Forecasting Australian GDP

Expenditure Approach - Point forecasting

Summary of GDP - The most aggregate series

	ETS								AI			
	MSE				MASE				MSE			
Method	1	2	3	4	1	2	3	4	1	2	3	
Benchmark	-418.74	-135.45	-36.30	-3.10	-127.28	-69.39	-28.70	-21.03	-420.06	-128.25	-39.11	-15.4
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Bottom-up	-24.62	-6.94	13.89	19.17	-6.68	-2.54	3.99	-2.73	-44.70	-16.08	0.96	7.7
OLS	8.32	8.19	11.30	11.18	6.06	5.67	6.74	4.30	5.37	5.72	7.59	7.7
WLS	8.75	10.69	17.96	18.90	8.48	7.91	9.37	4.83	0.97	5.08	10.24	11.5
MinT Shrink	9.80	10.20	16.71	18.44	9.02	6.77	9.30	5.88	2.45	3.64	8.33	8.6

Summary of all aggregate level series

	ETS								ARI			
	MSE				MASE				MSE			
Method	1	2	3	4	1	2	3	4	1	2	3	4
Benchmark	-342.16	-149.39	-58.77	-21.04	-56.72	-32.10	-14.58	-2.78	-311.20	-147.72	-57.31	-28.38
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottom-up	-9.67	1.15	6.67	10.92	2.99	4.94	4.17	5.56	-28.47	-15.65	-8.36	-2.91
OLS	9.39	9.12	9.29	8.96	1.49	1.23	1.04	0.93	7.67	5.77	6.24	6.01
WLS	12.33	14.06	13.73	14.24	5.97	6.17	5.21	5.56	5.56	5.02	7.25	8.18
MinT Shrink	13.99	16.04	14.26	14.47	7.46	7.41	6.25	5.56	7.71	4.56	7.32	7.20

Summary of all disaggregate series

	ETS								ARIM			
	MSE				MASE				MSE			
Method	1	2	3	4	1	2	3	4	1	2	3	4
Benchmark	-167.10	-69.04	-24.00	-3.48	-53.01	-27.45	-11.76	-2.27	-136.49	-43.61	-10.04	6.21
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottom-up	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	-1.06	-5.53	-11.11	-15.14	-14.46	-13.73	-16.81	-17.42	3.40	2.61	-3.02	-4.06
WLS	1.91	-0.99	-4.84	-7.77	0.00	0.00	0.00	-1.52	6.53	7.03	1.43	0.90
MinT Shrink	2.36	-2.43	-6.15	-8.77	1.20	0.00	0.00	-1.52	5.37	7.14	0.48	-0.96

Summary of all series in the hierarchy

	ETS								ARI			
	MSE				MASE				MSE			
Method	1	2	3	4	1	2	3	4	1	2	3	4
Benchmark	-301.11	-132.24	-52.19	-17.98	-55.84	-28.42	-12.61	-2.42	-268.67	-122.65	-47.54	-21.5
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
Bottom-up	-7.41	0.91	5.41	9.02	0.00	1.05	0.90	1.61	-21.54	-11.88	-6.64	-2.3
OLS	6.94	5.99	5.43	4.77	-10.39	-9.47	-11.71	-12.10	6.63	5.01	4.33	4.0
WLS	9.89	10.84	10.22	10.41	1.30	2.11	0.90	0.81	5.79	5.50	6.05	6.7
MinT Shrink	11.26	12.10	10.40	10.42	2.60	2.11	1.80	0.81	7.14	5.18	5.91	5.5

Expenditure approach - Probabilistic forecasting (Non-parametric Bootstrap approach)

Predictive ability of multivariate forecast distribution of the whole hierarchy

	ETS								ARIMA				
	ES				VS				ES				
Method	1	2	3	4	1	2	3	4	1	2	3	4	
Benchmark	-103.71	-50.21	-16.69	-1.06	-95.71	-45.37	-12.23	4.58	-93.65	-48.12	-17.52	-4.58	-84.
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.
Bottom-up	-1.16	1.74	3.00	3.23	1.49	3.84	4.86	7.07	-5.24	-2.23	-0.85	0.23	-2.
OLS	4.42	3.79	3.35	2.90	0.44	-1.80	-3.56	-4.66	3.92	3.04	2.65	2.54	0.
WLS	6.58	6.36	5.37	4.40	5.09	4.29	3.66	2.91	4.25	3.50	3.31	3.24	5.
MinT Shrink	6.73	6.31	4.89	4.05	6.12	3.63	2.66	1.28	4.34	2.62	2.42	1.84	4.

