Forecast reconciliation: Methodological issues and applications

Chapter 3 - Forecast combination-based forecast reconciliation: Insights and extensions[1]

Online appendix

Candidate: Daniele Girolimetto
Supervisors: Prof. Tommaso Di Fonzo, Prof. George Athanasopoulos and Prof. Rob J Hyndman

Contents

[1]Di Fonzo, T. and Girolimetto, D. (2022c) Forecast combination-based forecast rec- onciliation: Insights and extensions. International Journal of Forecasting doi:10.1016j.ijforecast.2022.07.001

A The Australian Tourism Demand (Visitor Nights) dataset

Table A.1: *Geographic divisions of Australia. The zones with a single region are written in italic font.*

Level Series	Name	Label
L1: *Total*		
1	Australia	Total
L2: *States*		
2	New South Wales (NSW)	A
3	Victoria (VIC)	B
4	Queensland (QLD)	C
5	South Australia (SA)	D
6	Western Australia (WA)	E
7	Tasmania (TAS)	F
8	Northern Territory (NT)	G
L3: *Zones*		
9	Metro NSW	AA
10	Nth Coast NSW	AB
	Sth Coast NSW	*AC*
11	Sth NSW	AD
12	Nth NSW	AE
	Australian Capital Territory	*AF*
13	Metro VIC	BA
	West Coast VIC	*BB*
14	East Coast VIC	BC
15	Nth East VIC	BD
16	Nth West VIC	BE
17	Metro QLD	CA
18	Central Coast QLD	CB
19	Nth Coast QLD	CC
20	Inland QLD	CD
21	Metro SA	DA
22	Sth Coast SA	DB
23	Inland SA	DC
24	West Coast SA	DD
25	West CoastWA	EA
	Nth WA	*EB*
	SthWA	*EC*
	Sth TAS	*FA*
26	Nth East TAS	FB
27	Nth West TAS	FC
28	Nth Coast NT	GA
29	Central NT	GB
L4: *Regions*		
30	Sydney	AAA
31	Central Coast	AAB
32	Hunter	ABA
33	North Coast NSW	ABB
34	South Coast	ACA
35	Snowy Mountains	ADA
36	Capital Country	ADB
37	The Murray	ADC
38	Riverina	ADD
39	Central NSW	AEA
40	New England North West	AEB
41	Outback NSW	AEC
42	Blue Mountains	AED
43	Canberra	AFA
44	Melbourne	BAA
45	Peninsula	BAB
46	Geelong	BAC
47	Western	BBA
48	Lakes	BCA
Continued L4: *Regions*		
49	Gippsland	BCB
50	Phillip Island	BCC
51	Central Murray	BDA
52	Goulburn	BDB
53	High Country	BDC
54	Melbourne East	BDD
55	Upper Yarra	BDE
56	MurrayEast	BDF
57	Mallee	BEA
58	Wimmera	BEB
59	Western Grampians	BEC
60	Bendigo Loddon	BED
61	Macedon	BEE
62	Spa Country	BEF
63	Ballarat	BEG
64	Central Highlands	BEG
65	Gold Coast	CAA
66	Brisbane	CAB
67	Sunshine Coast	CAC
68	Central Queensland	CBA
69	Bundaberg	CBB
70	Fraser Coast	CBC
71	Mackay	CBD
72	Whitsundays	CCA
73	Northern	CCB
74	Tropical North Queensland	CCC
75	Darling Downs	CDA
76	Outback	CDB
77	Adelaide	DAA
78	Barossa	DAB
79	Adelaide Hills	DAC
80	Limestone Coast	DBA
81	Fleurieu Peninsula	DBB
82	Kangaroo Island	DBC
83	Murraylands	DCA
84	Riverland	DCB
85	Clare Valley	DCC
86	Flinders Range and Outback	DCD
87	Eyre Peninsula	DDA
88	Yorke Peninsula	DDB
89	Australia's Coral Coast	EAA
90	Experience Perth	EAB
91	Australia's SouthWest	EAC
92	Australia's North West	EBA
93	Australia's Golden Outback	ECA
94	Hobart and the South	FAA
95	East Coast	FBA
96	Launceston, Tamar and the North	FBB
97	North West	FCA
98	WildernessWest	FCB
99	Darwin	GAA
100	Kakadu Arnhem	GAB
101	Katherine Daly	GAC
102	Barkly	GBA
103	Lasseter	GBB
104	Alice Springs	GBC
105	MacDonnell	GBD

Source: Wickramasuriya et al. (2019)

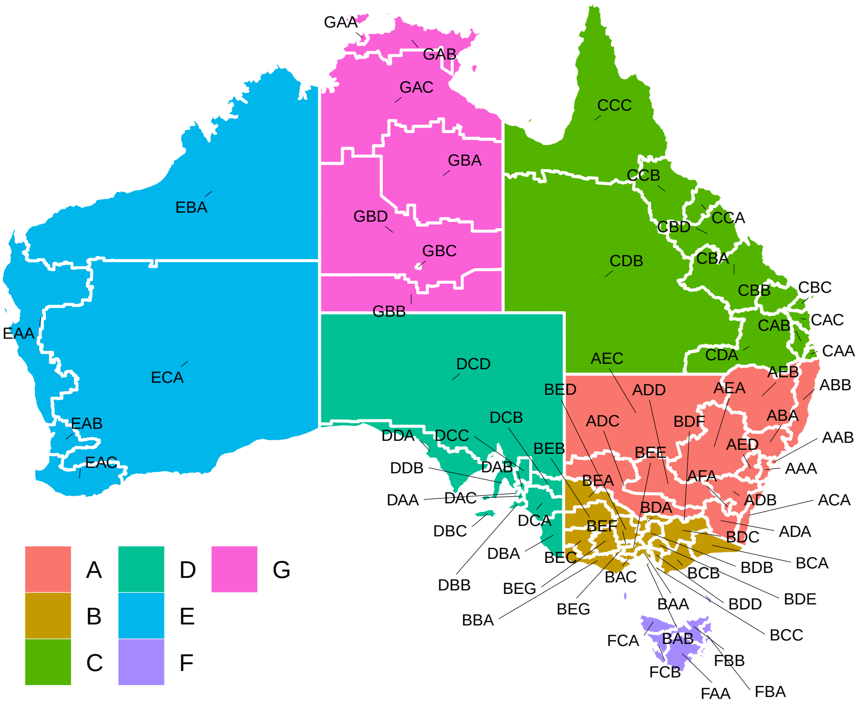


Figure A.1: *Map of Australia by Regions*

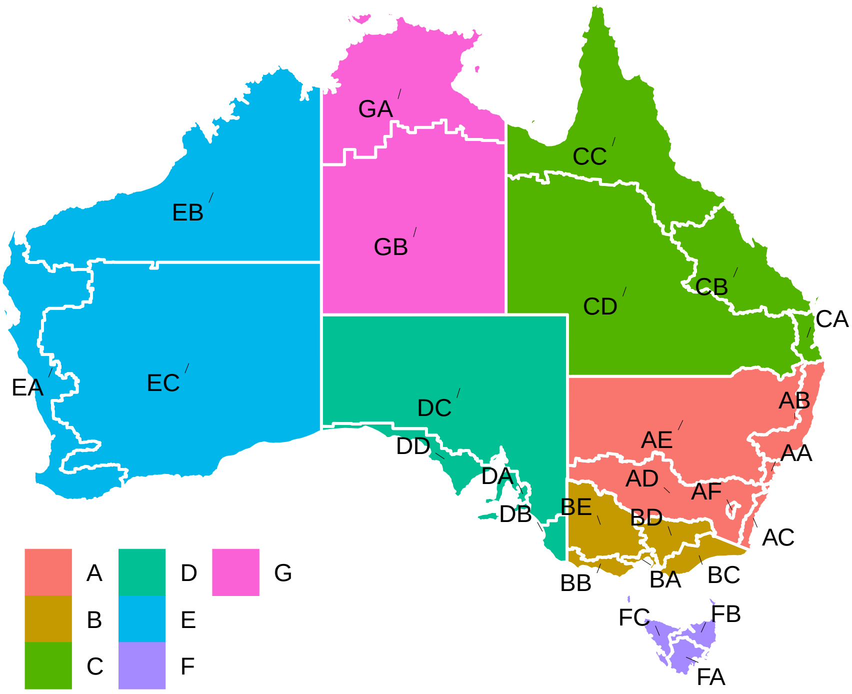


Figure A.2: *Map of Australia by States and Zones*

Table A.2: *Series' name and id in the VN525 dataset. The duplicated series are written in italic font.*

id	Series	id	Series	id	Series	id	Series	id	Series
Level 1		104	GBC	202	EAHol	302	BCCHol	415	DABVis
1	Total	105	GBD	203	EAVis	303	BCCVis	416	DABBus
Level 2		*Level 5*		204	EABus	304	BCCBus	417	DABOth
2	A	106	Hol	205	EAOth	305	BCCOth	418	DACHol
3	B	107	Vis		*EBHol*	306	BDAHol	419	DACVis
4	C	108	Bus		*EBVis*	307	BDAVis	420	DACBus
5	D	109	Oth		*EBBus*	308	BDABus	421	DACOth
6	E	*Level 6*			*EBOth*	309	BDAOth	422	DBAHol
7	F	110	AHol		*ECHol*	310	BDBHol	423	DBAVis
8	G	111	AVis		*ECVis*	311	BDBVis	424	DBABus
Level 3		112	ABus		ECBus	312	BDBBus	425	DBAOth
9	AA	113	AOth		*ECOth*	313	BDBOth	426	DBBHol
10	AB	114	BHol		*FAHol*	314	BDCHol	427	DBBVis
	AC	115	BVis		*FAVis*	315	BDCVis	428	DBBBus
11	AD	116	BBus		*FABus*	316	BDCBus	429	DBBOth
12	AE	117	BOth		*FAOth*	317	BDCOth	430	DBCHol
	AF	118	CHol	206	FBHol	318	BDDHol	431	DBCVis
13	BA	119	CVis	207	FBVis	319	BDDVis	432	DBCBus
	BB	120	CBus	208	FBBus	320	BDDBus	433	DBCOth
14	BC	121	COth	209	FBOth	321	BDDOth	434	DCAHol
15	BD	122	DHol	210	FCHol	322	BDEHol	435	DCAVis
16	BE	123	DVis	211	FCVis	323	BDEVis	436	DCABus
17	CA	124	DBus	212	FCBus	324	BDEBus	437	DCAOth
18	CB	125	DOth	213	FCOth	325	BDEOth	438	DCBHol
19	CC	126	EHol	214	GAHol	326	BDFHol	439	DCBVis
20	CD	127	EVis	215	GAVis	327	BDFVis	440	DCBBus
21	DA	128	EBus	216	GABus	328	BDFBus	441	DCBOth
22	DB	129	EOth	217	GAOth	329	BDFOth	442	DCCHol
23	DC	130	FHol	218	GBHol	330	BEAHol	443	DCCVis
24	DD	131	FVis	219	GBVis	331	BEAVis	444	DCCBus
25	EA	132	FBus	220	GBBus	332	BEABus	445	DCCOth
	EB	133	FOth	221	GBOth	333	BEAOth	446	DCDHol
	EC	134	GHol	222	AAAHol	334	BEBHol	447	DCDVis
	FA	135	GVis	223	AAAVis	335	BEBVis	448	DCDBus
26	FB	136	GBus	*Level 8*		336	BEBBus	449	DCDOth
27	FC	137	GOth	224	AAABus	337	BEBOth	450	DDAHol
28	GA	*Level 7*		225	AAAOth	338	BECHol	451	DDAVis
29	GB	138	AAHol	226	AABHol	339	BECVis	452	DDABus
Level 4		139	AAVis	227	AABVis	340	BECBus	453	DDAOth
30	AAA	140	AABus	228	AABBus	341	BECOth	454	DDBHol
31	AAB	141	AAOth	229	AABOth	342	BEDHol	455	DDBVis
32	ABA	142	ABHol	230	ABAHol	343	BEDVis	456	DDBBus
33	ABB	143	ABVis	231	ABAVis	344	BEDBus	457	DDBOth

