

Follow-Up Study to Master Thesis

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Abstract

Any scientific result should, if possible, be validated (preferably by external peers) on data that was not available at the time of the original analysis. This is to ensure that no deliberate or accidental peeking has biased the results. Here I apply the same methods that were used in thesis on new 2015 data. Obtaining data turned out to – still – be a non-trivial exercise, because of serious data quality issues affecting the entsoe transparency platform.

The results from the follow-up study are in line with the original results. The jonsson model still performs best amongst the individual models. The combined forecast that shows the best forecast performance in the thesis is again superiour, being only slightly worse on average than the exaa benchmark. It is also shown that a combination of the best combination forecast and the exaa benchmark forecast has a better precision than the exaa forecast on its own.

1 Data

In Jan 2016, I updated the data with an additional year so I could test whether the results from my thesis are still valid.

Originally I had planned to use ENTSOE's new transparency website but, surprisingly, it had a lot of missing values (and a horrible description of data). Therefore I defaulted to the TSO data sources described in the thesis. The entsoe consumption forecast was again missing in around 5% of observations, while both consumption forecasts and actuals were missing in 0.5% of observations. For these missing values a combination of LOCF, previous day and linear was used for imputing missing values.

I thought it would be a breeze to update data, but it turned out that this is still quite an involved task.. Hopefully ENTSOE will improve their act and eventually make quality data easily accessible for countries throughout Europe..

2 Results

The main tables being compared with in the thesis are: Table 15 – Root Mean Square Errors (wRMSE) by week, Table 16 – Relative Root Mean Squared Errors (wRRMSE) by week, Table 36 – Weekly Mean Absolute Errors (wMAE) by week and Table 37 – Relative Weekly Mean Absolute Errors (wRMAE) by week.

Note that the model names shown in columns are slightly different from the thesis convention – most importantly exaa = mcb. Also, compared to the thesis some of the more simple models have been excluded and two additional combination forecasts have been added.

In table 2 we observe that the exaa forecast has a RMSE of 4.56 in 2015, compared with 4.02 during the period covered in the thesis. This indicates that the series is slightly harder to forecast in 2015 compared to 2014 (but note that the 3 last days were excluded from 2014 in the thesis). We see that the best performing single model is the two-step jonsson model with a RMSE of 4.73. In table 2 we see that this is only 4% higher than the exaa benchmark forecast. Comparing with 2014 we see that most models are closer to the exaa benchmark, indicating that forecast performance for the models have not deteriorated as much as the exaa forecast performance.

In the follow-up study two additional combination forecasts are included. The most interesting here is CF4 which is an equal weighted combination of the exaa price and the best combination forecasts from the thesis. This reduces the RMSE with 9 percentage points.

For an epex auction participant it might make sense to wait for the exaa price available at 10.15 on weekdays and combine the information present in the public exaa price with any private forecast, before bidding into the primary day-ahead auction.

An obvious improvement to the models, which was also hinted at in the thesis, is to include a forecast of the cross-country electricity flows. My guess is that the omission of this variable is one of the reasons for the superior performance of the jonsson model. Because of the seasonality present in the flows (Fig 35 in thesis), the jonsson model is able to implicitly account for some of the effect by adjusting parameters. This advantage would diminish by explicitly including a flow forecasts. In general one of the attractive features of the jonsson model, is this ability to quickly adapt to changing x-y relationships. In the context of electricity systems such shifts are to be expected as a result of plant outages, etc.

