Coupling high-frequency data with nonlinear models in multiple-step-ahead forecasting of energy markets' volatility[☆]

SUPPLEMENTARY APPENDIX

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This document presents supplementary results from the analysis to the paper *Coupling high-frequency data with nonlinear models in multiple-step-ahead forecasting of energy markets' volatility*.

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Table 1: **Before September 2008**: MME(U)/MME(O). The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	2.602	2.636	2.693	2.556	2.553^a	2.547^a	**2.184**	**2.193**	**2.256**	**2.049**^{a}	**2.188**^{a}	**2.101**^{a}	2.824^b	**2.839**^{b}	**2.881**^{b}	**2.738**^{b}	2.793^b	2.729^b
HAR	**2.383**^{b}	**2.385**^{b}	**2.447**^{b}	2.251^b	**2.296**^{a,b}	2.287^a	2.262^b	2.346	2.355^b	2.130^a	2.298^a	2.193^{a,b}	**2.777**^{b}	**2.810**^{b}	**2.837**^{b}	**2.698**^{b}	**2.737**^{a,b}	**2.707**^{a,b}
ANN	**2.358**^{b}	**2.373**^{b}	**2.409**^{b}	**2.219**^{b}	**2.289**^{b}	**2.236**^{a}	**2.216**^{b}	2.287	**2.294**^{b}	**2.073**^{a,b}	**2.252**^{a}	**2.130**^{a,b}	**2.754**^{b}	**2.785**^{b}	**2.829**^{b}	**2.708**^{b}	**2.751**^{a,b}	**2.705**^{a,b}
HAR-ANN	**2.366**^{b}	**2.375**^{b}	**2.430**^{b}	**2.228**^{b}	**2.292**^{a,b}	2.260^{a,b}	**2.230**^{b}	2.308^b	**2.312**^{b}	2.098^{a,b}	2.264^{a,b}	**2.142**^{a,b}	**2.744**^{b}	**2.784**^{b}	**2.826**^{b}	**2.695**^{b}	**2.732**^{a,b}	**2.693**^{a,b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	4.405	4.407	4.488	4.143	4.226^a	4.127^a	**2.932**^{b}	**2.908**	**3.005**^{b}	**2.669**^{a,b}	**2.877**^{a,b}	**2.785**^{a,b}	4.153	4.146	4.232	3.993	4.013^a	4.008^a
HAR	3.238	3.257	3.234	2.978	3.106^a	3.033^a	**2.973**^{b}	3.073^b	**2.986**^{b}	**2.632**^{a,b}	**2.980**^{a,b}	**2.918**^{a,b}	**3.581**^{b}	**3.577**	**3.537**^{b}	**3.560**	**3.487**^{a,b}	**3.510**^{a,b}
ANN	**3.137**	**3.114**	**3.120**^{b}	**2.869**^{b}	**2.989**	**2.869**^{a}	**2.924**^{b}	**3.028**^{b}	**2.977**^{b}	**2.574**^{a,b}	**2.939**^{a,b}	**2.839**^{a,b}	**3.680**^{b}	3.705^b	**3.676**^{b}	3.690^{a,b}	**3.578**^{a,b}	**3.558**^{a,b}
HAR-ANN	**3.186**^{b}	3.182^b	**3.165**^{b}	**2.914**^{b}	3.044^b	2.940^{a,b}	**2.944**^{b}	**3.033**^{b}	**2.985**^{b}	**2.595**^{a,b}	**2.952**^{a,b}	**2.866**^{a,b}	**3.603**^{b}	**3.587**^{b}	**3.575**^{b}	**3.600**^{a,b}	**3.513**^{a,b}	**3.510**^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	5.688	5.708	5.791	5.498	5.544^a	5.340^a	**3.348**	**3.289**	**3.414**^{b}	**2.899**^{a}	**3.219**^{a}	**3.186**^{a}	5.288	5.197	5.414	5.118	5.068^a	5.029^a
HAR	**3.938**^{b}	3.940	**3.991**^{b}	3.655^a	3.745^a	**3.669**^{a,b}	3.454^b	3.576^b	**3.433**^{b}	3.060^{a,b}	3.486^{a,b}	3.446^a	**4.385**^{b}	**4.333**	**4.441**^{b}	**4.357**^{a,b}	**4.338**^{a,b}	**4.290**^{a,b}
ANN	**3.845**^{b}	**3.764**^{b}	**3.862**^{b}	**3.524**^{a,b}	**3.589**^{a}	**3.514**^{a,b}	**3.318**^{b}	**3.441**^{b}	**3.306**^{b}	**2.929**^{a,b}	**3.326**^{a,b}	3.402^a	**4.434**^{b}	4.556^{a,b}	**4.550**^{a,b}	**4.418**^{a,b}	**4.404**^{a,b}	**4.326**^{a,b}