Predictive ability of univariate forecast distributions

Summary of GDP - The most aggregate series

	ETS (CRPS)				ARIMA (CRPS)			
Method	1	2	3	4	1	2	3	4
Benchmark	-145.58	-62.25	-15.91	-5.28	-146.33	-54.60	-22.52	-9.98
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottom-up	-9.78	-4.06	4.99	-0.41	-15.96	1.99	-2.61	-0.23
OLS	5.54	4.93	5.94	4.29	2.18	3.60	3.17	4.03
WLS	6.86	5.91	8.71	4.73	0.75	3.38	2.41	3.65
MinT Shrink	6.86	4.51	8.15	5.67	0.38	0.87	0.75	1.59

Summary of all aggregate level series

	ETS (CRPS)				ARIMA (CRPS)			
Method	1	2	3	4	1	2	3	4
Benchmark	-78.02	-61.91	-26.48	-7.91	-73.77	-60.75	-26.93	-11.29
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	3.96	3.77	3.28	2.87	3.66	2.39	2.54	1.96
WLS	6.72	6.84	5.29	3.96	3.61	2.45	3.50	2.75
MinT Shrink	7.07	7.35	5.21	3.84	3.92	1.72	2.90	1.66

Summary of all disaggregate series

	ETS (CRPS)				ARIMA (CRPS)			
Method	1	2	3	4	1	2	3	4
Benchmark	-21.66	-6.40	-23.56	-20.25	-19.81	-3.71	-20.12	-17.64
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	-4.76	-6.87	-6.02	-7.84	-3.47	-3.37	-3.99	-4.75
WLS	1.17	-0.43	-0.73	-2.24	1.18	0.81	0.43	0.07
MinT Shrink	1.68	-0.89	-1.40	-2.87	1.05	0.61	-0.25	-1.03

Summary of all series in the hierarchy

	ETS (CRPS)				ARIMA (CRPS)			
Method	1	2	3	4	1	2	3	4
Benchmark	-55.07	-38.75	-25.54	-11.54	-51.91	-36.69	-24.68	-13.23
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	0.41	-0.67	0.27	-0.28	0.78	-0.04	0.39	-0.08
WLS	4.46	3.81	3.35	2.14	2.63	1.76	2.49	1.93
MinT Shrink	4.87	3.91	3.08	1.87	2.76	1.25	1.86	0.84

Expenditure approach - Probabilistic forecasting (Parametric approach assuming Gaussianity)

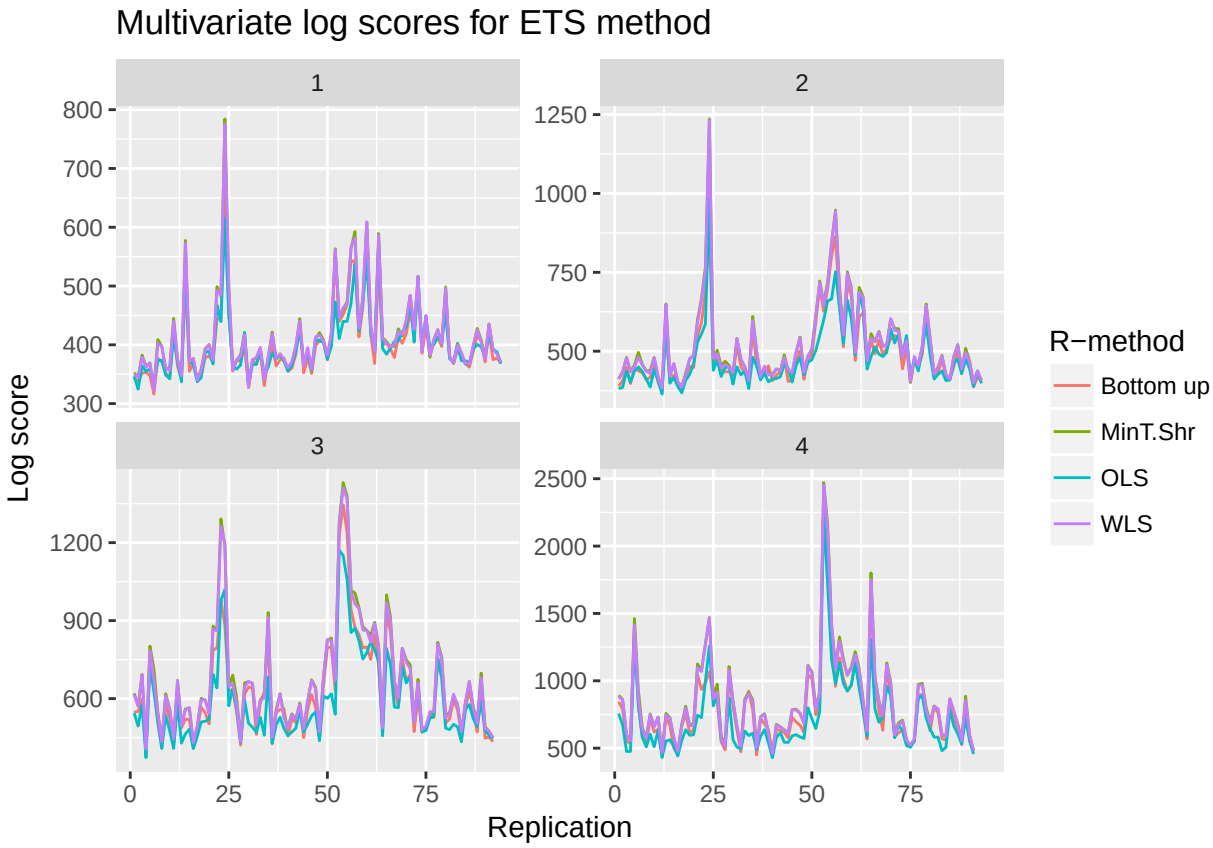
Predictive ability in the multivariate forecast distribution of the whole hierarchy

