot 0 = 5010$

$\hat{Y}_2 = 10 + 5 \cdot 0 + 10 \cdot 1000 + 2 \cdot 0 = 10010$

$\hat{Y}_3 = 10 + 5 \cdot 0 + 10 \cdot 0 + 2 \cdot 1000 = 2010$

$\hat{Y}_4 = 10 + 5 \cdot 0 + 10 \cdot 0 + 2 \cdot 0 = 10$

ok

After 3 lags the shock will disappear and have no further effect 3

c) $y_t = \beta_0 + \beta_1 (c+1) + \beta_2 c + \beta_3 c$

$Y_{t+1} = \beta_0 + \beta_1 (c+1) + \beta_2 (c+1) + \beta_3 c$

$Y_{t+2} = \beta_0 + \beta_1 (c+1) + \beta_2 (c+1) + \beta_3 (c+1)$ Giving $LRP = \beta_1 + \beta_2 + \beta_3 = 5 + 10 + 2 = 17$ ok

So over time the amount of games would have increased with $17 \cdot 1000 = 17000$ games 4

x_t measured in thousands

d) $LRP = \beta_1 + \beta_2 + \beta_3$ hur testa?

e) TS 1: linear in all parameters

TS 2: No perfect collinearity

TS 3: Zero conditional mean

TS 4: Homoskedastisticity

TS 5: No serial correlation 4

TS 6: Normality most important to be able to use t-statistics

other assumptions are at least as important.

tot: 14/20

Poäng: (Points)

Uppg.nr.:
(*Task no.*)

Lärarens kommentar:
(*Teacher's note*)

Poäng:
(*Points*)

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Stockholms universitet

Uppg.nr.: (Task no.) 3

Lärarens kommentar: (Teacher's note)

a) Weak stationarity occurs when $E(X_t^2) < \infty$ and is covariance stationary if $E(X_t)$ is constant, $Var(X_t)$ is constant, for any $t, h \geq 1$, $cov(X_t, X_{t+h})$ depends only on h and not on t

Autocorrelation is when there is correlation between the errors in different time periods

Not necessarily errors just observations

White noise occurs when a time series consists of uncorrelated observations and has constant variance. ok

4

b) 1. $Y_t = \alpha + Y_{t-1} + e_t$ or $(1-B)Y_t = \varepsilon_t + \alpha$ ok

2. $Y_t = \delta + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} + \phi_3 Y_{t-3} + \theta_1 \varepsilon_{t-1} + \varepsilon_t$

or $(1 - \phi_1 B - \phi_2 B^2 - \phi_3 B^3) Y_t = \delta + \varepsilon_t(1 + \theta_1 B)$ ok

3. $y_t = \delta + \phi_1 y_{t-1} + \varepsilon_t + \theta_1 \varepsilon_{t-1}$ or $\phi(B)(1-\phi_1 B)' Y_t = \delta + \varepsilon_t(1 + \theta_1 B)$

not the same

4

c) 1. Is a ARIMA(0,0,1) also MA(1) which is always stationary and is invertible since $|\theta_1| < 1$ $\theta_1 = 0.8$ ok

2. Is a ARIMA(~~1~~ 0,1,0) and is not stationary hence I(1) although since it is a AR(1) when differenced it is invertible

due to $|\phi_1| < 1$ is not correct $\phi_1 = 1$

stationary

even if not differenced

3. It is not stationary, it is a AR(2) when differenced and then invertible. However I'm unsure how many times it need to be differenced but 1 seems good if so it is a ARIMA(2,1,0)

4

even if not differenced

$\phi_1 + \phi_2 < 1$ not accurate $0.6 + 0.5 = 1.1 > 1$ not stationary

Poäng: (Points) 12/15

Tentamensservice/SU/typ_a

Uppg.nr.:
(*Task no.*)

Lärarens kommentar:
(*Teacher's note*)

Poäng:
(*Points*)