Week	EXAA	Linear	ARIMAX	JonssonStep1	JonssonStep2	SvmLinear	SvmRadial	avNNET	CF1	CF2	CF3	CF4
1	8.98	7.49	8.62	8.10	7.76	9.99	12.68	10.41	9.44	8.32	7.96	8.48
2	5.19	7.22	6.46	6.82	6.98	6.56	8.53	10.37	7.44	6.71	6.71	5.68
3	4.59	6.66	5.52	5.16	4.83	5.74	5.49	7.38	5.45	4.70	4.65	4.30
4	2.68	8.08	5.16	3.14	3.21	6.08	6.92	8.30	6.20	3.83	3.17	2.81
5	3.11	4.71	3.36	3.51	3.50	5.46	5.20	5.54	4.46	3.70	3.52	2.90
6	6.12	4.44	4.74	5.41	5.25	4.65	5.22	6.06	4.60	4.58	4.84	5.07
7	5.06	4.20	4.30	4.33	4.19	4.75	5.32	4.95	4.27	4.07	4.09	4.30
8	3.97	5.01	5.02	4.96	4.90	5.31	4.48	4.50	4.46	4.53	4.68	3.99
9	4.03	4.18	3.77	4.36	4.02	4.49	3.95	4.59	3.49	3.54	3.74	3.55
10	3.98	4.36	3.62	4.54	4.33	3.94	3.91	3.90	3.40	3.61	3.92	3.43
11	3.80	4.79	3.98	4.36	4.01	5.21	3.92	3.85	3.81	3.78	3.87	3.50
12	3.69	3.95	3.64	3.97	3.74	4.10	3.31	3.47	3.24	3.36	3.52	3.37
13	4.90	5.03	4.61	5.08	4.80	4.64	5.32	5.83	4.75	4.60	4.66	4.48
14	5.75	5.44	5.05	5.06	5.17	6.59	5.99	5.94	5.09	4.93	5.00	4.86
15	13.04	10.45	10.19	11.68	11.62	11.04	11.12	10.48	10.53	11.00	11.29	11.93
16	7.66	4.77	5.95	5.05	4.89	5.50	5.37	5.33	4.87	4.69	4.75	5.82
17	2.36	2.68	2.43	2.74	2.62	3.09	2.65	2.76	2.36	2.33	2.44	2.06
18	3.21	4.96	3.91	3.43	3.29	4.08	5.49	4.68	4.24	3.55	3.35	2.91
19	4.41	7.07	6.28	5.74	5.66	5.75	5.06	5.78	4.36	4.39	4.91	3.96
20	2.94	4.32	3.51	3.37	3.21	4.16	4.99	4.87	3.85	2.84	2.84	2.52
21	2.69	4.43	3.31	3.66	3.39	4.33	5.29	5.68	4.17	3.30	3.21	2.80
22	3.34	3.63	3.88	3.77	3.88	2.72	3.87	3.44	3.00	3.14	3.45	3.06
23	3.20	4.39	4.00	3.54	3.39	3.75	4.39	4.38	3.67	3.29	3.28	2.93
24	2.65	4.27	4.21	4.45	4.23	3.84	3.24	4.24	3.48	3.69	3.93	2.93
25	2.63	3.72	4.22	4.58	4.54	3.77	2.43	3.27	2.87	3.58	4.04	2.65
26	2.35	5.20	5.65	3.59	3.61	4.04	2.75	2.86	3.37	3.29	3.41	2.36
27	3.73	5.35	5.05	5.02	4.52	6.52	6.26	6.44	5.87	5.08	4.77	3.69
28	5.56	6.58	6.06	5.91	5.59	8.57	8.38	8.68	7.33	6.08	5.72	4.94
29	3.66	5.20	4.64	5.16	4.94	6.67	6.43	5.57	5.54	4.62	4.62	3.50
30	4.87	6.53	6.53	4.48	4.26	8.34	6.78	6.03	6.38	4.91	4.45	4.38
31	4.06	5.50	4.22	5.21	4.83	3.66	4.44	5.17	3.53	3.91	4.32	3.40
32	4.01	3.42	3.32	4.72	4.46	3.64	4.50	4.33	3.65	3.86	4.12	3.69
33	3.45	3.61	3.47	2.83	2.82	2.87	4.07	4.39	3.37	2.92	2.82	3.05
34	2.87	3.25	3.18	3.26	3.11	3.09	3.35	3.99	3.10	2.85	2.92	2.72
35	3.34	4.10	3.89	3.97	3.95	3.10	3.65	3.77	3.28	3.55	3.74	3.15
36	5.57	8.40	8.81	5.95	5.73	4.36	5.02	4.27	3.57	3.96	4.75	4.45
37	3.02	4.83	5.13	4.04	3.78	3.92	3.68	4.36	3.80	3.62	3.66	3.17
38	3.13	3.42	3.08	3.28	2.91	3.38	3.56	3.31	2.86	2.71	2.77	2.68
39	3.47	5.40	4.71	4.74	4.79	4.39	4.77	4.86	4.47	4.50	4.62	3.78
40	2.70	3.80	3.00	3.16	2.53	3.50	2.82	3.54	2.92	2.54	2.49	2.43
41	2.73	4.84	4.39	3.58	3.61	3.77	4.88	5.83	4.46	3.63	3.50	2.60
42	4.08	4.16	4.23	4.54	4.37	4.92	4.24	4.07	3.89	3.90	4.09	3.71
43	4.26	4.04	3.84	3.78	3.66	4.17	3.94	3.98	3.67	3.47	3.52	3.30
44	3.88	4.80	4.52	4.63	4.71	4.68	5.11	5.64	4.66	4.20	4.34	3.90
45	3.62	5.25	5.12	5.92	5.73	5.01	4.42	4.60	4.33	4.68	5.13	3.84
46	6.61	10.53	8.23	5.72	5.41	8.71	7.81	8.18	7.71	6.08	5.59	5.99
47	4.32	7.15	6.56	4.44	4.34	5.98	5.11	4.69	4.39	4.07	4.13	3.98
48	5.07	5.89	5.73	5.90	5.95	7.05	5.66	5.46	5.42	5.53	5.71	5.12
49	4.00	4.52	3.96	3.95	3.97	4.94	6.69	6.25	4.71	3.92	3.83	3.70
50	3.47	5.12	4.53	5.60	5.44	4.14	5.26	5.34	4.41	4.59	4.94	3.16
51	2.62	4.54	3.87	3.94	3.53	5.03	4.51	4.05	3.99	3.58	3.51	2.67
52	6.50	7.36	7.94	6.12	6.16	6.72	5.54	5.64	5.64	5.74	5.91	5.15
53	3.38	5.68	5.28	5.13	4.55	4.56	5.16	4.58	4.62	4.49	4.50	3.09
	4.56	5.49	5.09	4.88	4.73	5.33	5.39	5.53	4.78	4.46	4.52	4.15