HAR-ANN	**3.874**^{b}	**3.834**^{b}	**3.920**^{b}	**3.573**^{a,b}	3.661^{a,b}	**3.587**^{a,b}	**3.364**^{b}	**3.481**^{b}	**3.348**^{b}	**2.968**^{a,b}	**3.388**^{a,b}	3.398^{a,b}	**4.373**^{b}	**4.376**^{b}	**4.444**^{b}	**4.364**^{a,b}	**4.341**^{a,b}	**4.277**^{a,b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**2.243**	**2.252**	**2.318**	**2.064**	**2.170**	**2.123**^{a}	2.788	2.811	2.862	2.504	2.718	2.705^a	**3.551**^{b}	**3.676**^{b}	**3.672**^{b}	**3.225**^{b}	**3.401**^{b}	**3.480**^{b}
HAR	2.533	2.580	2.587	2.349	2.488	2.439^a	**2.669**	**2.671**	**2.722**	**2.410**	**2.609**	**2.567**^{a}	**3.528**^{b}	**3.661**^{b}	**3.687**^{b}	**3.229**^{b}	**3.412**^{b}	**3.436**^{b}
ANN	2.547	2.611	2.643	2.391	2.531	2.504^a	2.741	2.776	2.788	2.514	2.698	2.684^a	**3.502**^{b}	**3.637**^{b}	**3.657**^{b}	**3.217**^{b}	**3.425**^{b}	**3.493**^{b}
HAR-ANN	2.536^b	2.596^b	2.612^b	2.366^b	2.503^b	2.475^{a,b}	2.707^b	2.727^b	2.757^b	2.458^b	2.643^b	2.632^{a,b}	**3.505**^{b}	**3.639**^{b}	**3.665**^{b}	**3.222**^{b}	**3.412**^{b}	**3.460**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**1.877**	**1.950**	**1.949**	**1.779**	**1.923**	**1.906**^{a}	**3.092**	**3.241**	**3.053**	**2.943**	**3.168**	**3.241**^{a}	**4.720**^{b}	**4.805**^{b}	**4.652**	**4.404**^{b}	**4.567**	**4.484**
HAR	2.867	2.876	2.952	2.791	2.927	2.884^a	**3.134**	**3.133**	**3.080**	**2.965**	**3.102**	**3.130**^{a}	**4.841**^{b}	**4.923**^{b}	5.056^b	**4.603**^{b}	4.821^b	4.656^b
ANN	2.980	3.033	3.077	2.934	3.056	3.064^a	3.275^b	3.369^b	3.279^b	3.199^b	3.339^b	3.343^{a,b}	**4.684**^{b}	**4.805**^{b}	**4.983**^{b}	**4.481**^{b}	**4.619**^{b}	**4.604**^{b}
HAR-ANN	2.912^b	2.942^b	2.987^b	2.849^b	2.981^b	2.957^{a,b}	3.193^b	3.252^b	3.187^b	3.070^b	3.226^b	3.231^{a,b}	**4.745**^{b}	**4.851**^{b}	**4.997**^{b}	**4.520**^{b}	**4.680**^{b}	**4.642**^{b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	**1.869**	**1.953**	**1.881**	**1.812**	**1.901**	**1.905**^{a}	**3.642**	3.871	**3.622**	**3.641**	**3.822**	**3.984**^{a}	**5.807**	**5.969**	**5.761**	**5.537**	**5.729**	**5.594**
HAR	3.469	3.509	3.545	3.335	3.488	3.466^a	**3.671**	**3.596**	**3.560**	**3.688**	**3.591**	**3.864**^{a}	6.169	6.254	6.424	5.908^b	6.187	5.908
ANN	3.612	3.707	3.667	3.532	3.653	3.774^a	3.939^b	3.922	3.891^b	3.996^b	3.951	4.153^{a,b}	**5.766**^{b}	**5.853**^{b}	**6.106**^{b}	**5.652**^{b}	**5.793**^{b}	**5.598**^{b}
HAR-ANN	3.546^b	3.599^b	3.616^b	3.431^b	3.561^b	3.612^{a,b}	3.793^b	3.746^b	3.702^b	3.837^b	3.767^b	4.002^{a,b}	5.961^b	6.019^b	**6.248**^{b}	**5.761**^{b}	5.978^b	5.744^b

Table 2: **Before September 2008**: MME(U)/MME(O) in %. The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	49.72	51.58	50.65	53.82	51.58^a	52.51^a	**40.44**	**41.91**	**41.73**	**43.20**^{a}	**43.57**^{a}	**42.10**^{a}	41.40^b	**42.14**^{b}	**41.40**^{b}	**43.81**^{b}	42.88^b	40.67^b
HAR	**45.81**^{b}	**44.51**^{b}	**46.18**^{b}	47.11^b	**45.81**^{a,b}	45.62^a	42.83^b	44.85	43.57^b	44.85^a	44.12^a	43.01^{a,b}	**41.40**^{b}	**41.04**^{b}	**40.30**^{b}	**43.62**^{b}	**41.77**^{a,b}	**41.59**^{a,b}