Stockholms universitet	Datum: 2022-01-13 (*Date YYYY-MM-DD*)	Kurs/Kurskod: ST223G (*Course/Course code*)	Sidnr.: (*Page no.*) 4
	Anonymiseringskod (*Anonymization code*)	311-001.5-JPO	

Uppg.nr.: (*Task no.*) 4

1. $\phi_1 = 1.2$ $\phi_2 = -0.4$ For stationarity: $\phi_1 + \phi_2 < 1 = 0.8 < 1$

$\phi_2 - \phi_1 < 1 = -1.6 < 1$

$|\phi_2| < 1 = 0.4 < 1$

y_t is stationary 5

2. $E[y_t] = \mu = \frac{\delta}{1-\phi_1-\phi_2}$ for stationary processes $= \frac{4}{1-1.2+0.4} = \frac{4}{0.2} = 20$ 5

3. $\rho_Y(1) = \frac{Cov(Y_t, Y_{t-1})}{Var(Y_t)}$ or Var(Y_t) is calculated by Yule Walker equations

$Var(Y_t) = \frac{(1-\phi_2)\sigma_e^2}{(1+\phi_2)(1-\phi_1-\phi_2)(1+\phi_1-\phi_2)}$

$Cov(Y_t, Y_{t-1}) = Cov(\phi_1 Y_{t-1} - \phi_2 Y_{t-2}, \phi_1 Y_{t-2} - \phi_2 Y_{t-3})$

$Var(Y_t) = \frac{2.8}{0.312} \approx 8{,}974...$

$-Cov(\phi_2 Y_{t-2}, \phi_1 Y_{t-2}) = -\phi_1\phi_2 Cov(Y_{t-2}, Y_{t-2})$

$Cov(Y_t, Y_{t-2}) = Cov(Y_t, Y_{t-2}) - Cov(Y_t, Y_{t-3}) - Cov(Y_{t-1}, Y_{t-2}) + Cov(Y_{t-1}, Y_{t-3})$

every pair have different indices therefore $\underbrace{Cov(Y_t, Y_{t-2}) = 0}_{\text{this is not correct}}$

$Cov(Y_{t-2}, Y_{t-2}) = Var(Y_{t-2})$ stationaritet ger $\rightarrow Var(Y_{t-2}) = Y_t$ 1

no $\rho_Y(1) = -(\phi_1 \cdot \phi_2) = 1{,}2 \cdot 0.4 = 0{,}48$

$\rho_Y(2) = \frac{Cov(Y_t, Y_{t-2})}{Var(Y_t)} \neq \frac{0}{Var(Y_t)} = 0$

Answer: $\rho_Y(1) = 0{,}48$ $\rho_Y(2) = 0$

4. $\hat{Y}_{100} = 4 + 1.2Y_{99} - 0{,}4Y_{98} = 15{,}2$

$\hat{Y}_{101} = 4 + 1{,}2\hat{Y}_{100} - 0{,}4Y_{99} = 15{,}44$ 5

$\hat{Y}_{102} = 4 + 1{,}2\hat{Y}_{101} - 0{,}4\hat{Y}_{100} = 16{,}448$

Lärarens kommentar: (*Teacher's note*)

Poäng: (*Points*) 16/20

Uppg.nr.:
(*Task no.*)

Lärarens kommentar:
(*Teacher's note*)

Poäng:
(*Points*)

Stockholms universitet

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Uppg.nr.: (Task no.) 5

Lärarens kommentar: (Teacher's note)

$\lambda = 0{,}2$ $\quad Y_0 = 3$ $\quad$ simple exponential smoothing: $\tilde{y}_t = \lambda y_T + (1-\lambda)\tilde{y}_{T-1}$

a)

double exponential smoothing: $\tilde{y}_t^{(2)} = \lambda \tilde{y}_t^{(1)} + (1-\lambda)\tilde{y}_{T-1}^{(2)}$

t	Y_t	$\tilde{y}_t^{(1)}$	$\tilde{y}_t^{(2)}$	$\tilde{y}_t$
2003	3	3	3	3
2004	16	5,6	3,52	7,68
2005	7	5,88	3,992	7,768
2006	15	7,704	4,7344	10,6736
2007	17	9,5632	5,70016	13,42624
2008	25	12,65056	7,09024	18,21088