Table 1: Weekly Root Mean Square Errors (wRMSE). CF1 is the combined forecast made by averaging the arimax, avnnet, svmlinear, and svmradial forecasts. CF2 is the average of the jonsson step two forecast and the CF1 forecast. CF3 is the average of the jonsson step two forecast and the exaa price. CF4 is the average of the CF2 forecast and the exaa price.

Week	EXAA	Linear	ARIMAX	JonssonStep1	JonssonStep2	SvmLinear	SvmRadial	avNNET	CF1	CF2	CF3	CF4
1	1.00	0.83	0.96	0.90	0.86	1.11	1.41	1.16	1.05	0.93	0.89	0.94
2	1.00	1.39	1.24	1.32	1.35	1.27	1.64	2.00	1.43	1.29	1.29	1.09
3	1.00	1.45	1.20	1.12	1.05	1.25	1.20	1.61	1.19	1.02	1.01	0.94
4	1.00	3.02	1.93	1.17	1.20	2.27	2.59	3.10	2.32	1.43	1.19	1.05
5	1.00	1.51	1.08	1.13	1.13	1.75	1.67	1.78	1.43	1.19	1.13	0.93
6	1.00	0.73	0.77	0.88	0.86	0.76	0.85	0.99	0.75	0.75	0.79	0.83
7	1.00	0.83	0.85	0.85	0.83	0.94	1.05	0.98	0.84	0.80	0.81	0.85
8	1.00	1.26	1.26	1.25	1.23	1.34	1.13	1.13	1.12	1.14	1.18	1.00
9	1.00	1.04	0.93	1.08	1.00	1.11	0.98	1.14	0.87	0.88	0.93	0.88
10	1.00	1.09	0.91	1.14	1.09	0.99	0.98	0.98	0.85	0.91	0.98	0.86
11	1.00	1.26	1.05	1.15	1.06	1.37	1.03	1.01	1.00	1.00	1.02	0.92
12	1.00	1.07	0.98	1.08	1.01	1.11	0.90	0.94	0.88	0.91	0.95	0.91
13	1.00	1.03	0.94	1.04	0.98	0.95	1.08	1.19	0.97	0.94	0.95	0.91
14	1.00	0.95	0.88	0.88	0.90	1.15	1.04	1.03	0.88	0.86	0.87	0.85
15	1.00	0.80	0.78	0.90	0.89	0.85	0.85	0.80	0.81	0.84	0.87	0.91
16	1.00	0.62	0.78	0.66	0.64	0.72	0.70	0.70	0.64	0.61	0.62	0.76
17	1.00	1.14	1.03	1.16	1.11	1.31	1.12	1.17	1.00	0.99	1.03	0.87
18	1.00	1.55	1.22	1.07	1.03	1.27	1.71	1.46	1.32	1.11	1.05	0.91
19	1.00	1.60	1.43	1.30	1.29	1.31	1.15	1.31	0.99	1.00	1.11	0.90
20	1.00	1.47	1.19	1.15	1.09	1.42	1.70	1.66	1.31	0.97	0.97	0.86
21	1.00	1.65	1.23	1.36	1.26	1.61	1.97	2.11	1.55	1.23	1.20	1.04
22	1.00	1.09	1.16	1.13	1.16	0.81	1.16	1.03	0.90	0.94	1.03	0.92
23	1.00	1.37	1.25	1.10	1.06	1.17	1.37	1.37	1.14	1.03	1.02	0.92