	ETS									
	ES				VS				ES	
Method	1	2	3	4	1	2	3	4	1	2
Benchmark	-93.6361	-44.9789	-13.7444	1.0137	-91.7685	-44.2491	-12.5531	4.1985	-84.6833	-43.3660
Base	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Bottom-up	-1.0528	1.8076	3.0052	2.9248	1.8086	4.0948	5.1375	7.0750	-6.3742	-3.7553
OLS	2.6334	1.9987	1.5944	1.1649	-0.4071	-2.4218	-3.9372	-5.0130	2.3400	1.3225
WLS	3.9289	3.6614	2.8443	1.9129	3.8934	3.3825	3.0640	2.3697	1.5594	0.6744
MinT Shrink	4.3696	4.0238	2.8784	1.8491	5.0031	2.8811	2.2176	0.7262	1.9085	0.1663

	ETS				ARIMA			
Method	1	2	3	4	1	2	3	4
Bottom-up	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	0.12	2.92	6.09	9.12	0.53	4.69	9.20	13.10
WLS	-3.26	-5.20	-6.58	-6.95	-3.05	-4.56	-5.51	-5.90
MinT Shrink	-3.47	-5.80	-7.59	-8.22	-3.48	-5.33	-6.47	-7.06

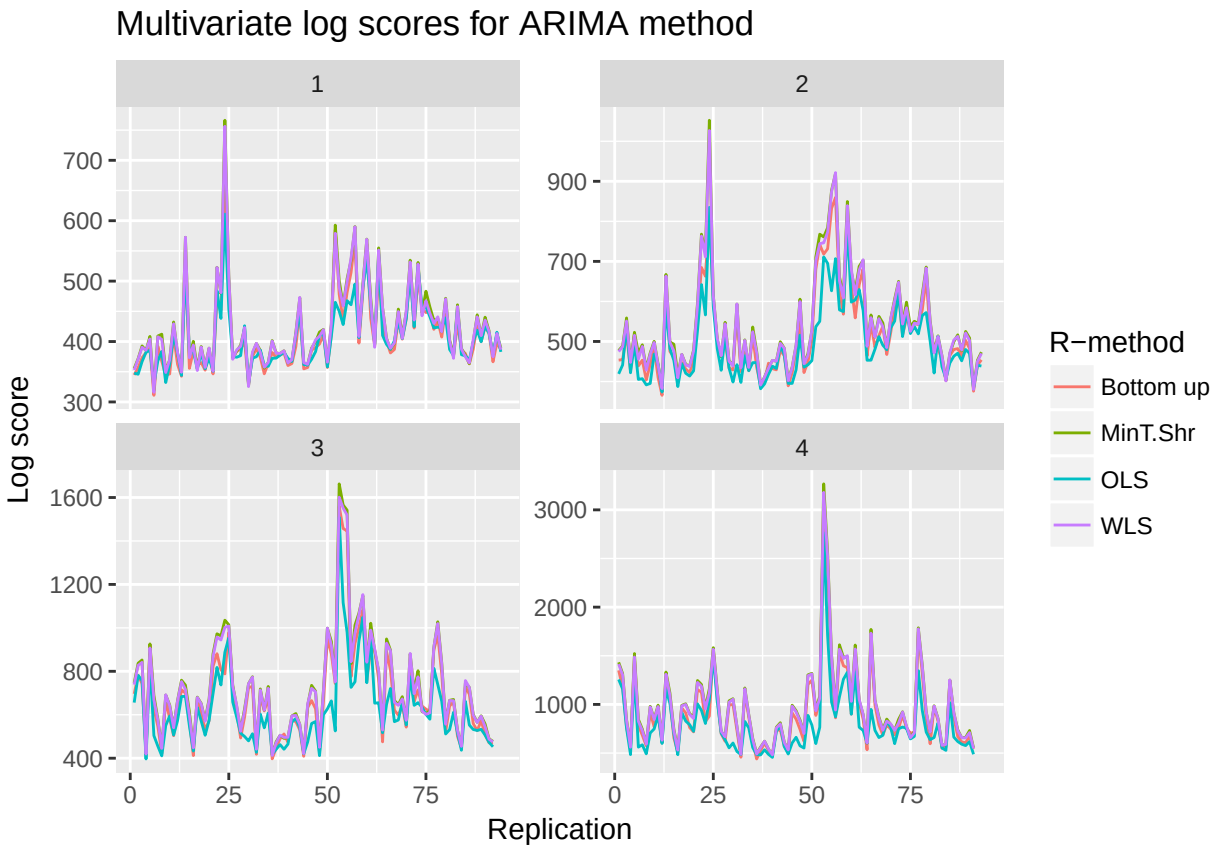
```
DF_MultiV %>% dplyr::select(-`Energy score`, -`Variogram score`) %>%
  filter(`Log score` != "NA") %>%
  filter(`F-method` == "ETS") -> DF_Mult_LS_ETS

DF_Mult_LS_ETS %>% ggplot(aes(x = `Replication`, y = `Log score`, color = `R-method`)) +