Table A.2: *Series' name and id in the VN525 dataset VN525 (continued)*

id	Series	id	Series	id	Series	id	Series	id	Series
34	ACA	144	ABBus	232	ABABus	345	BEDOth	458	EAAHol
35	ADA	145	ABOth	233	ABAOth	346	BEEHol	459	EAAVis
36	ADB		*ACHol*	234	ABBHol	347	BEEVis	460	EAABus
37	ADC		*ACVis*	235	ABBVis	348	BEEBus	461	EAAOth
38	ADD		*ACBus*	236	ABBBus	349	BEEOth	462	EABHol
39	AEA		*ACOth*	237	ABBOth	350	BEFHol	463	EABVis
40	AEB	146	ADHol	238	ACAHol	351	BEFVis	464	EABBus
41	AEC	147	ADVis	239	ACAVis	352	BEFBus	465	EABOth
42	AED	148	ADBus	240	ACABus	353	BEFOth	466	EACHol
43	AFA	149	ADOth	241	ACAOth	354	BEGHol	467	EACVis
44	BAA	150	AEHol	242	ADAHol	355	BEGVis	468	EACBus
45	BAB	151	AEVis	243	ADAVis	356	BEGBus	469	EACOth
46	BAC	152	AEBus	244	ADABus	357	BEGOth	470	EBAHol
47	BBA	153	AEOth	245	ADAOth	358	BEHHol	471	EBAVis
48	BCA		*AFHol*	246	ADBHol	359	BEHVis	472	EBABus
49	BCB		*AFVis*	247	ADBVis	360	BEHBus	473	EBAOth
50	BCC		*AFBus*	248	ADBBus	361	BEHOth	474	ECAHol
51	BDA		*AFOth*	249	ADBOth	362	CAAHol	475	ECAVis
52	BDB	154	BAHol	250	ADCHol	363	CAAVis	476	ECABus
53	BDC	155	BAVis	251	ADCVis	364	CAABus	477	ECAOth
54	BDD	156	BABus	252	ADCBus	365	CAAOth	478	FAAHol
55	BDE	157	BAOth	253	ADCOth	366	CABHol	479	FAAVis
56	BDF		*BBHol*	254	ADDHol	367	CABVis	480	FAABus
57	BEA		*BBVis*	255	ADDVis	368	CABBus	481	FAAOth
58	BEB		*BBBus*	256	ADDBus	369	CABOth	482	FBAHol
59	BEC		*BBOth*	257	ADDOth	370	CACHol	483	FBAVis
60	BED	158	BCHol	258	AEAHol	371	CACVis	484	FBABus
61	BEE	159	BCVis	259	AEAVis	372	CACBus	485	FBAOth
62	BEF	160	BCBus	260	AEABus	373	CACOth	486	FBBHol
63	BEG	161	BCOth	261	AEAOth	374	CBAHol	487	FBBVis
64	BEH	162	BDHol	262	AEBHol	375	CBAVis	488	FBBBus
65	CAA	163	BDVis	263	AEBVis	376	CBABus	489	FBBOth
66	CAB	164	BDBus	264	AEBBus	377	CBAOth	490	FCAHol
67	CAC	165	BDOth	265	AEBOth	378	CBBHol	491	FCAVis
68	CBA	166	BEHol	266	AECHol	379	CBBVis	492	FCABus
69	CBB	167	BEVis	267	AECVis	380	CBBBus	493	FCAOth
70	CBC	168	BEBus	268	AECBus	381	CBBOth	494	FCBHol
71	CBD	169	BEOth	269	AECOth	382	CBCHol	495	FCBVis
72	CCA	170	CAHol	270	AEDHol	383	CBCVis	496	FCBBus
73	CCB	171	CAVis	271	AEDVis	384	CBCBus	497	FCBOth
74	CCC	172	CABus	272	AEDBus	385	CBCOth	498	GAAHol
75	CDA	173	CAOth	273	AEDOth	386	CBDHol	499	GAAVis
76	CDB	174	CBHol	274	AFAHol	387	CBDVis	500	GAABus

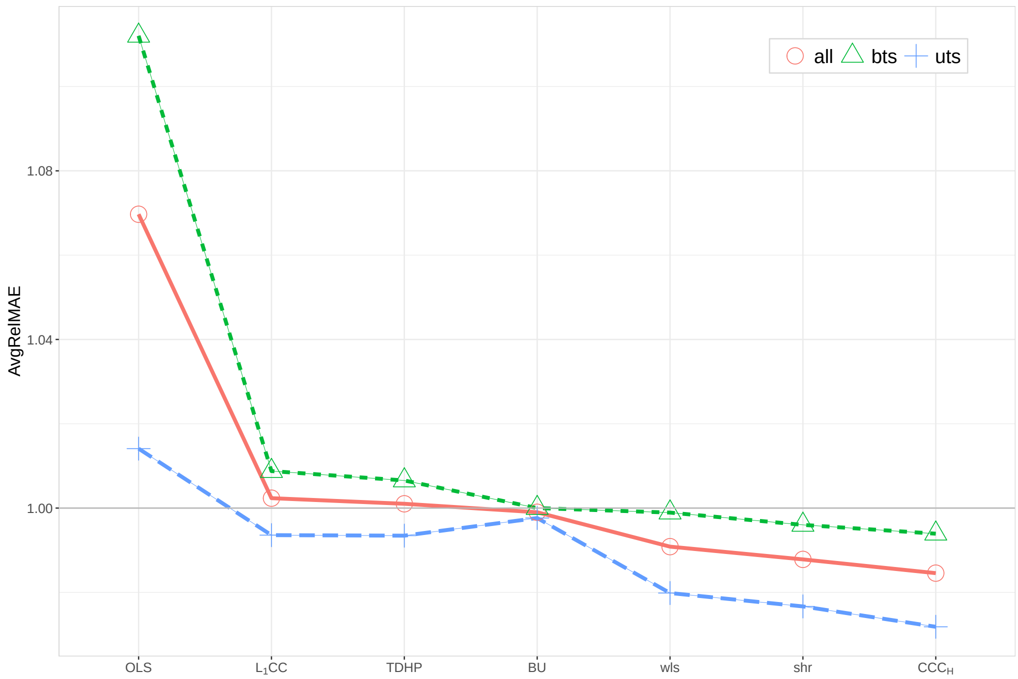
Table A.2: *Series' name and id in the VN525 dataset VN525 (continued)*

id	Series	id	Series	id	Series	id	Series	id	Series
77	DAA	175	CBVis	275	AFAVis	388	CBDBus	501	GAAOth
78	DAB	176	CBBus	276	AFABus	389	CBDOth	502	GABHol
79	DAC	177	CBOth	277	AFAOth	390	CCAHol	503	GABVis
80	DBA	178	CCHol	278	BAAHol	391	CCAVis	504	GABBus
81	DBB	179	CCVis	279	BAAVis	392	CCABus	505	GABOth
82	DBC	180	CCBus	280	BAABus	393	CCAOth	506	GACHol
83	DCA	181	CCOth	281	BAAOth	394	CCBHol	507	GACVis
84	DCB	182	CDHol	282	BABHol	395	CCBVis	508	GACBus
85	DCC	183	CDVis	283	BABVis	396	CCBBus	509	GACOth
86	DCD	184	CDBus	284	BABBus	397	CCBOth	510	GBAHol
87	DDA	185	CDOth	285	BABOth	398	CCCHol	511	GBAVis
88	DDB	186	DAHol	286	BACHol	399	CCCVis	512	GBABus
89	EAA	187	DAVis	287	BACVis	400	CCCBus	513	GBAOth
90	EAB	188	DABus	288	BACBus	401	CCCOth	514	GBBHol
91	EAC	189	DAOth	289	BACOth	402	CDAHol	515	GBBVis
92	EBA	190	DBHol	290	BBAHol	403	CDAVis	516	GBBBus
93	ECA	191	DBVis	291	BBAVis	404	CDABus	517	GBBOth
94	FAA	192	DBBus	292	BBABus	405	CDAOth	518	GBCHol
95	FBA	193	DBOth	293	BBAOth	406	CDBHol	519	GBCVis
96	FBB	194	DCHol	294	BCAHol	407	CDBVis	520	GBCBus
97	FCA	195	DCVis	295	BCAVis	408	CDBBus	521	GBCOth
98	FCB	196	DCBus	296	BCABus	409	CDBOth	522	GBDHol
99	GAA	197	DCOth	297	BCAOth	410	DAAHol	523	GBDVis
100	GAB	198	DDHol	298	BCBHol	411	DAAVis	524	GBDBus
101	GAC	199	DDVis	299	BCBVis	412	DAABus	525	GBDOth
102	GBA	200	DDBus	300	BCBBus	413	DAAOth		
103	GBB	201	DDOth	301	BCBOth	414	DABHol		