24	1.00	1.61	1.59	1.68	1.60	1.45	1.22	1.60	1.31	1.39	1.48	1.11
25	1.00	1.42	1.61	1.74	1.73	1.43	0.93	1.24	1.09	1.36	1.54	1.01
26	1.00	2.21	2.40	1.53	1.54	1.72	1.17	1.22	1.43	1.40	1.45	1.00
27	1.00	1.43	1.35	1.34	1.21	1.75	1.68	1.73	1.57	1.36	1.28	0.99
28	1.00	1.18	1.09	1.06	1.00	1.54	1.51	1.56	1.32	1.09	1.03	0.89
29	1.00	1.42	1.26	1.41	1.35	1.82	1.75	1.52	1.51	1.26	1.26	0.96
30	1.00	1.34	1.34	0.92	0.87	1.71	1.39	1.24	1.31	1.01	0.91	0.90
31	1.00	1.35	1.04	1.28	1.19	0.90	1.09	1.27	0.87	0.96	1.06	0.84
32	1.00	0.85	0.83	1.18	1.11	0.91	1.12	1.08	0.91	0.96	1.03	0.92
33	1.00	1.05	1.01	0.82	0.82	0.83	1.18	1.27	0.98	0.85	0.82	0.89
34	1.00	1.13	1.11	1.14	1.09	1.08	1.17	1.39	1.08	1.00	1.02	0.95
35	1.00	1.23	1.17	1.19	1.18	0.93	1.09	1.13	0.98	1.07	1.12	0.94
36	1.00	1.51	1.58	1.07	1.03	0.78	0.90	0.77	0.64	0.71	0.85	0.80
37	1.00	1.60	1.70	1.34	1.25	1.30	1.22	1.44	1.26	1.20	1.21	1.05
38	1.00	1.09	0.98	1.05	0.93	1.08	1.14	1.06	0.91	0.87	0.88	0.86
39	1.00	1.56	1.36	1.37	1.38	1.27	1.38	1.40	1.29	1.30	1.33	1.09
40	1.00	1.41	1.11	1.17	0.94	1.30	1.04	1.31	1.08	0.94	0.92	0.90
41	1.00	1.77	1.61	1.31	1.32	1.38	1.79	2.14	1.63	1.33	1.28	0.95
42	1.00	1.02	1.04	1.11	1.07	1.21	1.04	1.00	0.95	0.96	1.00	0.91
43	1.00	0.95	0.90	0.89	0.86	0.98	0.93	0.93	0.86	0.82	0.83	0.77
44	1.00	1.24	1.17	1.19	1.22	1.21	1.32	1.45	1.20	1.08	1.12	1.01
45	1.00	1.45	1.41	1.63	1.58	1.38	1.22	1.27	1.20	1.29	1.42	1.06
46	1.00	1.59	1.25	0.87	0.82	1.32	1.18	1.24	1.17	0.92	0.85	0.91
47	1.00	1.65	1.52	1.03	1.01	1.38	1.18	1.09	1.02	0.94	0.96	0.92
48	1.00	1.16	1.13	1.16	1.17	1.39	1.12	1.08	1.07	1.09	1.13	1.01
49	1.00	1.13	0.99	0.99	0.99	1.24	1.67	1.56	1.18	0.98	0.96	0.93
50	1.00	1.48	1.31	1.62	1.57	1.19	1.51	1.54	1.27	1.32	1.43	0.91
51	1.00	1.73	1.48	1.50	1.34	1.92	1.72	1.55	1.52	1.37	1.34	1.02
52	1.00	1.13	1.22	0.94	0.95	1.03	0.85	0.87	0.87	0.88	0.91	0.79
53	1.00	1.68	1.56	1.52	1.35	1.35	1.53	1.36	1.37	1.33	1.33	0.92
	1.00	1.20	1.12	1.07	1.04	1.17	1.18	1.21	1.05	0.98	0.99	0.91