ANN	**46.18**^{b}	**45.44**^{b}	**44.51**^{b}	**45.44**^{b}	**45.44**^{b}	**45.81**^{a}	**41.54**^{b}	42.10	**42.65**^{b}	**42.65**^{a,b}	**43.93**^{a}	**41.36**^{a,b}	**42.14**^{b}	**41.22**^{b}	**40.30**^{b}	**44.55**^{b}	**42.14**^{a,b}	**40.30**^{a,b}
HAR-ANN	**46.00**^{b}	**44.88**^{b}	**46.00**^{b}	**46.18**^{b}	**45.81**^{a,b}	45.25^{a,b}	**41.73**^{b}	43.01^b	**42.28**^{b}	43.75^{a,b}	44.30^{a,b}	**41.36**^{a,b}	**41.22**^{b}	**41.04**^{b}	**40.85**^{b}	**43.81**^{b}	**41.77**^{a,b}	**40.85**^{a,b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	69.42	67.92	67.73	67.92	65.48^a	65.85^a	**45.37**^{b}	**44.07**	**47.59**^{b}	**47.41**^{a,b}	**46.67**^{a,b}	**43.89**^{a,b}	41.53	42.27	42.46	43.95	43.39^a	43.58^a
HAR	51.59	52.53	50.84	48.41	49.16^a	48.78^a	**45.74**^{b}	47.04^b	**46.85**^{b}	**44.44**^{a,b}	**46.30**^{a,b}	**46.30**^{a,b}	**39.66**^{b}	**39.29**	**36.31**^{b}	**42.27**	**37.99**^{a,b}	**40.60**^{a,b}
ANN	**50.28**	**50.09**	**48.03**^{b}	**47.09**^{b}	**48.78**	**47.65**^{a}	**44.63**^{b}	**45.74**^{b}	**46.48**^{b}	**43.52**^{a,b}	**45.56**^{a,b}	**43.70**^{a,b}	**42.27**^{b}	41.34^b	**39.29**^{b}	43.39^{a,b}	**40.97**^{a,b}	**40.78**^{a,b}
HAR-ANN	**51.59**^{b}	51.78^b	**50.28**^{b}	**48.22**^{b}	49.34^b	48.78^{a,b}	**45.74**^{b}	**45.37**^{b}	**46.48**^{b}	**44.26**^{a,b}	**45.19**^{a,b}	**44.81**^{a,b}	**40.60**^{b}	**39.48**^{b}	**37.80**^{b}	**42.83**^{a,b}	**40.78**^{a,b}	**40.04**^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	72.92	71.97	72.16	73.48	71.21^a	69.70^a	**44.30**	**42.06**	**45.42**^{b}	**41.31**^{a}	**42.80**^{a}	**40.56**^{a}	44.92	42.67	44.74	46.05	43.98^a	44.17^a
HAR	**48.86**^{b}	48.67	**49.81**	48.86^a	48.67^a	**47.92**^{a,b}	45.42^b	45.98^b	**45.79**^{b}	41.12^{a,b}	45.23^{a,b}	42.43^a	**38.91**^{b}	**38.72**	**37.41**^{b}	**40.41**^{a,b}	**37.97**^{a,b}	**39.47**^{a,b}
ANN	**48.67**^{b}	**47.73**^{b}	**49.24**^{b}	**46.97**^{a,b}	**47.73**^{a}	**46.02**^{a,b}	**42.24**^{b}	**43.74**^{b}	**42.43**^{b}	**38.88**^{a,b}	**43.18**^{a,b}	41.68^a	**41.92**^{b}	42.67^{a,b}	**39.29**^{a,b}	**41.73**^{a,b}	**41.54**^{a,b}	**40.98**^{a,b}
HAR-ANN	**47.92**^{b}	**47.92**^{b}	**48.48**^{b}	**47.16**^{a,b}	48.48^{a,b}	**46.97**^{a,b}	**43.55**^{b}	**44.49**^{b}	**44.67**^{b}	**39.25**^{a,b}	**44.67**^{a,b}	42.06^{a,b}	**39.66**^{b}	**40.04**^{b}	**37.78**^{b}	**41.54**^{a,b}	**39.66**^{a,b}	**40.04**^{a,b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**50.28**	**48.42**	**49.35**	**46.18**	**48.42**	**47.49**^{a}	59.56	58.09	58.27	56.80	56.43	57.90^a	**58.60**^{b}	**57.86**^{b}	**58.60**^{b}	**56.19**^{b}	**57.12**^{b}	**59.33**^{b}
HAR	54.19	55.49	53.82	52.89	54.19	54.38^a	**57.17**	**55.15**	**56.43**	**55.15**	**55.88**	**56.99**^{a}	**58.60**^{b}	**58.96**^{b}	**59.70**^{b}	**56.38**^{b}	**58.23**^{b}	**58.41**^{b}
ANN	53.82	54.56	55.49	54.56	54.56	54.19^a	58.46	57.90	57.35	57.35	56.07	58.64^a	**57.86**^{b}	**58.78**^{b}	**59.70**^{b}	**55.45**^{b}	**57.86**^{b}	**59.70**^{b}