  geom_line() + facet_wrap(~`Forecast Horizon`, scales = "free_y") + ggtitle("Multivariate log scores fo
```




```
DF_MultiV %>% dplyr::select(-`Energy score`, -`Variogram score`) %>%
  filter(`Log score` != "NA") %>%
  filter(`F-method` == "ARIMA") -> DF_Mult_LS_ARIMA

DF_Mult_LS_ARIMA %>% ggplot(aes(x = `Replication`, y = `Log score`, color = `R-method`)) +
  geom_line() + facet_wrap(~`Forecast Horizon`, scales = "free_y") + ggtitle("Multivariate log scores fo
```



Predictive ability of univariate forecast distributions

Summary of GDP - The most aggregate series

	ETS								ARIMA				
	CRPS				LS				CRPS				
Method	1	2	3	4	1	2	3	4	1	2	3	4	
Benchmark	-130.00	-58.82	-12.94	-4.28	-5.53	11.24	29.09	36.32	-133.49	-49.65	-20.19	-8.14	-4.1
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
OLS	4.24	3.26	4.98	3.17	-1.44	-4.49	-5.58	-7.27	1.39	2.29	2.09	3.08	-2.1
WLS	5.87	3.75	7.82	2.85	-2.85	-7.56	-7.39	-9.31	-0.22	1.83	1.00	2.05	-3.7
MinT Shrink	5.72	2.98	7.43	4.21	-3.36	-9.06	-10.51	-12.34	-0.87	-0.69	-0.46	0.31	-4.1