Table 2: Weekly Relative Root Mean Square Errors (wRRMSE). CF1 is the combined forecast made by averaging the arimax, avnnet, svmlinear, and svmradial forecasts. CF2 is the average of the jonsson step two forecast and the CF1 forecast. CF3 is the average of the jonsson step two forecast and the exaa price. CF4 is the average of the CF2 forecast and the exaa price.

Week	EXAA	Linear	ARIMAX	JonssonStep1	JonssonStep2	SvmLinear	SvmRadial	avNNET	CF1	CF2	CF3	CF4
1	6.35	5.23	5.61	4.84	4.72	6.68	9.95	7.41	6.56	5.22	4.83	5.60
2	3.99	5.54	5.09	5.03	5.23	4.99	7.04	8.66	6.01	5.09	4.99	4.44
3	2.95	5.09	4.16	4.10	3.62	4.27	4.20	5.55	4.10	3.54	3.52	3.01
4	2.06	6.33	3.47	2.37	2.46	5.28	5.88	6.79	5.08	2.79	2.36	2.11
5	2.26	3.76	2.58	2.62	2.57	4.32	3.89	4.38	3.44	2.81	2.64	2.19
6	4.32	3.25	3.65	4.00	3.92	3.42	3.70	4.79	3.40	3.34	3.55	3.76
7	3.47	3.08	3.13	3.17	3.09	3.50	3.97	3.89	3.22	3.04	3.02	3.06
8	3.12	3.97	3.95	3.98	3.98	4.13	3.52	3.40	3.50	3.65	3.79	3.16
9	3.14	3.44	3.10	3.58	3.25	3.72	3.30	3.64	2.96	2.96	3.07	2.94
10	3.17	3.50	2.82	3.56	3.41	3.05	3.18	3.16	2.72	2.85	3.09	2.68
11	2.65	3.61	3.01	3.44	3.08	3.95	2.95	2.94	2.87	2.89	2.96	2.55
12	2.68	3.09	2.91	3.07	3.03	3.24	2.69	2.68	2.59	2.73	2.87	2.59
13	3.37	3.53	3.13	3.35	3.20	3.04	3.64	4.21	3.26	3.06	3.08	3.04
14	4.47	4.40	4.07	3.89	3.99	5.35	4.62	4.88	4.06	3.90	3.90	3.80
15	5.92	4.61	4.41	5.08	5.06	5.09	4.89	4.67	4.36	4.49	4.74	5.03
16	3.62	3.36	3.96	3.35	3.43	3.53	3.09	3.19	3.04	3.02	3.19	3.05
17	1.78	2.14	1.91	2.21	2.15	2.37	2.05	2.19	1.82	1.89	1.98	1.57
18	2.43	3.93	3.09	2.72	2.62	3.15	3.95	3.53	3.19	2.78	2.66	2.34
19	3.14	5.76	4.24	4.32	4.25	4.64	4.27	4.46	3.47	3.35	3.70	3.03
20	2.27	3.70	2.69	2.66	2.56	3.29	4.01	4.01	3.10	2.14	2.18	1.96
21	2.04	3.65	2.59	2.89	2.66	3.60	4.25	4.70	3.38	2.57	2.51	2.19
22	2.54	2.60	2.80	2.89	2.95	1.98	3.00	2.66	2.24	2.39	2.63	2.33
23	2.59	3.69	3.27	2.76	2.61	2.99	3.41	3.61	2.99	2.66	2.58	2.33