HAR-ANN	54.00^b	55.12^b	54.00^b	53.82^b	54.19^b	54.75^{a,b}	58.27^b	56.99^b	57.72^b	56.25^b	55.70^b	58.64^{a,b}	**58.78**^{b}	**58.96**^{b}	**59.15**^{b}	**56.19**^{b}	**58.23**^{b}	**59.15**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**30.58**	**32.08**	**32.27**	**32.08**	**34.52**	**34.15**^{a}	**54.63**	**55.93**	**52.41**	**52.59**	**53.33**	**56.11**^{a}	**58.47**^{b}	**57.73**^{b}	**57.54**	**56.05**^{b}	**56.61**	**56.42**
HAR	48.41	47.47	49.16	51.59	50.84	51.22^a	**54.26**	**52.96**	**53.15**	**55.56**	**53.70**	**53.70**^{a}	**60.34**^{b}	**60.71**^{b}	63.69^b	**57.73**^{b}	62.01^b	59.40^b
ANN	49.72	49.91	51.97	52.91	51.22	52.35^a	55.37^b	54.26^b	53.52^b	56.48^b	54.44^b	56.30^{a,b}	**57.73**^{b}	**58.66**^{b}	**60.71**^{b}	**56.61**^{b}	**59.03**^{b}	**59.22**^{b}
HAR-ANN	48.41^b	48.22^b	49.72^b	51.78^b	50.66^b	51.22^{a,b}	54.26^b	54.63^b	53.52^b	55.74^b	54.81^b	55.19^{a,b}	**59.40**^{b}	**60.52**^{b}	**62.20**^{b}	**57.17**^{b}	**59.22**^{b}	**59.96**^{b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	**27.08**	**28.03**	**27.84**	**26.52**	**28.79**	**30.30**^{a}	**55.70**	57.94	**54.58**	**58.69**	**57.20**	**59.44**^{a}	**55.08**	**57.33**	**55.26**	**53.95**	**56.02**	**55.83**
HAR	51.14	51.33	50.19	51.14	51.33	52.08^a	**54.58**	**54.02**	**54.21**	**58.88**	**54.77**	**57.57**^{a}	61.09	61.28	62.59	59.59^b	62.03	60.53
ANN	51.33	52.27	50.76	53.03	52.27	53.98^a	57.76^b	56.26	57.57^b	61.12^b	56.82	58.32^{a,b}	**58.08**^{b}	**57.33**^{b}	**60.71**^{b}	**58.27**^{b}	**58.46**^{b}	**59.02**^{b}
HAR-ANN	52.08^b	52.08^b	51.52^b	52.84^b	51.52^b	53.03^{a,b}	56.45^b	55.51^b	55.33^b	60.75^b	55.33^b	57.94^{a,b}	60.34^b	59.96^b	**62.22**^{b}	**58.46**^{b}	60.34^b	59.96^b

Table 3: **September 2008 – November 2010**: MME(U)/MME(O). The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	2.919	2.853	3.026	2.868^a	2.835^a	2.847^a	**2.413**	2.449	2.602	**2.321**^{a}	2.422^a	2.446^a	**3.388**^{b}	**3.503**^{b}	**3.546**^{b}	**2.965**^{b}	**3.243**^{b}	**3.265**^{b}
HAR	**2.508**	**2.493**	**2.620**	**2.508**^{a}	**2.452**^{a}	**2.479**^{a}	**2.340**^{b}	**2.289**	**2.469**	**2.250**^{a,b}	**2.275**^{a}	**2.339**^{a}	**3.401**^{b}	**3.500**^{b}	**3.568**^{b}	**2.929**^{b}	**3.269**^{b}	**3.272**^{b}
ANN	2.638^b	2.632	2.783^{a,b}	2.582^{a,b}	2.602^a	2.630^a	2.421^b	2.443	2.598	2.313^{a,b}	2.439^a	2.461^a	**3.438**^{b}	**3.527**^{b}	**3.629**^{b}	**2.979**^{b}	**3.327**^{a,b}	**3.349**^{a,b}
HAR-ANN	**2.545**^{b}	2.549^b	**2.655**^{a,b}	**2.528**^{a,b}	2.519^{a,b}	2.543^{a,b}	**2.355**^{b}	2.341^b	2.525^b	**2.265**^{a,b}	2.331^{a,b}	2.386^{a,b}	**3.396**^{b}	**3.484**^{b}	**3.579**^{b}	**2.956**^{b}	**3.291**^{b}	**3.313**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	4.389	4.400	4.586	4.376^a	4.383^a	4.334^a	3.356	3.438	3.563	3.290	3.402	3.346^a	5.235	5.505	5.412	4.288	4.711	4.868
HAR	**2.963**	**3.029**	**3.106**	**3.032**^{a}	**3.039**^{a}	**2.942**^{a}	**2.666**	**2.653**	**2.838**	**2.804**^{a}	**2.609**^{a}	**2.561**^{a}	**4.578**	**4.909**^{b}	**4.709**	**3.968**	**4.330**^{a}	**4.432**^{a}