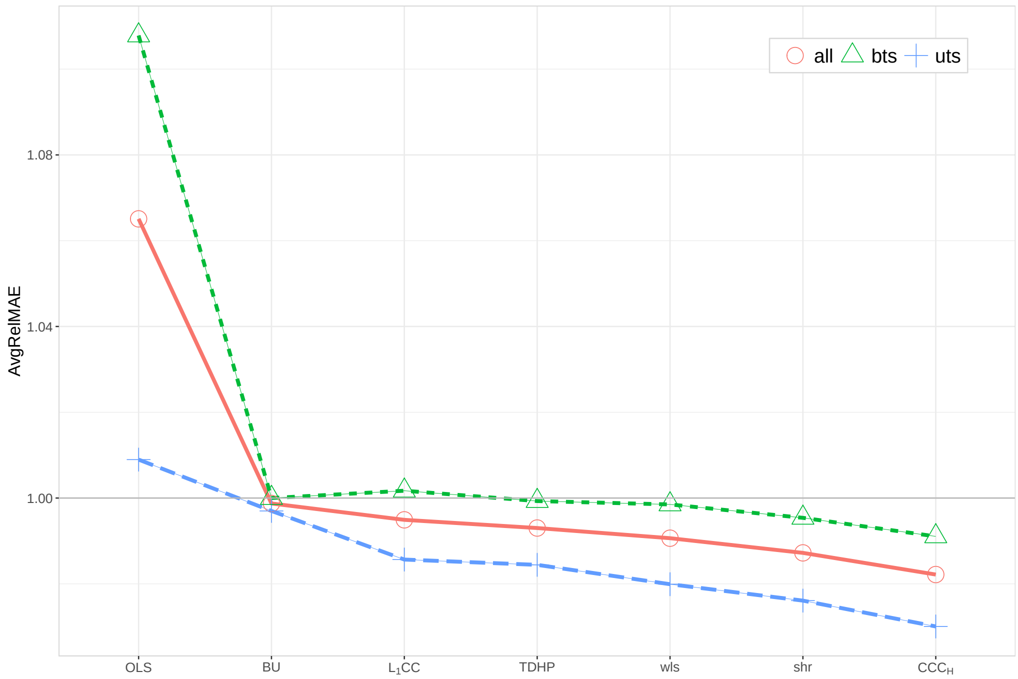
B Forecasting accuracy of the reconciliation approaches considered by Hollyman et al. (2021)

Table B.3: *Monthly forecasts reconciliation in the forecasting experiment on the Australian tourism dataset: **AvgRelMAE** of the approaches considered by Hollyman et al. (2021). Approach TDHP apart, some reconciled forecasts are negative (see Tables 4 and 5 in the main paper). Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Forecast horizon						
Approach	1	2	3	6	12	1:6	1:12
			all (525 series)				
BU	0.9990	0.9971	0.9973	0.9991	0.9998	0.9982	0.9987
L_1CC	1.0024	1.0006	0.9994	0.9967	0.9865	0.9988	0.9949
TDHP	1.0010	0.9995	0.9984	0.9951	0.9837	0.9975	0.9930
OLS	1.0697	1.0660	1.0685	1.0644	1.0630	1.0673	1.0651
wls	0.9909	0.9903	0.9901	0.9903	0.9908	0.9904	0.9906
shr	0.9878	0.9875	0.9872	0.9870	0.9869	0.9874	0.9872
CCC_H	**0.9846**	**0.9844**	**0.9835**	**0.9824**	**0.9796**	**0.9832**	**0.9822**
			upper time series (221 series)				
BU	0.9976	0.9931	0.9935	0.9978	0.9994	0.9956	0.9970
L_1CC	0.9936	0.9913	0.9906	0.9886	0.9762	0.9899	0.9857
TDHP	0.9935	0.9910	0.9906	0.9878	0.9737	0.9895	0.9844
OLS	1.0141	1.0093	1.0115	1.0081	1.0074	1.0104	1.0090
wls	0.9798	0.9780	0.9783	0.9795	0.9824	0.9789	0.9799
shr	0.9767	0.9751	0.9751	0.9758	0.9780	0.9757	0.9761
CCC_H	**0.9718**	**0.9707**	**0.9701**	**0.9707**	**0.9695**	**0.9703**	**0.9701**
			bottom time series (304 series)				
BU	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
L_1CC	1.0088	1.0074	1.0058	1.0027	0.9941	1.0053	1.0017
TDHP	1.0065	1.0057	1.0041	1.0005	0.9910	1.0034	0.9993
OLS	1.1120	1.1092	1.1120	1.073	1.1053	1.1107	1.1079
wls	0.9989	0.9993	0.9987	0.9982	0.9969	0.9988	0.9985
shr	0.9960	0.9966	0.9960	0.9953	0.9934	0.9959	0.9954
CCC_H	**0.9939**	**0.9944**	**0.9933**	**0.9911**	**0.9871**	**0.9928**	**0.9911**



(a) *forecast horizon* $h = 1$



(b) *forecast horizon* $h = 1{:}12$

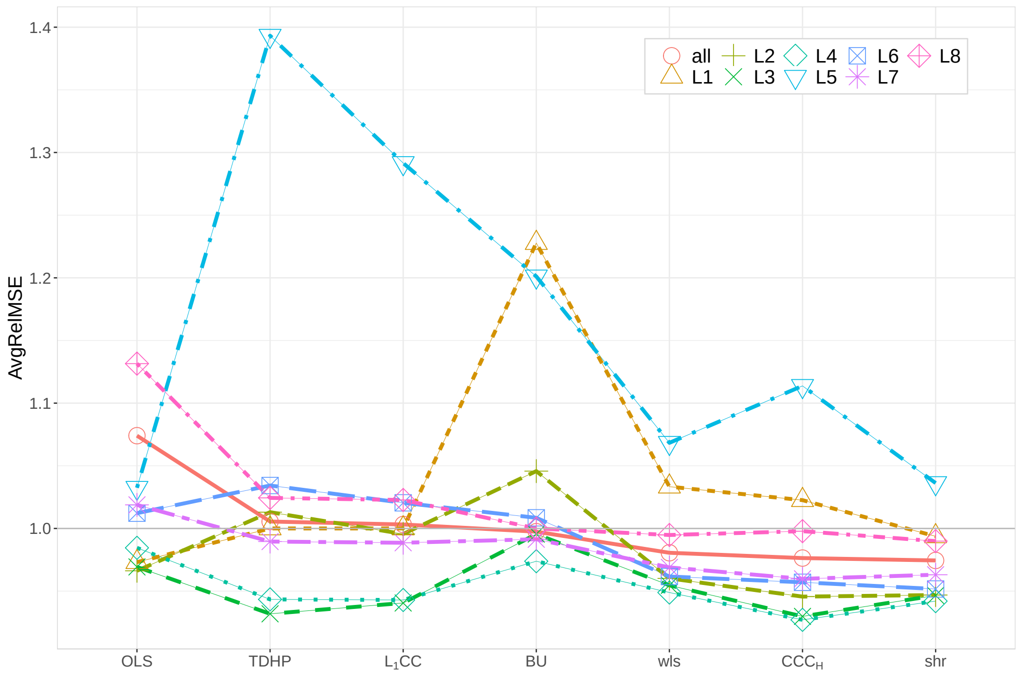
Figure B.3: ***AvgRelMAE*** *of the reconciliation approaches considered by Hollyman et al. (2021). (a) forecast horizon* $h = 1$*, (b) forecast horizon* $h = 1{:}12$ *(values from the second and last column of Tables B.3, respectively). Approach TDHP apart, some reconciled forecasts are negative (see Tables 4 and 5 in the main paper).*

Table B.4: *Monthly forecasts reconciliation in the forecasting experiment on the Australian tourism dataset:* ***AvgRelMSE*** *of the approaches considered by Hollyman et al. (2021). Approach TDHP apart, some reconciled forecasts are negative (see Tables 4 and 5 in the main paper). Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

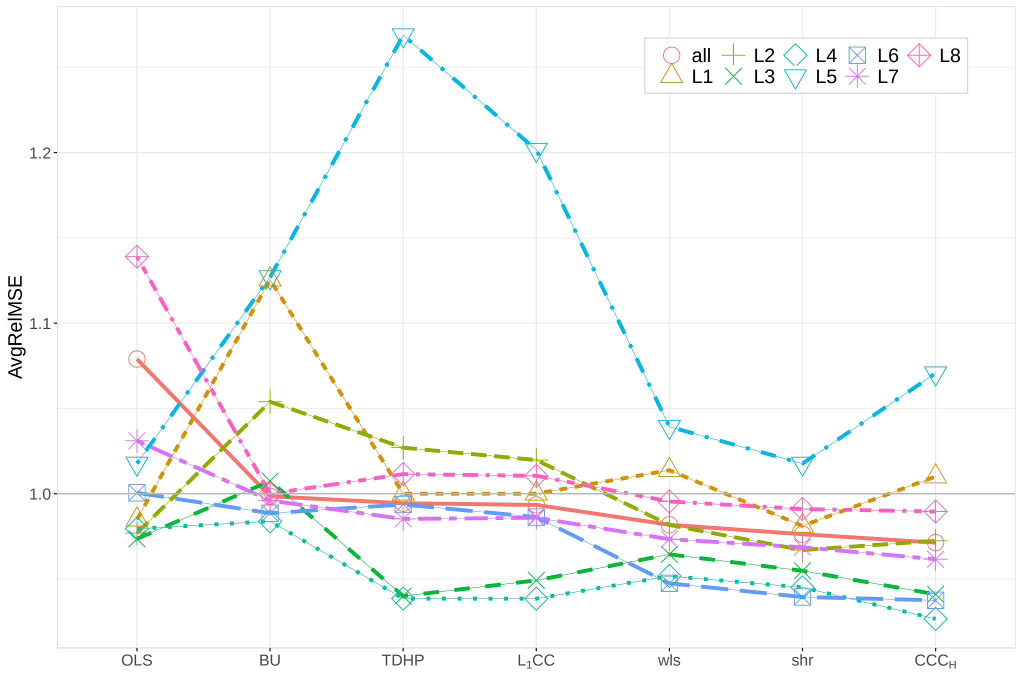
	Approach	Forecast horizon													
		All purposes							*By purpose of travel*						
		1	2	3	6	12	1:6	7:12	1	2	3	6	12	1:6	7:12
Australia	BU	1.2277	1.1095	1.0783	1.1010	1.1402	1.1166	1.1256	1.2011	1.1319	1.1152	1.1231	1.1300	1.1338	1.1270
	L_1CC	1.0000	1.0000	1.0000	1.0000	**1.0000**	1.0000	1.0000	1.2916	1.2767	1.2644	1.2206	1.1140	1.2559	1.2017
	TDHP	1.0000	1.0000	1.0000	1.0000	**1.0000**	1.0000	1.0000	1.3932	1.3798	1.3585	1.2957	1.1409	1.3451	1.2689
	OLS	**0.9731**	0.9707	0.9685	0.9854	1.0107	0.9745	0.9848	**1.0324**	1.0255	1.0236	1.0146	**1.0050**	1.0237	1.0177
	wls	1.0334	0.9835	0.9736	1.0098	1.0597	0.9956	1.0138	1.0683	1.0410	1.0364	1.0352	1.0536	1.0392	1.0393
	shr	0.9937	**0.9622**	**0.9489**	**0.9760**	1.0249	**0.9670**	**0.9812**	1.0362	**1.0201**	**1.0147**	**1.0141**	1.0339	1.0168	1.0177
	CCC_H	1.0226	0.9800	0.9713	1.0071	1.0559	0.9916	1.0101	1.1138	1.0918	1.0832	1.0734	1.0588	1.0838	1.0706
States	BU	1.0458	1.0239	1.0246	1.0708	1.0454	1.0393	1.0539	1.0085	0.9947	0.9826	0.9947	0.9629	0.9930	0.9886
	L_1CC	0.9956	1.0176	1.0249	1.0382	0.9924	1.0199	1.0197	1.0205	1.0126	1.0010	1.0037	0.9319	1.0051	0.9863
	TDHP	1.0130	1.0379	1.0432	1.0455	0.9889	1.0348	1.0270	1.0343	1.0271	1.0133	1.0120	0.9327	1.0165	0.9937
	OLS	0.9662	0.9815	0.9813	0.9848	**0.9724**	0.9783	0.9769	1.0122	1.0027	1.0106	1.0036	0.9953	1.0072	1.0005
	wls	0.9602	0.9650	0.9735	0.9927	0.9936	0.9722	0.9817	0.9617	0.9578	0.9511	0.9519	0.9255	0.9540	0.9475
	shr	0.9469	0.9553	**0.9620**	**0.9759**	0.9792	**0.9597**	**0.9670**	**0.9517**	**0.9496**	0.9431	**0.9438**	0.9191	**0.9458**	0.9394
	CCC_H	**0.9456**	**0.9549**	0.9621	0.9842	0.9823	0.9617	0.9724	0.9570	0.9524	**0.9430**	0.9483	**0.9061**	0.9469	**0.9375**
Zones	BU	0.9955	0.9988	0.9884	1.0056	1.0076	0.9991	1.0075	0.9914	0.9886	0.9827	0.9889	1.0098	0.9883	0.9960
	L_1CC	0.9405	0.9568	0.9576	0.9504	0.9279	0.9542	0.9492	0.9886	0.9927	0.9912	0.9908	0.9762	0.9899	0.9859
	TDHP	0.9319	0.9489	0.9504	0.9409	0.9188	0.9459	0.9400	0.9896	0.9938	0.9924	0.9908	0.9731	0.9906	0.9852
	OLS	0.9693	0.9777	0.9786	0.9694	0.9664	0.9762	0.9735	1.0188	1.0199	1.0295	1.0254	1.0686	1.0240	1.0311
	wls	0.9546	0.9604	0.9595	0.9623	0.9646	0.9615	0.9644	0.9689	0.9701	0.9702	0.9708	0.9812	0.9703	0.9734
	shr	0.9465	0.9546	0.9519	0.9526	0.9543	0.9539	0.9548	0.9631	0.9663	0.9660	0.9665	0.9769	0.9659	0.9686
	CCC_H	**0.9298**	**0.9392**	**0.9383**	**0.9387**	**0.9395**	**0.9389**	**0.9410**	**0.9598**	**0.9626**	**0.9615**	**0.9632**	**0.9621**	**0.9613**	**0.9616**
Regions	BU	0.9738	0.9653	0.9681	0.9827	0.9957	0.9744	0.9838	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	L_1CC	0.9429	0.9412	0.9442	0.9384	0.9359	0.9411	0.9385	1.0227	1.0227	1.0217	1.0124	0.9982	1.0181	1.0105
	TDHP	0.9434	0.9417	0.9450	0.9386	0.9352	0.9417	0.9385	1.0244	1.0251	1.0240	1.0138	0.9976	1.0201	1.0115
	OLS	0.9845	0.9798	0.9784	0.9765	0.9809	0.9792	0.9794	1.1315	1.1339	1.1366	1.1306	1.1653	1.1343	1.1390
	wls	0.9489	0.9436	0.9457	0.9506	0.9616	0.9476	0.9517	0.9948	0.9960	0.9966	0.9956	0.9955	0.9957	0.9955
	shr	0.9420	0.9390	0.9400	0.9433	0.9548	0.9416	0.9451	**0.9899**	**0.9923**	**0.9927**	0.9909	0.9912	**0.9914**	0.9910
	CCC_H	**0.9271**	**0.9238**	**0.9270**	**0.9255**	**0.9325**	**0.9255**	**0.9266**	0.9978	0.9981	0.9974	**0.9905**	**0.9821**	0.9946	**0.9896**