$\tilde{y}_3 = 0{,}2\cdot 3 + 0{,}8\cdot 3 = 3$
$\tilde{y}_4 = 0{,}2\cdot 16 + 0{,}8\cdot 3 = 5{,}6$
$\vdots$

$\tilde{y}_3^{(2)} = 0{,}2\cdot 3 + 0{,}8\cdot 3 = 3$
$\tilde{y}_4^{(2)} = 0{,}2\cdot 5{,}6 + 0{,}8\cdot 3 = 3{,}52$

good! 6

Need to clear out the Bias by $\tilde{y}_t = 2\tilde{y}_t^{(1)} - \tilde{y}_t^{(2)}$ $\quad$ double exponential smoothing = $\tilde{y}_t$ (des)

b) Of the two methods I think that double exponential smoothing is more suitable since there is a clear trend and des takes the trend more into account when smoothing an extra time. and taking away bias

Simple exponential smoothing (SES) is more suitable when there is no trend

4

c) Forecast for simple exponential smoothing is constant $Y_T = \mu + \varepsilon_T$ last smoothed value

	SES	DES	Y_t
2009	12,65	19,4998	16
2010	12,65	20,99104	14
2011	12,65	22,38112	28
2012	12,65	23,7712	30

~~mindre räknefel.~~
small calculation error

DES: $\hat{y}_{T+\tau}(\tau) = \left(2 + \frac{\lambda}{1-\lambda}\tau\right)\tilde{y}_T^{(1)} - \left(1 + \frac{\lambda}{1-\lambda}\tau\right)\tilde{y}_T^{(2)}$

Ex: $\hat{y}_{2009}(1) = 2{,}25\cdot\tilde{y}_{2008}^{(1)} - 1{,}25\cdot\tilde{y}_{2008}^{(2)}$
$\hat{y}_{2010}(2) = 2{,}5\cdot\tilde{y}_{2008}^{(1)} - 1{,}5\cdot\tilde{y}_{2008}^{(2)}$

5

d) $ME = \frac{1}{n}\sum_{t=1}^{n}(Y_t - \tilde{y}_t)$

SES: $ME = \frac{1}{4}\sum_{t=1}^{4}(Y_t - 12{,}65056) = \frac{37{,}39776}{4} = 9{,}34944$ ok

DES: $ME = \frac{1}{4}\sum_{t=1}^{4}(Y_t - \hat{Y}_t) = \frac{1{,}35684}{4} = 0{,}33921$ ok

This was expected since in DES forecast we overestimate the first two years which gave us negative errors that's why ME is so close to zero and why SES is much larger since we always underestimated every year.

5

Poäng: (Points)

Uppg.nr.:
(*Task no.*)

Lärarens kommentar:
(*Teacher's note*)

Poäng:
(*Points*)

Stockholms universitet

Datum: 2022-01-13 (Date YYYY-MM-DD) | Kurs/Kurskod: ST223G (Course/Course code) | Sidnr.: (Page no.) 6

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Uppgg.nr.: (Task no.) 5

e) $MAE = \frac{1}{n}\sum_{t=1}^{n}|e_t|$ $RMSE = \sqrt{\frac{1}{\tau}\sum_{i=1}^{\tau}(y_{T+i} - \hat{y}_{t+i}(T))^2}$

	MAE	RMSE
SES	9,34944	13,1191...
DES	5,58463	5,7335...

Small errors due to (c)

4

Answer: The double exponential smoother is more accurate since the MAE and RMSE are both smaller than for simple exponential smoother

Lärarens kommentar: (Teacher's note)

Poäng: (Points) 24/25

Uppg.nr.:
(*Task no.*)

Lärarens kommentar:
(*Teacher's note*)

Poäng:
(*Points*)