ANN	3.341	3.322	3.527	3.326^a	3.315^a	3.370^a	3.115	3.079	3.253	3.116^a	3.088^a	3.117^a	4.739	**5.002**^{b}	4.902	4.174^a	4.470^{a,b}	4.670^{a,b}
HAR-ANN	3.128^b	3.145^b	3.287^b	3.146^{a,b}	3.140^{a,b}	3.110^{a,b}	2.872^b	2.833^b	3.017^b	2.945^b	2.800^{a,b}	2.792^{a,b}	4.643^b	**4.954**^{b}	4.790^b	4.056^b	**4.391**^{a,b}	**4.529**^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	5.735	5.701	5.920	5.693^a	5.716^a	5.715^a	4.168	4.284	4.409	4.134^a	4.273^a	4.223^a	6.579	6.986	6.819^a	5.127^{a,b}	5.945^a	5.986^a
HAR	**3.528**	**3.556**	**3.713**	**3.631**^{a}	**3.600**^{a}	**3.525**^{a}	**3.193**	**3.098**	**3.378**	**3.339**^{a}	**3.193**^{a}	**3.099**^{a}	**5.726**^{a,b}	**6.014**^{a}	**5.695**^{a,b}	**4.799**^{a,b}	**5.362**^{a,b}	**5.292**^{a,b}
ANN	4.018	3.943	4.195	3.975^a	3.994^a	3.988^a	3.635	3.710	3.968	3.872^a	3.778^a	3.862^a	**5.831**^{a,b}	6.254^{a,b}	**5.806**^{a,b}	**4.893**^{a,b}	**5.563**^{a,b}	**5.481**^{a,b}
HAR-ANN	3.756^b	3.690^b	3.911^b	3.753^{a,b}	3.747^{a,b}	3.710^{a,b}	3.363^b	3.374^b	3.587^b	3.545^{a,b}	3.457^{a,b}	3.421^{a,b}	**5.732**^{a,b}	**6.066**^{a,b}	**5.680**^{a,b}	**4.803**^{a,b}	**5.390**^{a,b}	**5.315**^{a,b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**2.817**	**2.890**	**3.051**	**2.706**	**2.802**	**2.757**^{a}	**2.872**^{b}	**2.826**	**3.048**	**2.743**^{b}	**2.767**	**2.743**^{a,b}	4.181	4.339	4.284	**3.275**^{b}	**3.633**^{b}	**3.726**^{b}
HAR	3.174	3.280	3.414	3.030	3.250	3.180^a	**2.958**^{b}	2.907^b	3.163	**2.808**^{b}	2.847^b	**2.831**^{a,b}	4.125	4.302	4.197	**3.275**^{b}	**3.643**^{b}	**3.753**^{b}
ANN	3.058	3.131	3.328	3.035	3.127	3.130^a	**2.889**^{b}	**2.808**^{b}	**3.099**^{b}	**2.743**^{b}	**2.743**^{b}	**2.759**^{a,b}	**3.961**	**4.131**	**4.069**^{b}	**3.287**^{b}	**3.608**^{b}	**3.734**^{b}
HAR-ANN	3.100^b	3.208^b	3.369^b	3.043^b	3.180^b	3.150^{a,b}	**2.918**^{b}	**2.845**^{b}	**3.133**^{b}	**2.782**^{b}	**2.782**^{b}	**2.794**^{a,b}	4.015^b	4.212^b	**4.126**^{b}	**3.271**^{b}	**3.625**^{b}	**3.739**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**2.922**	**3.002**	**3.036**	**2.944**	**2.995**	**2.980**^{a}	**3.479**	**3.444**	**3.534**	**3.547**^{b}	**3.488**	**3.454**^{a}	**4.433**	**4.366**	**4.300**	**4.037**	**4.315**^{a}	**4.220**^{a}
HAR	4.274	4.261	4.460	4.124	4.238	4.293^a	3.942	3.989	4.204	**3.814**^{b}	3.986	3.931^a	5.078	5.046	5.073	4.507	4.961	4.967
ANN	4.085	4.070	4.270	4.028	4.062	4.019^a	3.735	3.732	3.997	**3.703**^{b}	3.733	3.681^a	5.015	4.987	4.928	4.425	4.912	4.836
HAR-ANN	4.160^b	4.159^b	4.349^b	4.059^b	4.133^b	4.130^{a,b}	3.809^b	3.850^b	4.070^b	**3.745**^{b}	3.833^b	3.758^{a,b}	5.006^b	4.999^b	4.971^b	4.447^b	4.926^b	4.887^b
				$h=10$						$h=10$						$h=10$		
ARFIMA	**3.540**	**3.632**	**3.639**	**3.558**	**3.646**	**3.695**^{a}	**4.354**^{b}	**4.393**^{b}	**4.372**	**4.377**^{b}	**4.374**^{b}	**4.323**^{a}	**5.065**	**5.175**	**4.800**	**4.854**	**5.032**^{a}	**4.876**^{a}
HAR	5.353	5.340	5.578	5.150	5.276	5.442^a	**4.966**^{b}	**5.029**^{b}	5.171	**4.816**^{b}	**4.951**^{b}	5.016^a	6.350	6.308	6.033	5.673	6.055	6.022