Table B.5: *Monthly forecasts reconciliation in the forecasting experiment on the Australian tourism dataset:* ***AvgRelMAE*** *of the approaches considered by Hollyman et al. (2021). Approach TDHP apart, some reconciled forecasts are negative (see Tables 4 and 5 in the main paper). Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Approach	Forecast horizon													
		All purposes							*By purpose of travel*						
		1	2	3	6	12	1:6	7:12	1	2	3	6	12	1:6	7:12
Australia	BU	1.1244	1.0832	1.0552	1.0557	1.0930	1.0769	1.0840	1.1114	1.0695	1.0685	1.0651	1.0602	1.0687	1.0648
	L_1CC	1.0000	1.0000	1.0000	1.0000	**1.0000**	1.0000	1.0000	1.1194	1.1131	1.1094	1.0978	1.0516	1.1018	1.0849
	TDHP	1.0000	1.0000	1.0000	1.0000	**1.0000**	1.0000	1.0000	1.1630	1.1555	1.1483	1.1257	1.0597	1.1380	1.1112
	OLS	**0.9877**	**0.9907**	0.9903	0.9899	1.0052	**0.9905**	**0.9944**	1.0242	1.0075	1.0126	1.0090	**1.0047**	1.0119	1.0096
	wls	1.0161	1.0130	0.9974	1.0032	1.0418	1.0075	1.0184	1.0377	1.0178	1.0185	1.0094	1.0221	1.0153	1.0169
	shr	0.9969	1.0018	**0.9847**	**0.9865**	1.0203	0.9939	1.0011	**1.0212**	**1.0051**	**1.0031**	**0.9954**	1.0063	**1.0019**	**1.0026**
	CCC_H	1.0099	1.0089	0.9942	0.9999	1.0377	1.0041	1.0150	1.0481	1.0352	1.0326	1.0224	1.0209	1.0282	1.0248
States	BU	1.0427	1.0191	1.0310	1.0404	1.0396	1.0332	1.0377	1.0091	0.9997	0.9974	1.0044	0.9927	1.0035	1.0005
	L_1CC	1.0133	1.0143	1.0246	1.0233	1.0007	1.0192	1.0168	1.0162	1.0108	1.0046	1.0054	0.9737	1.0080	0.9978
	TDHP	1.0281	1.0267	1.0367	1.0290	0.9944	1.0299	1.0213	1.0205	1.0138	1.0082	1.0085	0.9747	1.0110	1.0002
	OLS	0.9932	0.9978	1.0066	1.0043	0.9850	1.0001	0.9972	1.0222	1.0156	1.0193	1.0134	1.0101	1.0183	1.0144
	wls	0.9906	0.9837	0.9915	0.9991	1.0025	0.9910	0.9956	0.9844	0.9779	0.9745	0.9775	0.9731	0.9793	0.9766
	shr	0.9868	0.9803	0.9864	0.9923	**0.9926**	0.9861	0.9887	0.9792	**0.9736**	0.9704	0.9742	0.9693	0.9750	0.9724
	CCC_H	**0.9816**	**0.9760**	**0.9837**	**0.9914**	0.9951	**0.9827**	**0.9880**	**0.9776**	0.9739	**0.9679**	**0.9709**	**0.9578**	**0.9723**	**0.9678**
Zones	BU	1.0139	1.0080	0.9996	1.0137	1.0143	1.0088	1.0103	0.9930	0.9924	0.9925	0.9963	1.0019	0.9938	0.9961
	L_1CC	0.9887	0.9877	0.9832	0.9801	0.9695	0.9843	0.9795	0.9988	0.9974	0.9964	0.9975	0.9863	0.9965	0.9932
	TDHP	0.9820	0.9820	0.9772	0.9718	0.9606	0.9774	0.9715	0.9969	0.9951	0.9948	0.9958	0.9827	0.9945	0.9906
	OLS	0.9976	0.9946	0.9925	0.9895	0.9857	0.9936	0.9910	1.0339	1.0276	1.0327	1.0293	1.0339	1.0307	1.0302
	wls	0.9819	0.9807	0.9777	0.9817	0.9859	0.9807	0.9830	0.9818	0.9821	0.9838	0.9841	0.9886	0.9831	0.9844
	shr	0.9784	0.9768	0.9733	0.9761	0.9794	0.9763	0.9772	0.9800	0.9804	0.9818	0.9822	0.9859	0.9814	0.9822
	CCC_H	**0.9721**	**0.9710**	**0.9670**	**0.9689**	**0.9722**	**0.9695**	**0.9704**	**0.9764**	**0.9773**	**0.9775**	**0.9790**	**0.9774**	**0.9772**	**0.9773**
Regions	BU	0.9830	0.9799	0.9837	0.9848	0.9872	0.9831	0.9849	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	L_1CC	0.9730	0.9705	0.9723	0.9666	0.9616	0.9694	0.9668	1.0088	1.0074	1.0058	1.0027	0.9941	1.0053	1.0017
	TDHP	0.9719	0.9696	0.9715	0.9655	0.9607	0.9685	0.9658	1.0065	1.0057	1.0041	1.0005	0.9910	1.0034	0.9993
	OLS	0.9960	0.9926	0.9916	0.9890	0.9860	0.9914	0.9901	1.1120	1.1092	1.1120	1.1073	1.1053	1.1107	1.1079
	wls	0.9711	0.9699	0.9704	0.9710	0.9734	0.9702	0.9715	0.9989	0.9993	0.9987	0.9982	0.9969	0.9988	0.9985
	shr	0.9682	0.9669	0.9674	0.9665	0.9689	0.9669	0.9676	0.9960	0.9966	0.9960	0.9953	0.9934	0.9959	0.9954
	CCC_H	**0.9595**	**0.9579**	**0.9591**	**0.9570**	**0.9586**	**0.9576**	**0.9579**	**0.9939**	**0.9944**	**0.9933**	**0.9911**	**0.9871**	**0.9928**	**0.9911**