Summary of all aggregate level series

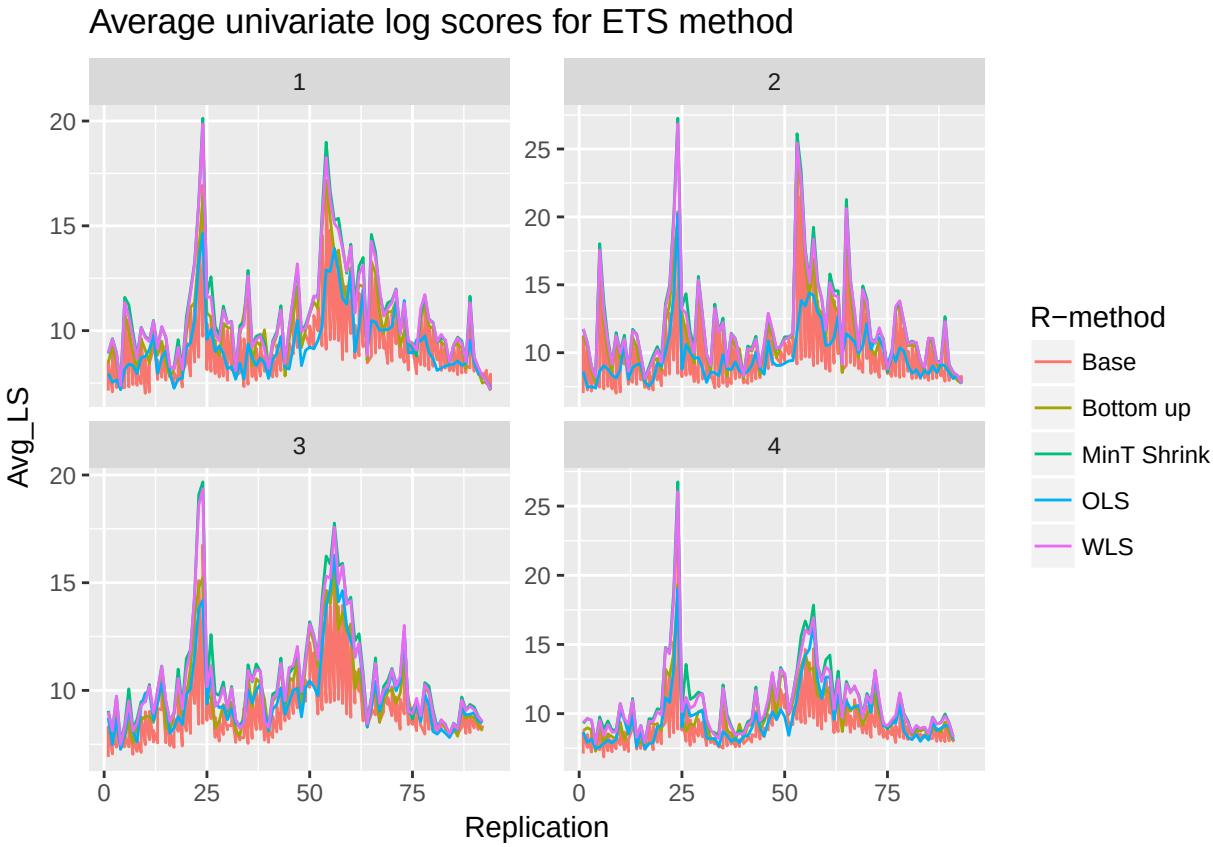
	ETS								ARIMA				
	CRPS				LS				CRPS				
Method	1	2	3	4	1	2	3	4	1	2	3	4	
Benchmark	-70.80	-55.79	-22.73	-5.75	11.95	1.74	12.44	22.13	-66.95	-55.09	-23.68	-9.08	11.2
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0
OLS	2.25	1.65	1.12	0.74	-1.35	-3.26	-4.78	-4.81	2.07	0.52	0.47	0.11	-0.6
WLS	4.13	3.80	2.27	0.97	-11.85	-8.79	-13.68	-17.23	0.89	-0.62	0.29	-0.41	-12.8
MinT Shrink	4.78	4.90	2.65	1.15	-12.91	-9.45	-15.31	-19.68	1.54	-0.96	0.19	-0.98	-14.5

