

A APPENDIX

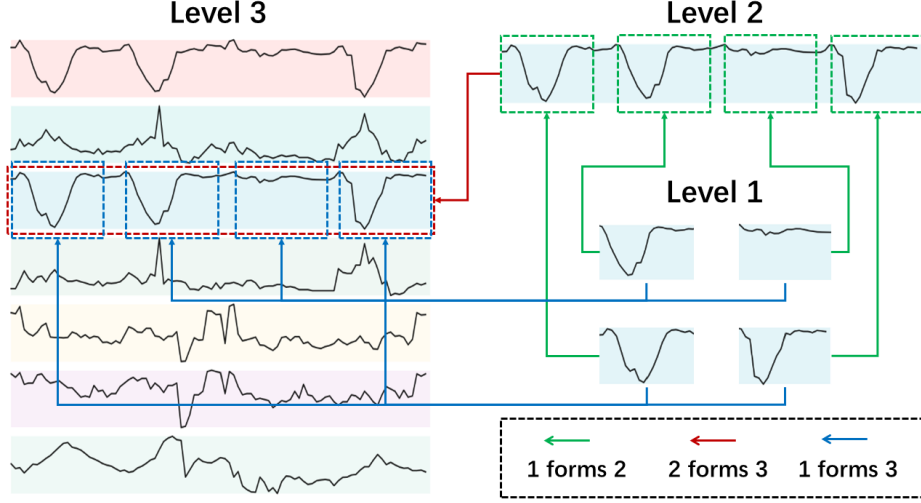


Figure 1: The ‘‘part-forms-whole’’ hierarchy in time series.

Table 1: Experiments with three recent strong baselines (TimePro, OLinear, and TimeMixer++) and the results for all models on the four PEMS subsets are included. The look-back window size is set to 96 for all experiments. The prediction horizons are $\{12, 24, 48, 96\}$ for the PEMS subsets and $\{96, 192, 336, 720\}$ for all other datasets.

Model	HyperTime		TimePro		OLinear		TimeXer		SOFTS		TimeMixer++		iTransformer		MSGNet	
Metric	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE
ETTh1	0.438	0.433	0.446	0.442	0.448	0.445	0.450	0.440	0.457	0.446	0.453	0.447	0.448	0.440	0.497	0.483
ETTh2	0.374	0.397	0.379	0.403	0.384	0.410	0.382	0.405	0.382	0.407	0.376	0.404	0.381	0.406	0.399	0.421
ETTm1	0.383	0.396	0.395	0.402	0.394	0.400	0.392	0.402	0.398	0.404	0.389	0.401	0.407	0.410	0.427	0.438
ETTm2	0.276	0.322	0.284	0.329	0.283	0.328	0.282	0.327	0.288	0.331	0.281	0.329	0.287	0.331	0.298	0.332
Exchange	0.348	0.395	0.354	0.401	0.346	0.407	0.374	0.411	0.361	0.405	0.351	0.397	0.360	0.405	0.360	0.406
Weather	0.251	0.274	0.255	0.278	0.252	0.273	0.247	0.276	0.257	0.278	0.245	0.275	0.260	0.281	0.254	0.279
ECL	0.179	0.274	0.182	0.275	0.180	0.274	0.184	0.280	0.190	0.276	0.184	0.279	0.185	0.275	0.195	0.298
Traffic	0.453	0.305	0.467	0.313	0.489	0.307	0.483	0.317	0.466	0.310	0.478	0.316	0.467	0.314	0.587	0.323
PEMS03	0.167	0.263	0.180	0.279	0.173	0.265	0.184	0.285	0.191	0.286	0.217	0.310	0.188	0.282	0.202	0.324
PEMS04	0.192	0.295	0.210	0.306	0.201	0.297	0.214	0.311	0.222	0.315	0.233	0.331	0.219	0.312	0.236	0.338
PEMS07	0.156	0.271	0.172	0.270	0.168	0.264	0.181	0.283	0.165	0.272	0.199	0.305	0.176	0.278	0.213	0.317
PEMS08	0.231	0.309	0.238	0.310	0.234	0.306	0.240	0.311	0.255	0.318	0.282	0.347	0.251	0.315	0.266	0.332

Table 2: The ablation study comparing HyperTime with HyperTime-CNN and HyperTime-Trans, to evaluate the performance impact of replacing the MLP with CNN or Transformer.