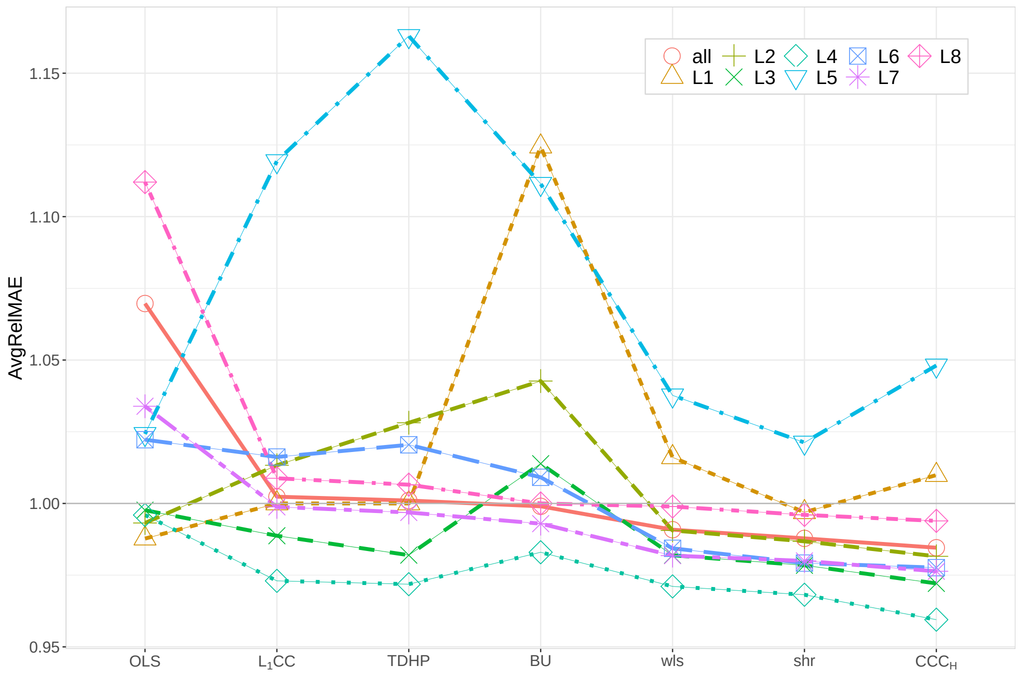
(a) *forecast horizon $h = 1$*



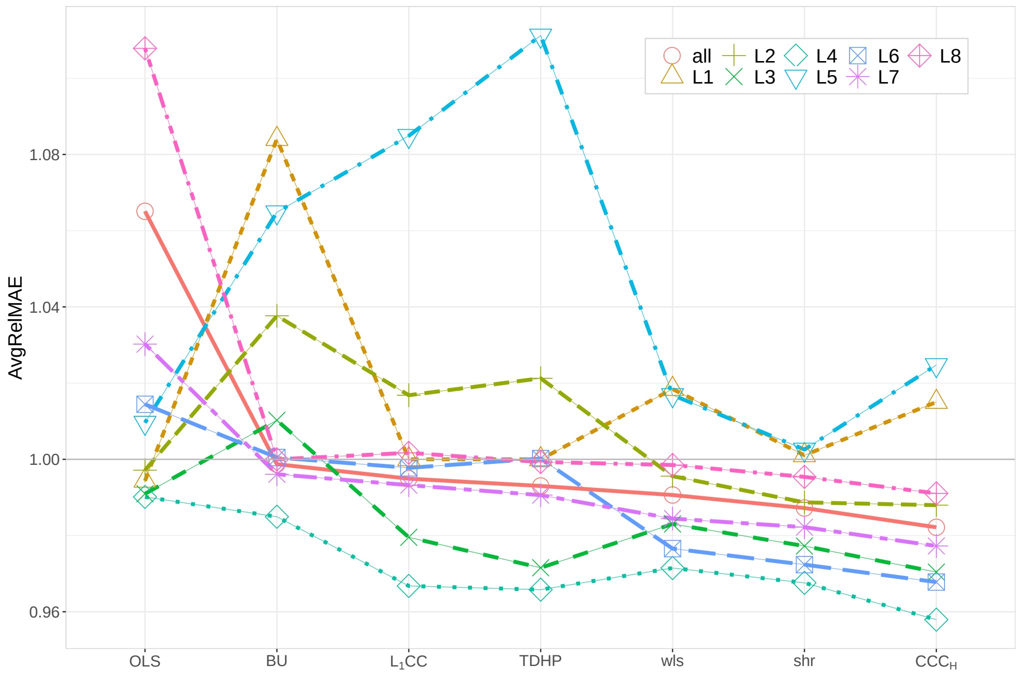
(b) *forecast horizon $h = 1{:}12$*

L1: Australia; L2: States; L3: Zones; L4: Regions; L5: Australia by PoT; L6: States by PoT; L7: Zones by PoT; L8: Regions by PoT.

Figure B.4: ***AvgRelMSE*** *of the reconciliation approaches considered by Hollyman et al. (2021). PoT: Purpose of Travel. (a) forecast horizon $h = 1$, (b) forecast horizon $h = 1{:}12$. Approach TDHP apart, some reconciled forecasts are negative (see Tables 4 and 5 in the main paper).*



(a) *forecast horizon h = 1*



(b) *forecast horizon h = 1:12*

L1: Australia; L2: States; L3: Zones; L4: Regions; L5: Australia by PoT; L6: States by PoT; L7: Zones by PoT; L8: Regions by PoT.

Figure B.5: ***AvgRelMAE*** *of the reconciliation approaches considered by Hollyman et al. (2021). PoT: Purpose of Travel. (a) forecast horizon $h = 1$, (b) forecast horizon $h = 1{:}12$. Approach TDHP apart, some reconciled forecasts are negative (see Tables 4 and 5 in the main paper).*

Table B.6: *Non-negative monthly forecasts reconciliation in the forecasting experiment on the Australian Tourism Demand dataset:* ***AvgRelMSE*** *of the approaches considered by Hollyman et al. (2021). Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Forecast horizon						
Approach	1	2	3	6	12	1:6	1:12
			all (525 series)				
BU	0.9972	0.9940	0.9923	0.9974	1.0008	0.9955	0.9983
L_1CC	1.0025	1.0035	1.0026	0.9962	0.9791	0.9998	0.9930
TDHP	1.0055	1.0070	1.0059	0.9980	0.9785	1.0027	0.9944
OLS	1.0537	1.0523	1.0559	1.0475	1.0585	1.0522	1.0499
wls	0.9801	0.9801	0.9802	0.9806	0.9816	0.9802	0.9806
shr	**0.9739**	**0.9757**	0.9754	0.9748	0.9768	0.9750	0.9752
CCC_H	0.9757	0.9759	**0.9753**	**0.9721**	**0.9659**	**0.9737**	**0.9708**
			upper time series (221 series)				
BU	0.9937	0.9861	0.9819	0.9941	1.0021	0.9894	0.9963
L_1CC	0.9761	0.9783	0.9775	0.9749	0.9540	0.9758	0.9699
TDHPs	0.9801	0.9826	0.9815	0.9768	0.9529	0.9792	0.9714
OLS	0.9948	0.9938	0.9975	0.9937	1.0030	0.9950	0.9951
wls	0.9612	0.9595	0.9595	0.9629	0.9687	0.9610	0.9636
shr	0.9532	0.9541	0.9533	0.9554	0.9626	0.9544	0.9566
CCC_H	**0.9473**	**0.9473**	**0.9467**	**0.9484**	**0.9449**	**0.9468**	**0.9466**
			bottom time series (304 series)				
BU	0.9998	0.9998	0.9998	0.9999	0.9998	0.9998	0.9998
L_1CC	1.0221	1.0223	1.0212	1.0120	0.9977	1.0177	1.0101
TDHP	1.0244	1.0251	1.0240	1.0138	0.9976	1.0201	1.0115
OLS	1.0987	1.0969	1.1004	1.0884	1.1008	1.0958	1.0917
wls	0.9941	0.9953	0.9956	0.9937	0.9911	0.9945	0.9931
shr	**0.9892**	**0.9917**	**0.9917**	**0.9890**	0.9873	**0.9903**	0.9889
CCC_H	0.9969	0.9972	0.9965	0.9897	**0.9814**	0.9938	**0.9887**

Table B.7: *Non-negative monthly forecasts reconciliation in the forecasting experiment on the Australian Tourism Demand dataset:* ***AvgRelMAE*** *of the approaches considered by Hollyman et al. (2021). Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Forecast horizon						
Approach	1	2	3	6	12	1:6	1:12
			all (525 series)				
BU	0.9988	0.9969	0.9971	0.9989	0.9994	0.9980	0.9985
L_1CC	1.0006	0.9991	0.9980	0.9955	0.9851	0.9974	0.9936
TDHP	1.0010	0.9995	0.9984	0.9951	0.9837	0.9975	0.9930
OLS	1.0433	1.0388	1.0415	1.0361	1.0294	1.0396	1.0354
wls	0.9900	0.9894	0.9892	0.9894	0.9893	0.9895	0.9896
shr	0.9870	0.9867	0.9865	0.9863	0.9859	0.9866	0.9864
CCC_H	**0.9842**	**0.9841**	**0.9832**	**0.9822**	**0.9795**	**0.9830**	**0.9819**
			upper time series (221 series)				
BU	0.9976	0.9931	0.9935	0.9977	0.9992	0.9956	0.9969
L_1CC	0.9928	0.9906	0.9901	0.9883	0.9756	0.9893	0.9852
TDHP	0.9935	0.9910	0.9906	0.9878	0.9737	0.9895	0.9844
OLS	1.0096	1.0048	1.0068	1.0039	1.0010	1.0058	1.0038
wls	0.9797	0.9780	0.9783	0.9796	0.9824	0.9788	0.9799
shr	0.9765	0.9751	0.9751	0.9758	0.9785	0.9756	0.9762
CCC_H	**0.9717**	**0.9705**	**0.9700**	**0.9706**	**0.9695**	**0.9702**	**0.9700**
			bottom time series (304 series)				
BU	0.9996	0.9997	0.9997	0.9997	0.9996	0.9997	0.9997
L_1CC	1.0063	1.0053	1.0037	1.0008	0.9921	1.0032	0.9997
TDHP	1.0065	1.0057	1.0041	1.0005	0.9910	1.0034	0.9993
OLS	1.0686	1.0642	1.0675	1.0601	1.0505	1.0648	1.0589
wls	0.9975	0.9979	0.9972	0.9966	0.9944	0.9973	0.9967
shr	0.9948	0.9953	0.9948	0.9939	0.9913	0.9946	0.9939
CCC_H	**0.9934**	**0.9940**	**0.9929**	**0.9907**	**0.9868**	**0.9923**	**0.9907**