ANN	4.991	4.976	5.187	4.760	4.922	5.010^a	**4.693**^{b}	**4.742**^{b}	4.963	**4.578**^{b}	**4.686**^{b}	**4.680**^{a}	6.068	6.048	5.663	5.550	5.740	5.801
HAR-ANN	5.122^b	5.087^b	5.371^b	4.927^b	5.056^b	5.220^{a,b}	**4.785**^{b}	**4.826**^{b}	5.024^b	**4.629**^{b}	**4.777**^{b}	**4.784**^{a,b}	6.191^b	6.159^b	5.833^b	5.609^b	5.911^b	5.911^b

Table 4: **September 2008 – November 2010**: MME(U)/MME(O) in %. The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	48.24	45.47	45.84	48.24^a	46.58^a	48.24^a	**42.39**	43.30	43.12	**42.39**^{a}	44.22^a	44.77^a	**40.82**^{b}	**42.30**^{b}	**41.74**^{b}	**45.83**^{b}	**45.27**^{b}	**44.16**^{b}
HAR	**42.70**	**41.04**	**40.67**	**44.73**^{a}	**40.85**^{a}	**42.51**^{a}	**42.20**^{b}	**42.20**	**41.10**	**42.02**^{a,b}	**43.30**^{a}	**44.77**^{a}	**42.12**^{b}	**41.93**^{b}	**43.60**^{b}	**44.53**^{b}	**45.83**^{b}	**44.34**^{b}
ANN	45.29^b	43.62	43.44^{a,b}	43.62^{a,b}	43.81^a	43.81^a	43.67^b	44.77	43.49	43.12^{a,b}	46.42^a	45.32^a	**44.90**^{b}	**43.60**^{b}	**45.45**^{b}	**44.90**^{b}	**46.94**^{a,b}	**45.64**^{a,b}
HAR-ANN	**43.81**^{b}	41.96^b	**40.85**^{a,b}	**43.62**^{a,b}	42.88^{a,b}	43.25^{a,b}	**42.02**^{b}	42.94^b	42.39^b	**41.65**^{a,b}	44.22^{a,b}	44.77^{a,b}	**43.97**^{b}	**41.56**^{b}	**44.53**^{b}	**45.45**^{b}	**46.01**^{b}	**45.45**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	55.82	53.97	56.56	55.08^a	54.34^a	54.90^a	44.95	45.69	46.24	43.12	45.14	44.22^a	50.65	53.06	52.50	50.65	49.54	51.58
HAR	**39.74**	**40.48**	**39.37**	**41.96**^{a}	**40.48**^{a}	**38.63**^{a}	**38.72**	**38.72**	**37.25**	**40.55**^{a}	**36.88**^{a}	**36.88**^{a}	**44.53**	**48.24**^{b}	**45.64**	**45.64**	**43.97**	**45.27**
ANN	43.07	41.96	43.44	44.36^a	42.88^a	43.44^a	43.12	43.49	41.28	43.49^a	43.12^a	43.67^a	44.90	**48.79**^{b}	48.24	47.87^a	45.45^a	47.68^a
HAR-ANN	41.04^b	40.67^b	41.22^b	42.51^{a,b}	41.22^{a,b}	41.04^{a,b}	41.47^b	40.73^b	39.63^b	42.39^{a,b}	39.27^{a,b}	40.18^{a,b}	45.64^b	**48.98**^{b}	47.50^b	46.75^b	**44.90**^{a,b}	**46.57**^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	57.49	54.71	57.30	56.38^a	54.90^a	55.27^a	43.49	44.22	45.32	44.22^a	45.50^a	44.59^a	54.36	54.55	56.96^a	48.61^{a,b}	51.95^a	52.32^a
HAR	**36.97**	**38.08**	**37.52**	**39.93**^{a}	**38.08**^{a}	**36.23**^{a}	**37.61**	**34.86**	**37.61**	**37.98**^{a}	**37.43**^{a}	**34.31**^{a}	**42.67**^{a,b}	**46.57**^{a}	**46.38**^{a,b}	**42.67**^{a,b}	**44.53**^{a,b}	**44.90**^{a,b}
ANN	43.07	43.25	43.44	44.92^a	43.25^a	42.14^a	41.28	41.83	42.20	44.95^a	43.49^a	42.20^a	**44.90**^{a,b}	48.79^{a,b}	**48.24**^{a,b}	**43.41**^{a,b}	**47.50**^{a,b}	**47.12**^{a,b}
HAR-ANN	41.04^b	41.22^b	39.93^b	42.33^{a,b}	40.67^{a,b}	39.00^{a,b}	39.27^b	38.90^b	38.53^b	42.02^{a,b}	40.37^{a,b}	38.35^{a,b}	**44.34**^{a,b}	**47.12**^{a,b}	**46.57**^{a,b}	**43.04**^{a,b}	**44.90**^{a,b}	**45.27**^{a,b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**51.76**	**54.53**	**54.16**	**51.76**	**53.42**	**51.76**^{a}	**57.61**^{b}	**56.70**	**56.88**	**57.61**^{b}	**55.78**	**55.23**^{a,b}	59.18	57.70	58.26	**54.17**^{b}	**54.73**^{b}	**55.84**^{b}