Model	HyperTime		HyperTime-CNN		HyperTime-Trans	
Metric	MSE	MAE	MSE	MAE	MSE	MAE
ETTh1 (7 channels)	0.438	0.433	0.438	0.434	0.440	0.436
Exchange (8 channels)	0.348	0.395	0.349	0.395	0.352	0.399
Weather (21 channels)	0.251	0.274	0.249	0.275	0.253	0.276
ECL (321 channels)	0.179	0.274	0.180	0.274	0.176	0.272
Traffic (862 channels)	0.453	0.305	0.455	0.306	0.447	0.301

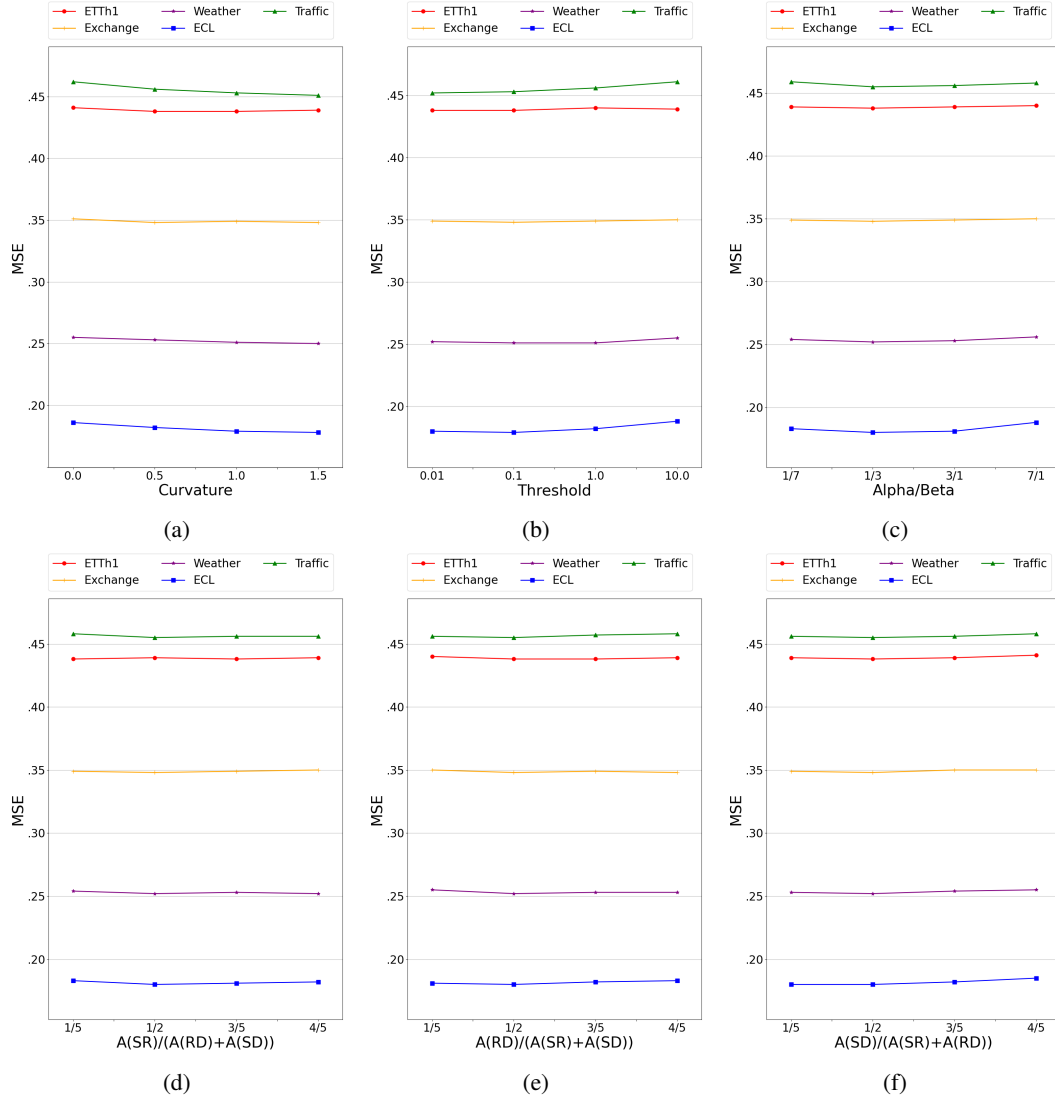


Figure 2: Analysis of the hyperbolic hyperparameters. Note that the curvature is inherently negative, we just present its absolute value.

Table 3: The results of all prediction horizons: $H \in \{96, 192, 336, 720\}$. The best results are shown in **bold**, and the second-best results are underlined.