C Level Conditional Coherent reconciliation using two different base forecasts

Table C.8: ***AvgRelMAE*** *of LCC and CCC monthly forecast reconciliation approaches in the forecasting experiment on the Australian Tourism Demand dataset.* ***Seasonal averages*** *of the training sets are used as base forecasts. BU identifies the bottom-up approach. Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Forecast horizon						
Approach	1	2	3	6	12	1:6	1:12
			all (525 series)				
BU	1.0120	1.0090	1.0072	1.0059	0.9961	1.0074	1.0039
L_1CC	1.0006	0.9991	0.9980	0.9955	0.9851	0.9974	0.9936
L_2CC	0.9981	0.9962	0.9945	0.9913	0.9834	0.9941	0.9905
L_3CC	1.0015	1.0019	1.0010	0.9994	0.9933	1.0003	0.9980
L_4CC	1.0112	1.0135	1.0113	1.0124	1.0067	1.0122	1.0108
L_5CC	0.9985	0.9964	0.9950	0.9936	0.9861	0.9951	0.9923
L_6CC	0.9998	0.9988	0.9990	0.9980	0.9968	0.9983	0.9977
L_7CC	1.0059	1.0034	1.0033	1.0016	0.9996	1.0034	1.0024
LCC	**0.9892**	**0.9892**	**0.9880**	**0.9868**	**0.9827**	**0.9877**	**0.9862**
CCC	0.9898	0.9895	0.9883	0.9873	0.9831	0.9881	0.9867
			uts (221 series)				
BU	1.0177	1.0140	1.0120	1.0111	0.9973	1.0121	1.0076
L_1CC	0.9928	0.9906	0.9901	0.9883	0.9756	0.9893	0.9852
L_2CC	0.9892	0.9861	0.9844	0.9811	0.9738	0.9841	0.9803
L_3CC	0.9952	0.9942	0.9940	0.9947	0.9891	0.9936	0.9920
L_4CC	1.0052	1.0060	1.0041	1.0082	1.0027	1.0060	1.0053
L_5CC	0.9852	0.9827	0.9816	0.9821	0.9743	0.9821	0.9798
L_6CC	0.9875	0.9859	0.9870	0.9875	0.9905	0.9864	0.9874
L_7CC	0.9966	0.9919	0.9927	0.9924	0.9917	0.9933	0.9931
LCC	**0.9747**	**0.9740**	**0.9733**	**0.9737**	**0.9711**	**0.9733**	**0.9726**
CCC	0.9763	0.9754	0.9745	0.9753	0.9723	0.9747	0.9740
			bts (304 series)				
BU	1.0079	1.0053	1.0038	1.0021	0.9953	1.0040	1.0013
L_1CC	1.0063	1.0053	1.0037	1.0008	0.9921	1.0032	0.9997
L_2CC	1.0047	1.0036	1.0018	0.9987	**0.9904**	1.0014	0.9979
L_3CC	1.0061	1.0076	1.0061	1.0028	0.9964	1.0051	1.0023
L_4CC	1.0157	1.0190	1.0166	1.0154	1.0097	1.0168	1.0149
L_5CC	1.0083	1.0064	1.0049	1.0021	0.9948	1.0046	1.0015
L_6CC	1.0088	1.0083	1.0077	1.0057	1.0014	1.0070	1.0052
L_7CC	1.0127	1.0118	1.0111	1.0084	1.0054	1.0107	1.0091
LCC	0.9999	1.0003	0.9989	0.9965	0.9913	0.9984	0.9963
CCC	**0.9997**	**0.9998**	**0.9984**	**0.9962**	0.9911	**0.9980**	**0.9960**

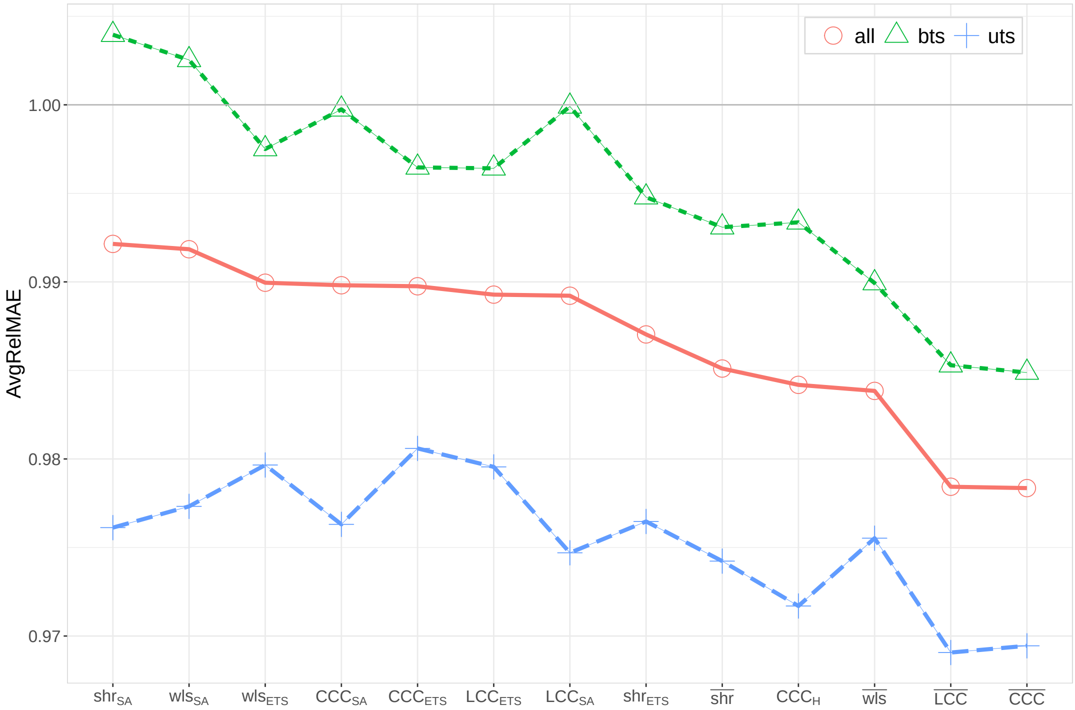
Table C.9: ***AvgRelMAE*** *of LCC and CCC monthly forecast reconciliation approaches in the forecasting experiment on the Australian Tourism Demand dataset.* ***Automatic ETS*** *are used as base forecasts. BU identifies the bottom-up approach. Bold entries identify the best performing approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Forecast horizon						
Approach	1	2	3	6	12	1:6	1:12
	all (525 series)						
BU	0.9988	0.9969	0.9971	0.9989	0.9994	0.9980	0.9985
L_1CC	0.9993	0.9949	0.9952	0.9956	0.9934	0.9960	0.9950
L_2CC	0.9972	0.9926	0.9926	0.9924	0.9918	0.9934	0.9925
L_3CC	0.9984	0.9968	0.9970	0.9966	0.9956	0.9969	0.9965
L_4CC	1.0073	1.0071	1.0067	1.0078	1.0061	1.0076	1.0076
L_5CC	0.9950	0.9923	0.9919	0.9928	0.9920	0.9928	0.9925
L_6CC	0.9986	0.9983	0.9993	0.9999	1.0013	0.9988	0.9996
L_7CC	1.0015	0.9993	0.9997	0.9988	0.9968	0.9998	0.9991
LCC	**0.9893**	**0.9872**	**0.9873**	**0.9878**	**0.9873**	**0.9877**	**0.9876**
CCC	0.9898	0.9877	0.9878	0.9885	0.9881	0.9883	0.9883
	uts (221 series)						
BU	0.9976	0.9931	0.9935	0.9977	0.9992	0.9956	0.9969
L_1CC	0.9947	0.9893	0.9906	0.9925	0.9914	0.9918	0.9914
L_2CC	0.9920	0.9865	0.9869	0.9875	0.9893	0.9881	0.9879
L_3CC	0.9940	0.9912	0.9923	0.9936	0.9941	0.9925	0.9929
L_4CC	1.0030	1.0017	1.0016	1.0043	1.0041	1.0031	1.0035
L_5CC	0.9879	0.9843	0.9842	0.9878	0.9888	0.9861	0.9870
L_6CC	0.9924	0.9918	0.9935	0.9957	1.0009	0.9931	0.9954
L_7CC	0.9972	0.9930	0.9939	0.9946	0.9941	0.9948	0.9950
LCC	**0.9796**	**0.9766**	**0.9773**	**0.9794**	**0.9813**	**0.9781**	**0.9790**
CCC	0.9806	0.9775	0.9781	0.9805	0.9826	0.9791	0.9802
	bts (304 series)						
BU	0.9996	0.9997	0.9997	0.9997	0.9996	0.9997	0.9997
L_1CC	1.0027	0.9990	0.9985	0.9978	0.9949	0.9991	0.9976
L_2CC	1.0010	0.9971	0.9968	0.9959	0.9935	0.9972	0.9959
L_3CC	1.0016	1.0008	1.0004	0.9988	0.9967	1.0001	0.9992
L_4CC	1.0105	1.0110	1.0104	1.0103	1.0075	1.0109	1.0105
L_5CC	1.0002	0.9981	0.9975	0.9965	0.9943	0.9976	0.9965
L_6CC	1.0031	1.0031	1.0035	1.0030	1.0016	1.0029	1.0026
L_7CC	1.0047	1.0039	1.0040	1.0019	0.9987	1.0034	1.0022
LCC	**0.9964**	**0.9950**	**0.9946**	**0.9940**	**0.9916**	**0.9948**	**0.9939**
CCC	0.9965	0.9952	0.9949	0.9943	0.9922	0.9950	0.9943

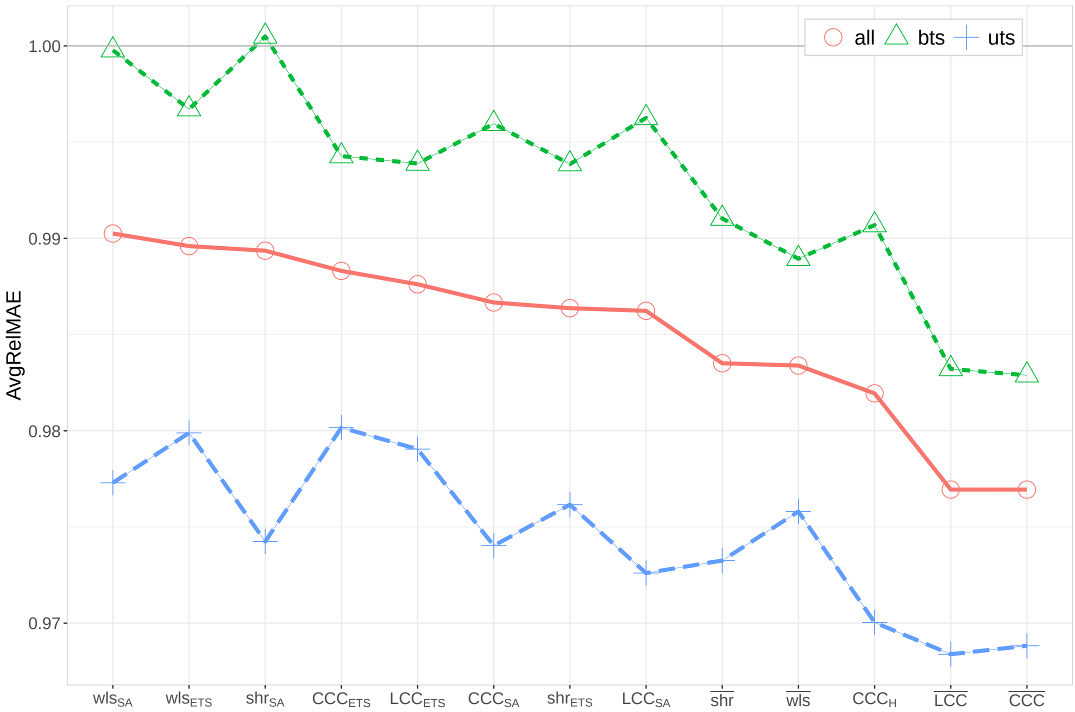
Table C.10: *AvgRelMAE of monthly reconciled forecasts in the forecasting experiment on the Australian Tourism Demand dataset. Optimal combination, LCC, and CCC reconciliation approaches, using seasonal averages and/or automatic ETS as bts base forecasts. Bold entries identify the best performing approaches. Italic entries identify averaging approaches improving the forecast accuracy of both single approaches. Red entries identify the approaches worsening the automatic ETS base forecasts' accuracy.*