HAR	57.30	58.96	59.33	55.27	59.15	57.49^a	**57.80**^{b}	57.80^b	58.90	**57.98**^{b}	56.70^b	**55.23**^{a,b}	57.88	58.07	56.40	**55.47**^{b}	**54.17**^{b}	**55.66**^{b}
ANN	54.71	56.38	56.56	56.38	56.19	56.19^a	**56.33**^{b}	**55.23**^{b}	**56.51**^{b}	**56.88**^{b}	**53.58**^{b}	**54.68**^{a,b}	**55.10**	**56.40**	**54.55**^{b}	**55.10**^{b}	**53.06**^{b}	**54.36**^{b}
HAR-ANN	56.19^b	58.04^b	59.15^b	56.38^b	57.12^b	56.75^{a,b}	**57.98**^{b}	**57.06**^{b}	**57.61**^{b}	**58.35**^{b}	**55.78**^{b}	**55.23**^{a,b}	56.03^b	58.44^b	**55.47**^{b}	**54.55**^{b}	**53.99**^{b}	**54.55**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**44.18**	**46.03**	**43.44**	**44.92**	**45.66**	**45.10**^{a}	**55.05**	**54.31**	**53.76**	**56.88**^{b}	**54.86**	**55.78**^{a}	**49.35**	**46.94**	**47.50**	**49.35**	**50.46**^{a}	**48.42**^{a}
HAR	60.26	59.52	60.63	58.04	59.52	61.37^a	61.28	61.28	62.75	**59.45**^{b}	63.12	63.12^a	55.47	51.76	54.36	54.36	56.03	54.73
ANN	56.93	58.04	56.56	55.64	57.12	56.56^a	56.88	56.51	58.72	**56.51**^{b}	56.88	56.33^a	55.10	51.21	51.76	52.13	54.55	52.32
HAR-ANN	58.96^b	59.33^b	58.78^b	57.49^b	58.78^b	58.96^{a,b}	58.53^b	59.27^b	60.37^b	**57.61**^{b}	60.73^b	59.82^{a,b}	54.36^b	51.02^b	52.50^b	53.25^b	55.10^b	53.43^b
				$h=10$						$h=10$						$h=10$		
ARFIMA	**42.51**	**45.29**	**42.70**	**43.62**	**45.10**	**44.73**^{a}	**56.51**^{b}	**55.78**^{b}	**54.68**	**55.78**^{b}	**54.50**^{b}	**55.41**^{a}	**45.64**	**45.45**	**43.04**	**51.39**	**48.05**^{a}	**47.68**^{a}
HAR	63.03	61.92	62.48	60.07	61.92	63.77^a	**62.39**^{b}	**65.14**^{b}	62.39	**62.02**^{b}	**62.57**^{b}	65.69^a	57.33	53.43	53.62	57.33	55.47	55.10
ANN	56.93	56.75	56.56	55.08	56.75	57.86^a	**58.72**^{b}	**58.17**^{b}	57.80	**55.05**^{b}	**56.51**^{b}	**57.80**^{a}	55.10	51.21	51.76	56.59	52.50	52.88
HAR-ANN	58.96^b	58.78^b	60.07^b	57.67^b	59.33^b	61.00^{a,b}	**60.73**^{b}	**61.10**^{b}	61.47^b	**57.98**^{b}	**59.63**^{b}	61.65^{a,b}	55.66^b	52.88^b	53.43^b	56.96^b	55.10^b	54.73^b

Table 5: **After November 2010**: MME(U)/MME(O). The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	2.243	2.280	2.347	2.139^{a}	2.265^{a}	2.195^{a}	**1.591**	**1.574**	**1.664**	**1.507**^{b}	**1.582**^{a}	**1.538**^{a}	**2.636**	**2.632**	**2.705**^{b}	**2.238**	**2.443**^{b}	**2.311**^{b}
HAR	2.051	2.105	2.157	1.950^{a}	2.077^{a}	1.979^{a}	1.613	1.629	1.722	**1.497**^{a,b}	1.610^{a}	1.599^{a}	2.672^{b}	2.652^{b}	**2.778**^{b}	2.331	**2.466**^{b}	**2.370**^{b}
ANN	**2.009**^{b}	**2.035**^{b}	**2.090**	**1.906**^{a,b}	**2.017**^{a,b}	**1.909**^{a}	**1.554**	**1.548**^{b}	**1.623**^{b}	**1.486**^{b}	**1.554**^{a,b}	**1.537**^{a,b}	**2.635**^{b}	**2.618**^{b}	**2.757**^{b}	**2.257**^{a,b}	**2.442**^{a,b}	**2.372**^{a,b}
HAR-ANN	**2.020**^{b}	**2.049**^{b}	2.123^{b}	**1.919**^{a,b}	**2.035**^{a,b}	1.937^{a,b}	1.581^{b}	1.589^{b}	1.658^{b}	**1.488**^{a,b}	1.580^{a,b}	1.563^{a,b}	**2.616**^{b}	**2.577**^{b}	**2.739**^{b}	2.294^{b}	**2.446**^{b}	**2.358**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	3.518	3.517	3.554	3.363^{a}	3.486^{a}	3.311^{a}	**1.927**^{b}	**1.929**^{b}	**1.960**^{b}	**1.851**^{a}	**1.912**^{a,b}	**1.868**^{a,b}	3.418	3.470	3.559	**2.894**^{b}	3.110	3.041