Model		HyperTime		TimeXer		SOFTS		TimeMixer		iTransformer		PatchTST		TimesNet		MSGNet	
Metric		MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE	MSE	MAE
ETTh1	96	0.379	<u>0.394</u>	0.386	<u>0.397</u>	0.390	0.403	0.405	0.413	0.386	0.400	<u>0.382</u>	0.399	0.417	0.425	0.415	0.428
	192	<u>0.428</u>	0.424	0.439	<u>0.429</u>	0.442	0.433	0.457	0.442	0.437	0.430	0.452	0.437	0.470	0.458	0.471	0.457
	336	0.473	0.448	0.480	<u>0.453</u>	0.488	0.458	0.503	0.466	0.481	0.456	<u>0.478</u>	0.461	0.521	0.495	0.532	0.501
	720	0.473	0.466	0.496	0.482	0.507	0.492	0.516	0.494	<u>0.483</u>	<u>0.477</u>	0.491	0.483	0.684	0.597	0.569	0.545
ETTh2	96	0.288	0.338	0.291	<u>0.342</u>	0.294	0.347	0.292	0.343	0.291	0.345	<u>0.289</u>	0.343	0.362	0.382	0.309	0.361
	192	<u>0.375</u>	0.389	0.376	0.396	0.383	0.400	0.387	0.399	0.379	0.398	0.381	<u>0.395</u>	0.407	0.414	0.402	0.413
	336	0.416	0.424	0.429	0.436	<u>0.424</u>	0.435	0.427	<u>0.434</u>	0.425	0.434	0.427	0.440	0.455	0.452	0.438	0.449
	720	0.418	0.438	0.438	0.449	0.428	0.446	0.430	0.446	<u>0.426</u>	<u>0.446</u>	0.434	0.453	0.463	0.467	0.446	0.461
ETTm1	96	0.317	0.356	0.327	<u>0.364</u>	0.331	0.367	<u>0.325</u>	0.365	0.342	0.375	0.329	0.367	0.349	0.385	0.351	0.392
	192	0.365	0.383	<u>0.367</u>	0.385	0.373	0.388	0.377	<u>0.385</u>	0.382	0.393	0.369	0.390	0.401	0.407	0.393	0.413
	336	0.396	0.407	0.402	0.409	0.409	0.410	0.411	<u>0.406</u>	0.419	0.416	<u>0.401</u>	0.411	0.477	0.457	0.468	0.464
	720	0.453	0.438	0.465	0.446	0.481	0.450	0.476	<u>0.441</u>	0.486	0.454	<u>0.462</u>	0.445	0.502	0.469	0.496	0.473
ETTm2	96	<u>0.174</u>	0.256	0.173	<u>0.259</u>	0.181	0.266	0.188	0.272	0.181	0.266	0.178	0.264	0.184	0.264	0.190	0.267
	192	0.239	0.299	0.243	<u>0.304</u>	0.247	0.307	0.252	0.311	0.248	0.308	<u>0.243</u>	0.306	0.272	0.320	0.261	0.308
	336	0.298	0.337	<u>0.304</u>	<u>0.343</u>	0.310	0.347	0.313	0.349	0.311	0.348	0.308	0.348	0.339	0.358	0.329	0.350
	720	0.394	0.395	<u>0.399</u>	<u>0.401</u>	0.412	0.405	0.413	0.404	0.408	0.403	0.409	0.405	0.421	0.414	0.410	0.407
Exchange	96	0.081	0.199	0.088	0.207	0.086	0.206	<u>0.085</u>	<u>0.204</u>	0.086	0.206	0.087	0.205	0.094	0.219	0.088	0.206