	Base forecasts*		Forecast horizon						
Approach**	uts	bts	1	2	3	6	12	1:6	1:12
			all (525 series)						
SA	SA	SA	1.0120	1.0090	1.0072	1.0059	0.9961	1.0074	1.0039
wls_{SA}	ETS	SA	0.9918	0.9919	0.9912	0.9904	0.9883	0.9910	0.9903
shr_{SA}	ETS	SA	0.9921	0.9920	0.9911	0.9895	0.9862	0.9908	0.9894
CCC_{SA}	ETS	SA	0.9898	0.9895	0.9883	0.9873	0.9831	0.9881	0.9867
LCC_{SA}	ETS	SA	*0.9892*	*0.9892*	*0.9880*	*0.9868*	*0.9827*	*0.9877*	*0.9862*
wls_{ETS}	ETS	ETS	0.9900	0.9894	0.9892	0.9894	0.9893	0.9895	0.9896
shr_{ETS}	ETS	ETS	*0.9870*	*0.9867*	*0.9865*	*0.9863*	*0.9859*	*0.9866*	*0.9864*
CCC_{ETS}	ETS	ETS	0.9898	0.9877	0.9878	0.9885	0.9881	0.9883	0.9883
LCC_{ETS}	ETS	ETS	0.9893	0.9872	0.9873	0.9878	0.9873	0.9877	0.9876
$\overline{wls}$	ETS	SA & ETS	0.9838	0.9838	0.9835	0.9832	0.9829	0.9834	0.9834
$\overline{shr}$	ETS	SA & ETS	0.9851	0.9849	0.9844	0.9835	0.9819	0.9842	0.9835
CCC_H	ETS	SA & ETS	0.9842	0.9841	0.9832	0.9822	0.9795	0.9830	0.9819
$\overline{CCC}$	ETS	SA & ETS	**0.9784**	**0.9775**	**0.9772**	0.9771	0.9761	**0.9772**	**0.9769**
$\overline{LCC}$	ETS	SA & ETS	0.9784	0.9778	0.9774	**0.9770**	**0.9759**	0.9773	0.9769
			uts (221 series)						
SA	SA	SA	1.0177	1.0140	1.0120	1.0111	0.9973	1.0121	1.0076
wls_{SA}	ETS	SA	0.9773	0.9770	0.9768	0.9779	0.9780	0.9769	0.9773
shr_{SA}	ETS	SA	*0.9761*	0.9754	0.9747	0.9748	0.9735	0.9749	0.9742
CCC_{SA}	ETS	SA	0.9763	0.9754	0.9745	0.9753	0.9723	0.9747	0.9740
LCC_{SA}	ETS	SA	0.9747	*0.9740*	*0.9733*	*0.9737*	*0.9711*	*0.9733*	*0.9726*
wls_{ETS}	ETS	ETS	0.9797	0.9780	0.9783	0.9796	0.9824	0.9788	0.9799
shr_{ETS}	ETS	ETS	*0.9765*	*0.9751*	*0.9751*	*0.9758*	*0.9785*	*0.9756*	*0.9762*
CCC_{ETS}	ETS	ETS	0.9806	0.9775	0.9781	0.9805	0.9826	0.9791	0.9802
LCC_{ETS}	ETS	ETS	0.9796	0.9766	0.9773	0.9794	0.9813	0.9781	0.9790
$\overline{wls}$	ETS	SA & ETS	0.9755	0.9746	0.9746	0.9757	0.9777	0.9749	0.9758
$\overline{shr}$	ETS	SA & ETS	0.9742	0.9731	0.9730	0.9733	0.9742	0.9732	0.9733
CCC_H	ETS	SA & ETS	0.9717	0.9705	0.9700	0.9706	0.9695	0.9702	0.9700
$\overline{CCC}$	ETS	SA & ETS	0.9694	0.9678	0.9677	0.9691	0.9700	0.9682	0.9688
$\overline{LCC}$	ETS	SA & ETS	**0.9691**	**0.9675**	**0.9675**	**0.9686**	**0.9694**	**0.9679**	**0.9684**
			bts (304 series)						
SA	SA	SA	1.0079	1.0053	1.0038	1.0021	0.9953	1.0040	1.0013
wls_{SA}	ETS	SA	1.0025	1.0029	1.0019	0.9995	0.9959	1.0014	0.9998
shr_{SA}	ETS	SA	1.0040	1.0043	1.0032	1.0003	0.9956	1.0025	1.0005
CCC_{SA}	ETS	SA	*0.9997*	*0.9998*	*0.9984*	*0.9962*	*0.9911*	*0.9980*	*0.9960*
LCC_{SA}	ETS	SA	0.9999	1.0003	0.9989	0.9965	0.9913	0.9984	0.9963
wls_{ETS}	ETS	ETS	0.9975	0.9979	0.9972	0.9966	0.9944	0.9973	0.9967
shr_{ETS}	ETS	ETS	*0.9948*	0.9953	0.9948	*0.9939*	*0.9913*	*0.9946*	*0.9939*
CCC_{ETS}	ETS	ETS	0.9965	0.9952	0.9949	0.9943	0.9922	0.9950	0.9943
LCC_{ETS}	ETS	ETS	0.9964	*0.9950*	*0.9946*	0.9940	0.9916	0.9948	0.9939
$\overline{wls}$	ETS	SA & ETS	0.9899	0.9906	0.9900	0.9887	0.9866	0.9897	0.9889
$\overline{shr}$	ETS	SA & ETS	0.9931	0.9935	0.9928	0.9910	0.9876	0.9923	0.9910
CCC_H	ETS	SA & ETS	0.9934	0.9940	0.9929	0.9907	0.9868	0.9923	0.9907
$\overline{CCC}$	ETS	SA & ETS	**0.9849**	**0.9847**	**0.9841**	**0.9830**	**0.9805**	**0.9838**	**0.9829**
$\overline{LCC}$	ETS	SA & ETS	0.9853	0.9853	0.9846	0.9832	0.9806	0.9842	0.9832

* SA: seasonal averages; ETS: automatic ETS forecasts.
** CCC_H: base forecasts as in Hollyman et al. (2021).



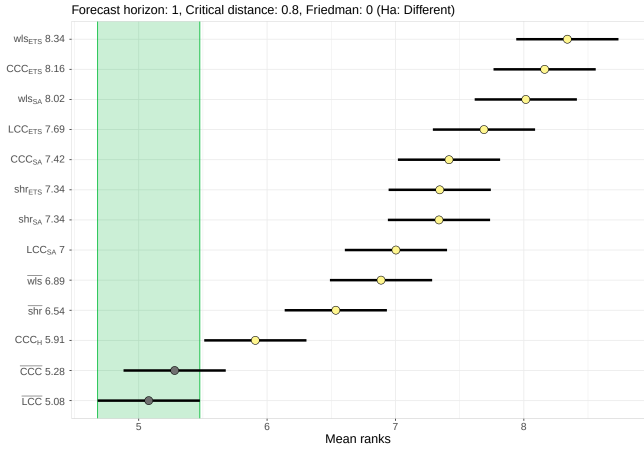
(a) *forecast horizon* $h = 1$



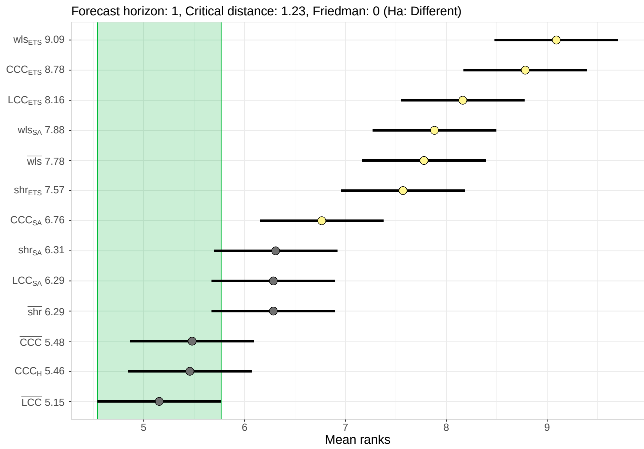
(b) *forecast horizon* $h = 1{:}12$

Figure C.6: ***AvgRelMAE*** *of Optimal combination, LCC, and CCC reconciliation approaches, using seasonal averages and/or automatic ETS as bts base forecasts. (a) forecast horizon* $h = 1$*, (b) forecast horizon* $h = 1{:}12$ *(values from the fourth and last column of Table C.10, respectively)*

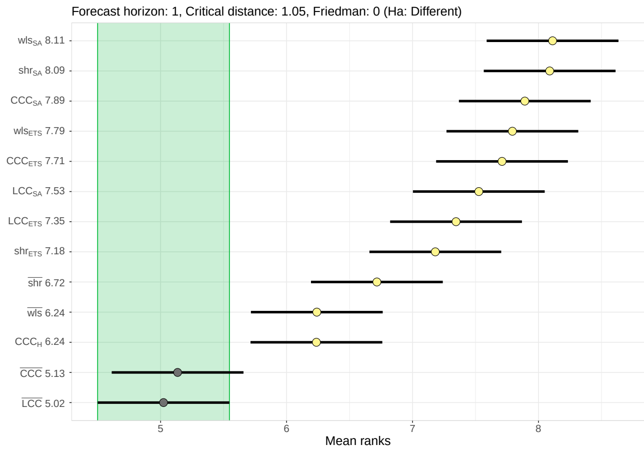
D Multiple Comparison with the Best for Optimal combination, *LCC*, and *CCC* reconciliation approaches