24	2.09	3.52	3.20	3.53	3.32	3.08	2.50	3.46	2.85	3.02	3.15	2.34
25	2.06	2.92	3.37	3.61	3.70	2.82	1.96	2.51	2.28	2.86	3.26	2.05
26	1.88	3.59	4.03	2.82	2.76	3.18	2.29	2.35	2.68	2.59	2.65	1.87
27	2.77	3.78	3.43	3.31	2.95	4.93	4.63	4.69	4.19	3.40	3.13	2.48
28	4.19	4.54	4.00	4.04	3.88	6.92	6.01	6.14	5.07	3.99	3.83	3.65
29	2.89	4.03	3.44	4.22	3.99	5.59	4.93	4.26	4.22	3.55	3.65	2.66
30	3.53	5.23	5.01	3.49	3.37	7.50	5.68	4.96	5.34	3.89	3.54	3.37
31	3.22	4.86	3.16	4.13	3.67	3.02	3.57	4.25	2.85	3.12	3.36	2.88
32	3.17	2.77	2.63	3.93	3.61	2.98	3.70	3.42	2.86	3.08	3.29	2.99
33	2.71	2.85	2.66	2.24	2.18	2.26	3.30	3.52	2.63	2.29	2.21	2.37
34	2.24	2.46	2.43	2.62	2.46	2.51	2.57	2.95	2.34	2.28	2.33	2.16
35	2.65	3.32	3.07	3.22	3.15	2.41	3.00	3.19	2.69	2.88	3.00	2.51
36	3.48	4.71	4.66	3.96	3.67	3.25	3.58	3.34	2.82	2.86	3.20	2.92
37	2.24	3.99	3.86	3.10	2.83	3.11	2.86	3.42	2.93	2.76	2.77	2.37
38	2.45	2.76	2.53	2.69	2.38	2.63	2.91	2.60	2.31	2.21	2.27	2.20
39	2.65	4.20	3.70	3.70	3.73	3.38	3.38	3.56	3.30	3.45	3.58	2.87
40	2.04	3.16	2.42	2.28	1.89	2.89	2.22	2.84	2.38	2.04	1.93	1.91
41	1.89	3.52	2.92	2.81	2.88	2.84	3.87	4.48	3.37	2.80	2.76	1.84
42	3.14	3.21	3.33	3.51	3.41	3.92	3.41	3.29	3.12	3.06	3.18	2.91
43	3.20	3.32	3.12	3.18	3.01	3.29	3.13	3.25	2.94	2.79	2.87	2.58
44	3.01	3.98	3.53	3.59	3.72	3.95	4.06	4.57	3.86	3.38	3.37	3.13
45	2.84	4.17	4.08	4.47	4.20	3.78	3.56	3.81	3.44	3.47	3.75	2.92
46	4.50	8.39	6.45	4.54	4.44	7.28	6.30	6.66	6.30	4.97	4.64	4.55
47	3.45	5.30	5.27	3.33	3.33	4.75	4.05	3.83	3.65	3.28	3.29	3.17
48	3.56	4.48	4.41	4.29	4.32	5.07	3.86	3.91	3.73	3.88	4.07	3.61
49	2.91	3.47	3.06	3.13	3.23	4.02	5.40	4.95	3.73	3.15	3.11	2.85
50	2.72	4.22	3.59	4.18	3.89	3.35	4.34	4.40	3.66	3.52	3.62	2.61
51	1.99	3.54	2.89	3.10	2.78	4.20	3.86	3.34	3.19	2.86	2.78	2.15
52	4.51	4.96	5.15	4.67	4.77	5.17	3.74	4.21	4.18	4.40	4.57	3.55
53	2.66	4.37	4.22	3.96	3.63	3.43	4.10	3.64	3.64	3.57	3.59	2.32
	3.01	3.97	3.55	3.49	3.36	3.89	3.88	4.04	3.44	3.16	3.20	2.82