	192	0.172	0.293	0.184	0.304	0.180	0.302	<u>0.175</u>	<u>0.297</u>	0.178	0.301	0.183	0.304	0.195	0.310	0.180	0.301
	336	<u>0.316</u>	<u>0.406</u>	0.348	0.427	0.332	0.418	0.324	0.410	0.334	0.419	0.335	0.420	0.344	0.431	0.327	0.420
	720	0.824	0.683	0.877	0.704	0.844	0.692	<u>0.834</u>	<u>0.687</u>	0.847	0.695	0.859	0.698	0.876	0.705	0.845	0.702
Weather	96	<u>0.170</u>	0.210	0.162	<u>0.211</u>	0.174	0.213	0.179	0.225	0.177	0.219	0.174	0.215	0.174	0.221	0.175	0.219
	192	<u>0.217</u>	<u>0.252</u>	0.209	0.252	0.221	0.255	0.224	0.262	0.222	0.256	0.220	0.257	0.224	0.263	0.222	0.253
	336	<u>0.274</u>	0.294	0.266	<u>0.295</u>	0.278	0.297	0.278	0.298	0.282	0.299	0.276	0.297	0.283	0.304	0.275	0.299
	720	<u>0.352</u>	0.345	0.345	<u>0.346</u>	0.356	0.348	0.356	0.348	0.358	0.349	0.353	0.346	0.366	0.361	0.354	0.348
ECL	96	0.152	0.245	<u>0.154</u>	0.255	0.161	<u>0.249</u>	0.184	0.273	0.158	0.249	0.183	0.274	0.166	0.268	0.187	0.284
	192	0.167	0.262	<u>0.169</u>	0.266	0.175	0.263	0.191	0.277	0.170	0.260	0.192	0.279	0.181	0.287	0.190	0.298
	336	0.182	<u>0.279</u>	0.188	0.284	0.193	0.278	0.205	0.294	<u>0.187</u>	0.279	0.205	0.296	0.195	0.299	0.206	0.305
	720	0.216	<u>0.311</u>	0.227	0.317	0.231	0.311	0.243	0.319	<u>0.224</u>	0.310	0.246	0.324	0.225	0.321	0.245	0.342
Traffic	96	0.420	0.289	0.453	0.306	0.436	<u>0.294</u>	0.483	0.312	<u>0.434</u>	0.299	0.479	0.312	0.594	0.313	0.552	0.310
	192	0.439	0.297	0.471	0.311	<u>0.452</u>	<u>0.301</u>	0.489	0.317	0.454	0.306	0.485	0.315	0.615	0.327	0.558	0.328
	336	0.458	0.309	0.487	0.317	<u>0.471</u>	<u>0.311</u>	0.501	0.327	0.472	0.315	0.496	0.321	0.624	0.332	0.589	0.326
	720	0.494	0.324	0.521	0.335	<u>0.505</u>	<u>0.333</u>	0.534	0.344	0.507	0.337	0.525	0.339	0.649	0.341	0.638	0.340
1 st Count		24	26	<u>6</u>	1	0	1	1	1	1	<u>2</u>	0	0	0	0	0	0

Table 4: Univariate short-term forecasting results, averaged across all M4 subsets.

Model	HyperTime	TimeMixer++	TimePro	OLinear	TimeXer	iTransformer
SMAPE	11.43	11.47	11.85	11.94	11.79	12.40
MASE	1.488	1.502	1.637	1.664	1.625	1.751
OWA	0.823	0.829	0.853	0.862	0.847	0.914