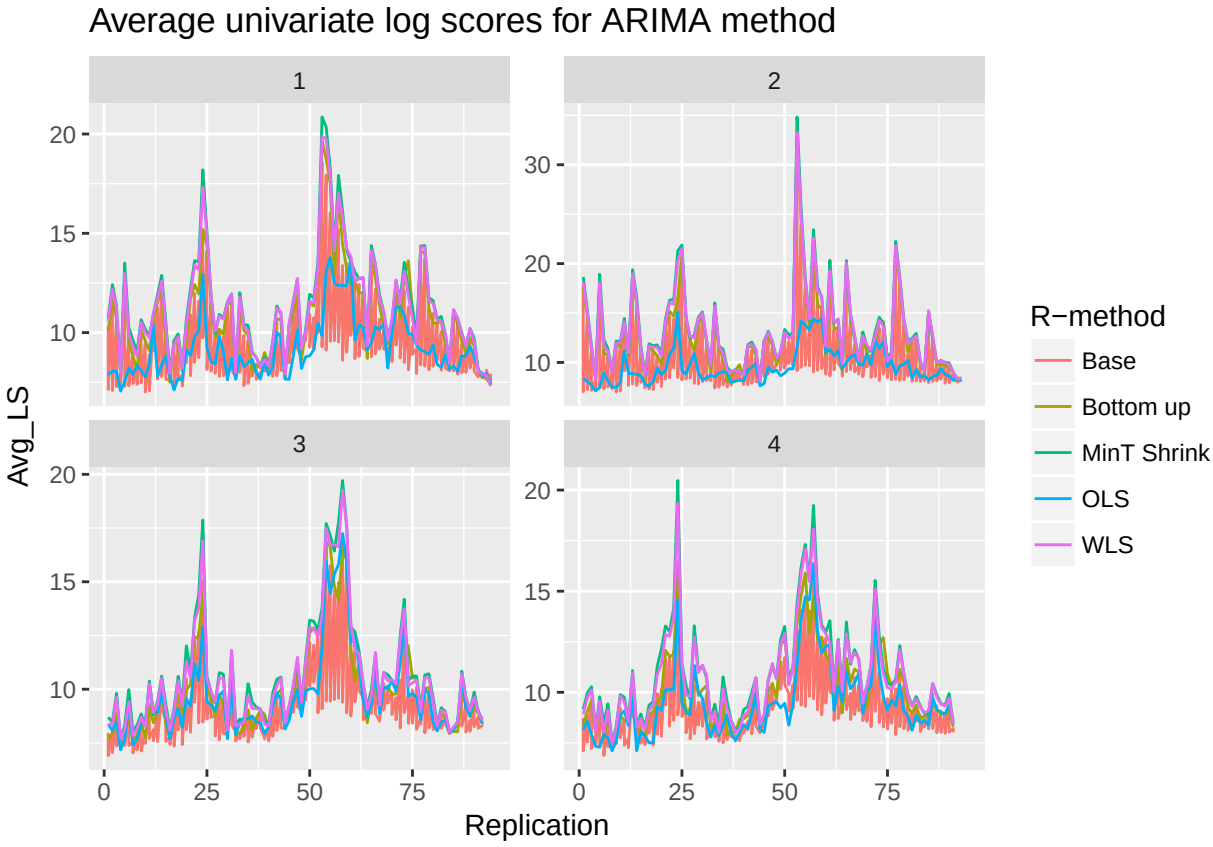
Summary of all disaggregate series

	ETS								ARIMA				
	CRPS				LS				CRPS				
Method	1	2	3	4	1	2	3	4	1	2	3	4	1
Benchmark	-21.37	-6.39	-22.58	-19.45	21.03	36.61	17.12	12.00	-18.89	-3.17	-18.96	-16.45	27.52
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	-4.64	-6.43	-6.11	-7.67	12.98	21.02	3.57	6.95	-3.16	-3.09	-4.04	-4.66	21.14
WLS	-0.06	-1.30	-1.58	-3.08	-3.02	-3.76	-2.94	-2.91	0.44	0.13	-0.36	-0.65	-2.22
MinT Shrink	0.64	-1.56	-2.05	-3.54	-4.12	-5.36	-4.20	-3.92	0.54	0.19	-0.79	-1.52	-3.60

Summary of all series in the hierarchy

	ETS								ARIMA				
	CRPS				LS				CRPS				
Method	1	2	3	4	1	2	3	4	1	2	3	4	1
Benchmark	-50.77	-35.31	-22.68	-9.74	17.94	27.04	15.46	16.15	-47.50	-33.24	-22.13	-11.32	22.25
Base	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OLS	-0.54	-1.70	-1.20	-1.71	8.03	14.31	0.51	2.22	-0.05	-1.00	-1.01	-1.33	13.99
WLS	2.43	1.69	1.03	-0.21	-6.14	-5.18	-6.82	-8.58	0.71	-0.30	0.08	-0.48	-5.63
MinT Shrink	3.10	2.22	1.14	-0.22	-7.14	-6.50	-8.24	-10.19	1.14	-0.48	-0.13	-1.14	-7.14


Average univariate log scores for ETS method
1
2
3
4
Avg_LS
Replication
R−method
Base
Bottom up
MinT Shrink
OLS
WLS


Average univariate log scores for ARIMA method
1
2
3
4
Avg_LS
Replication
R−method
Base
Bottom up
MinT Shrink
OLS
WLS