(a) *all series (525)*

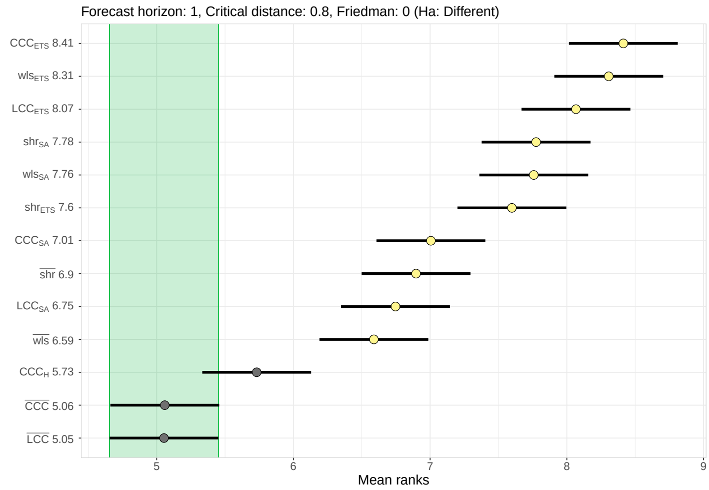


(b) *uts (221)*

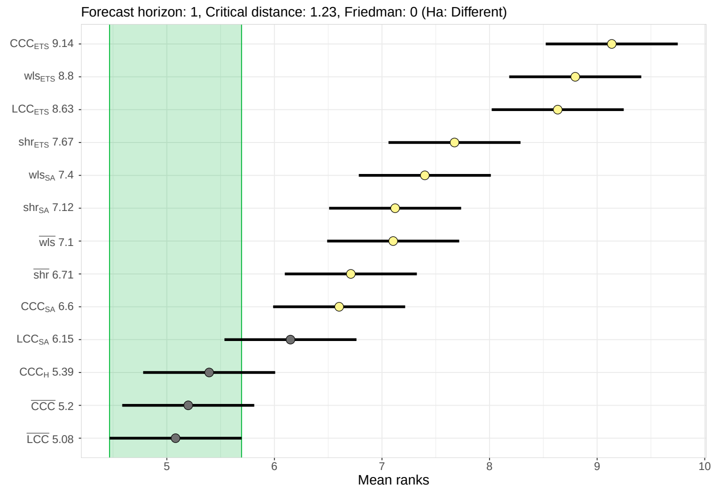


(c) *bts (304)*

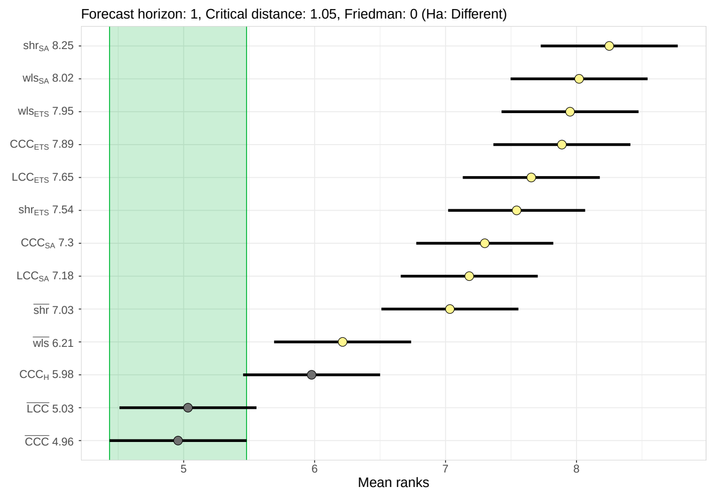
Figure D.7: *Multiple Comparison with the Best using* **AvgRelMSE** *(forecast horizon $h = 1$). Optimal combination, LCC, and CCC reconciliation approaches, using seasonal averages and/or automatic ETS as base forecasts: (a) all (b) upper (c) bottom time series.*



(a) *all series (525)*

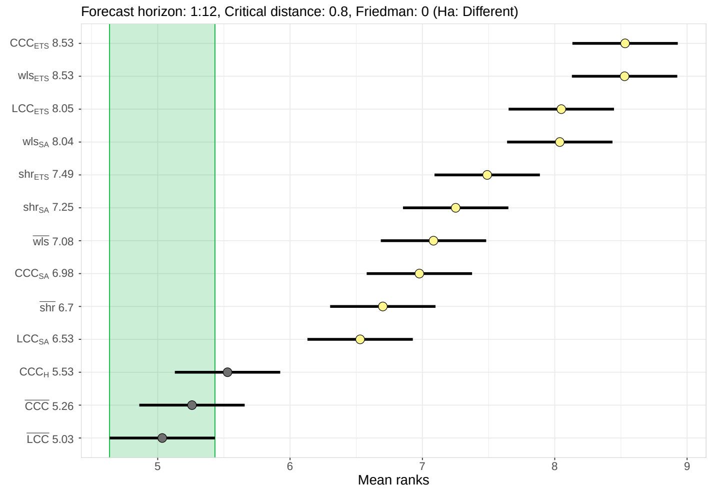


(b) *uts (221)*

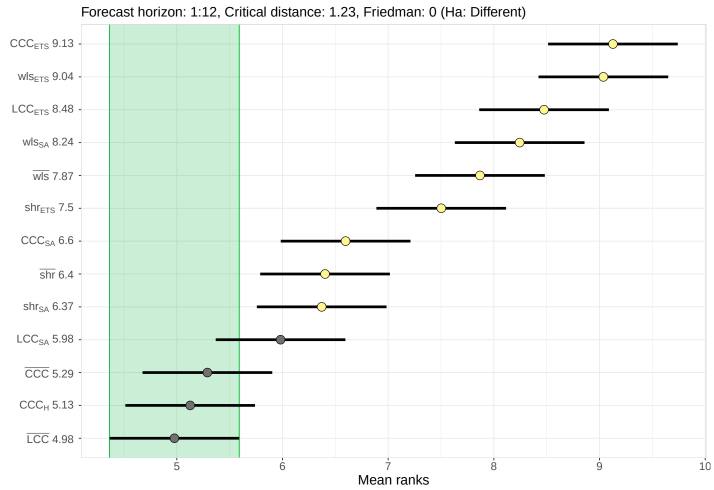


(c) *bts (304)*

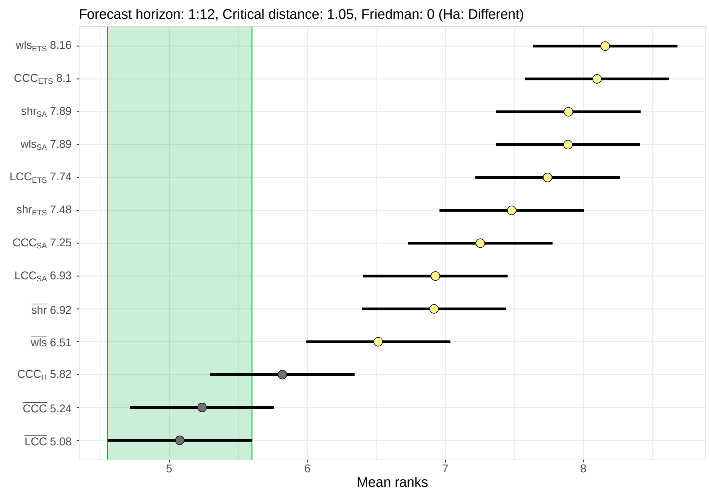
Figure D.8: *Multiple Comparison with the Best using* ***AvgRelMAE*** *(forecast horizon $h = 1$). Optimal combination, LCC, and CCC reconciliation approaches, using seasonal averages and/or automatic ETS as base forecasts: (a) all (b) upper (c) bottom time series.*



(a) *all series (525)*

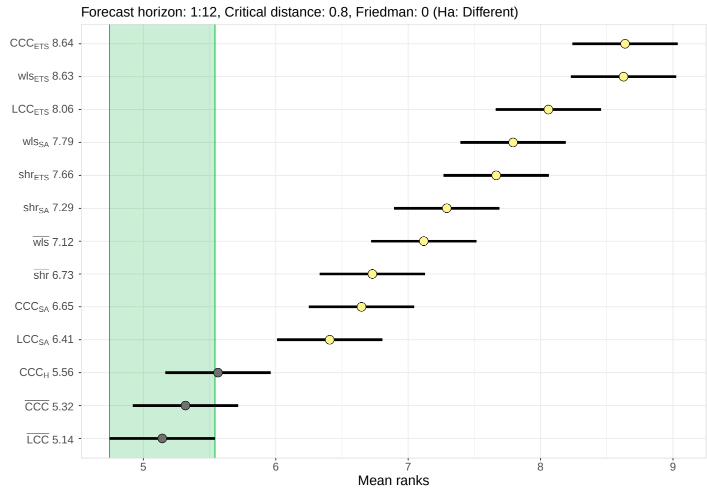


(b) *uts (221)*

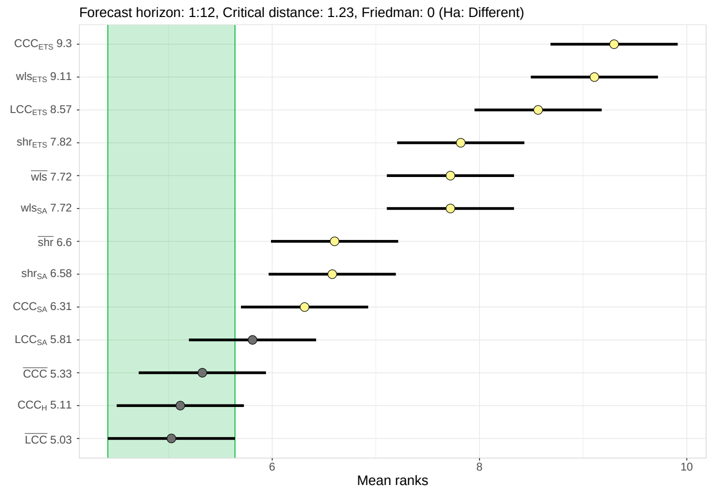


(c) *bts (304)*

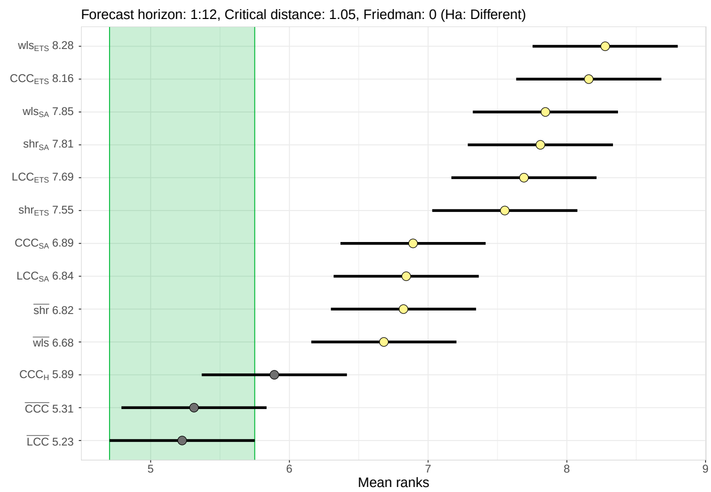
Figure D.9: *Multiple Comparison with the Best using* ***AvgRelMSE*** *(forecast horizon h = 1:12). Optimal combination, LCC, and CCC reconciliation approaches, using seasonal averages and/or automatic ETS as base forecasts: (a) all (b) upper (c) bottom time series.*



(a) *all series (525)*



(b) *uts (221)*



(c) *bts (304)*

Figure D.10: *Multiple Comparison with the Best using* ***AvgRelMAE*** *(forecast horizon $h = 1{:}12$). Optimal combination, LCC, and CCC reconciliation approaches, using seasonal averages and/or automatic ETS as base forecasts: (a) all (b) upper (c) bottom time series.*

References

Hollyman, R., Petropoulos, F. & Tipping, M. E. (2021), 'Understanding Forecast Reconciliation', *European Journal of Operational Research* **in press**.

Wickramasuriya, S. L., Athanasopoulos, G. & Hyndman, R. J. (2019), 'Optimal Forecast Reconciliation for Hierarchical and Grouped Time Series Through Trace Minimization', *Journal of the American Statistical Association* **114**(526), 804–819.