Table 3: Weekly Mean Absolute Errors (wMAE). CF1 is the combined forecast made by averaging the arimax, avnnet, svmlinear, and svmradial forecasts. CF2 is the average of the jonsson step two forecast and the CF1 forecast. CF3 is the average of the jonsson step two forecast and the exaa price. CF4 is the average of the CF2 forecast and the exaa price.

Week	EXAA	Linear	ARIMAX	JonssonStep1	JonssonStep2	SvmLinear	SvmRadial	avNNET	CF1	CF2	CF3	CF4
1	1.00	0.82	0.88	0.76	0.74	1.05	1.57	1.17	1.03	0.82	0.76	0.88
2	1.00	1.39	1.27	1.26	1.31	1.25	1.76	2.17	1.51	1.27	1.25	1.11
3	1.00	1.72	1.41	1.39	1.23	1.45	1.42	1.88	1.39	1.20	1.19	1.02
4	1.00	3.07	1.68	1.15	1.19	2.56	2.86	3.29	2.47	1.36	1.15	1.02
5	1.00	1.66	1.14	1.15	1.13	1.91	1.72	1.94	1.52	1.24	1.16	0.97
6	1.00	0.75	0.85	0.93	0.91	0.79	0.86	1.11	0.79	0.77	0.82	0.87
7	1.00	0.89	0.90	0.91	0.89	1.01	1.14	1.12	0.93	0.87	0.87	0.88
8	1.00	1.27	1.27	1.28	1.28	1.32	1.13	1.09	1.12	1.17	1.21	1.01
9	1.00	1.09	0.99	1.14	1.03	1.18	1.05	1.16	0.94	0.94	0.97	0.93
10	1.00	1.10	0.89	1.12	1.07	0.96	1.00	0.99	0.86	0.90	0.97	0.85
11	1.00	1.36	1.14	1.30	1.16	1.49	1.11	1.11	1.08	1.09	1.12	0.96
12	1.00	1.15	1.08	1.14	1.13	1.21	1.00	1.00	0.96	1.02	1.07	0.97
13	1.00	1.05	0.93	0.99	0.95	0.90	1.08	1.25	0.97	0.91	0.91	0.90
14	1.00	0.98	0.91	0.87	0.89	1.20	1.04	1.09	0.91	0.87	0.87	0.85
15	1.00	0.78	0.75	0.86	0.86	0.86	0.83	0.79	0.74	0.76	0.80	0.85
16	1.00	0.93	1.09	0.92	0.95	0.97	0.85	0.88	0.84	0.83	0.88	0.84
17	1.00	1.20	1.07	1.24	1.21	1.33	1.15	1.23	1.02	1.06	1.11	0.88
18	1.00	1.62	1.27	1.12	1.08	1.30	1.63	1.45	1.31	1.14	1.10	0.96
19	1.00	1.84	1.35	1.38	1.36	1.48	1.36	1.42	1.11	1.07	1.18	0.97
20	1.00	1.63	1.18	1.17	1.13	1.45	1.77	1.77	1.36	0.94	0.96	0.86
21	1.00	1.79	1.27	1.42	1.31	1.77	2.08	2.31	1.66	1.26	1.23	1.07
22	1.00	1.02	1.10	1.14	1.16	0.78	1.18	1.05	0.88	0.94	1.04	0.92
23	1.00	1.43	1.26	1.07	1.01	1.15	1.32	1.39	1.15	1.03	1.00	0.90
24	1.00	1.69	1.53	1.69	1.59	1.48	1.20	1.66	1.37	1.45	1.51	1.12
25	1.00	1.42	1.63	1.75	1.80	1.37	0.95	1.22	1.11	1.39	1.58	0.99
26	1.00	1.91	2.15	1.51	1.47	1.69	1.22	1.25	1.43	1.38	1.41	1.00
27	1.00	1.36	1.24	1.19	1.06	1.78	1.67	1.69	1.51	1.22	1.13	0.90
28	1.00	1.08	0.95	0.96	0.93	1.65	1.44	1.46	1.21	0.95	0.91	0.87
29	1.00	1.39	1.19	1.46	1.38	1.93	1.70	1.47	1.46	1.23	1.26	0.92
30	1.00	1.48	1.42	0.99	0.95	2.12	1.61	1.40	1.51	1.10	1.00	0.95
31	1.00	1.51	0.98	1.28	1.14	0.94	1.11	1.32	0.88	0.97	1.04	0.89
32	1.00	0.88	0.83	1.24	1.14	0.94	1.17	1.08	0.90	0.97	1.04	0.94
33	1.00	1.05	0.98	0.83	0.80	0.83	1.22	1.30	0.97	0.85	0.82	0.88
34	1.00	1.10	1.08	1.17	1.10	1.12	1.15	1.32	1.04	1.02	1.04	0.97
35	1.00	1.25	1.16	1.22	1.19	0.91	1.13	1.21	1.02	1.09	1.13	0.95
36	1.00	1.35	1.34	1.14	1.05	0.93	1.03	0.96	0.81	0.82	0.92	0.84
37	1.00	1.78	1.73	1.39	1.27	1.39	1.28	1.53	1.31	1.23	1.24	1.06
38	1.00	1.13	1.03	1.10	0.97	1.07	1.19	1.06	0.94	0.90	0.92	0.90
39	1.00	1.59	1.39	1.40	1.41	1.27	1.28	1.34	1.25	1.30	1.35	1.08
40	1.00	1.55	1.19	1.12	0.93	1.42	1.09	1.39	1.17	1.00	0.95	0.94
41	1.00	1.86	1.54	1.48	1.52	1.50	2.04	2.36	1.78	1.48	1.45	0.97
42	1.00	1.02	1.06	1.12	1.08	1.25	1.08	1.05	0.99	0.97	1.01	0.92
43	1.00	1.04	0.98	0.99	0.94	1.03	0.98	1.02	0.92	0.87	0.90	0.81
44	1.00	1.32	1.17	1.20	1.24	1.31	1.35	1.52	1.28	1.12	1.12	1.04
45	1.00	1.47	1.44	1.57	1.48	1.33	1.25	1.34	1.21	1.22	1.32	1.03
46	1.00	1.86	1.43	1.01	0.99	1.62	1.40	1.48	1.40	1.10	1.03	1.01
47	1.00	1.54	1.53	0.97	0.97	1.38	1.17	1.11	1.06	0.95	0.95	0.92
48	1.00	1.26	1.24	1.20	1.21	1.42	1.08	1.10	1.05	1.09	1.14	1.01
49	1.00	1.19	1.05	1.08	1.11	1.38	1.85	1.70	1.28	1.08	1.07	0.98
50	1.00	1.55	1.32	1.54	1.43	1.23	1.60	1.62	1.34	1.30	1.33	0.96
51	1.00	1.78	1.45	1.56	1.40	2.11	1.94	1.68	1.60	1.44	1.40	1.08
52	1.00	1.10	1.14	1.04	1.06	1.15	0.83	0.93	0.93	0.97	1.01	0.79
53	1.00	1.64	1.59	1.49	1.37	1.29	1.54	1.37	1.37	1.34	1.35	0.87
	1.00	1.32	1.18	1.16	1.12	1.29	1.29	1.34	1.14	1.05	1.06	0.94

Table 4: Weekly Relative Mean Absolute Errors (wRMAE). CF1 is the combined forecast made by averaging the arimax, avnnet, svmlinear, and svmradial forecasts. CF2 is the average of the jonsson step two forecast and the CF1 forecast. CF3 is the average of the jonsson step two forecast and the exaa price. CF4 is the average of the CF2 forecast and the exaa price.