HAR	**2.580**^{b}	**2.662**^{b}	**2.616**^{b}	**2.557**^{a,b}	**2.574**^{a,b}	**2.472**^{a,b}	**1.920**^{b}	**1.954**^{b}	**1.940**^{b}	1.827^{a}	**1.912**^{a,b}	**1.855**^{a,b}	**3.140**^{b}	**3.011**	**3.186**^{b}	**2.861**^{b}	**2.945**	**2.917**
ANN	**2.508**^{b}	**2.586**^{b}	**2.546**^{b}	**2.476**^{a,b}	**2.533**^{a,b}	**2.400**^{a,b}	**1.843**^{b}	**1.864**^{b}	**1.857**^{b}	**1.719**^{a,b}	**1.891**^{a,b}	**1.801**^{a,b}	**3.227**^{b}	3.111^{b}	**3.282**^{b}	**2.851**^{b}	**3.035**^{b}	**3.031**^{b}
HAR-ANN	**2.523**^{b}	**2.618**^{b}	**2.555**^{b}	**2.512**^{a,b}	**2.545**^{a,b}	**2.425**^{a,b}	**1.871**^{b}	**1.903**^{b}	**1.899**^{b}	**1.752**^{a,b}	**1.907**^{a,b}	**1.821**^{a,b}	**3.168**^{b}	**3.033**^{b}	**3.227**^{b}	**2.849**^{b}	**2.974**^{b}	**2.967**^{b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	4.482	4.508	4.580	4.299^{a}	4.403^{a}	4.199^{a}	**2.077**^{b}	**2.088**^{b}	**2.042**	**1.986**^{a,b}	**2.072**^{a,b}	**2.045**^{a}	**3.957**^{b}	3.946	4.091	**3.439**^{b}	**3.613**^{a,b}	**3.446**^{a,b}
HAR	**2.805**^{b}	**2.993**^{a,b}	**2.853**^{a,b}	**2.833**^{a,b}	**2.912**^{a,b}	**2.851**^{a,b}	**2.118**^{b}	**2.199**^{b}	2.112^{b}	**2.073**^{a,b}	**2.085**^{a,b}	2.158^{a,b}	**3.637**^{b}	**3.382**^{b}	**3.598**^{b}	**3.374**^{b}	**3.488**^{b}	**3.285**^{b}
ANN	**2.801**^{b}	**2.988**^{b}	**2.872**^{a,b}	**2.803**^{a,b}	**2.877**^{a,b}	**2.805**^{a,b}	**2.040**^{b}	**2.119**^{b}	**1.940**^{b}	**2.002**^{a,b}	**2.036**^{a,b}	**2.065**^{a,b}	**3.789**^{b}	**3.527**^{b}	**3.825**^{b}	**3.428**^{b}	**3.588**^{b}	**3.475**^{b}
HAR-ANN	**2.773**^{b}	**2.971**^{b}	**2.831**^{a,b}	**2.790**^{a,b}	**2.881**^{a,b}	**2.801**^{a,b}	**2.025**^{b}	**2.133**^{b}	**1.983**^{b}	**2.015**^{a,b}	**2.031**^{a,b}	**2.063**^{a,b}	**3.684**^{b}	**3.448**^{b}	**3.702**^{b}	**3.360**^{b}	**3.500**^{b}	**3.385**^{b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**2.337**	**2.342**	**2.465**	**2.237**	**2.320**	**2.274**^{a}	**2.583**	**2.608**	**2.694**	**2.405**	**2.522**	**2.514**^{a}	4.121	4.289	4.148	**2.938**	3.476^{a}	3.402^{a}
HAR	2.662	2.656	2.795	2.533	2.622	2.576^{a}	**2.575**	**2.572**	**2.634**	**2.407**	**2.489**	**2.464**^{a}	**3.846**^{b}	4.019	**3.907**^{b}	**2.895**	**3.371**^{a,b}	**3.321**^{a,b}
ANN	2.723	2.729	2.856	2.556	2.668	2.619^{a}	2.681^{b}	2.683^{b}	2.817	2.492^{b}	2.595^{b}	2.561^{a,b}	**3.779**^{b}	**3.906**^{b}	**3.921**^{b}	2.972	**3.404**^{b}	**3.338**^{b}
HAR-ANN	2.689^{b}	2.683^{b}	2.815^{b}	2.541^{b}	2.636^{b}	2.596^{a,b}	2.622^{b}	2.619^{b}	2.724^{b}	2.455^{b}	2.539^{b}	2.516^{a,b}	**3.823**^{b}	**3.936**^{b}	**3.898**^{b}	2.932^{b}	**3.394**^{b}	**3.336**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**2.534**	**2.596**	**2.511**	**2.541**	**2.579**	**2.504**^{a}	**3.561**	**3.672**	**3.614**	**3.460**	**3.617**	**3.606**^{a}	**4.193**	**4.375**	**4.247**	**3.888**	**4.051**^{a}	**4.134**^{a}
HAR	3.779	3.904	3.798	3.773	3.897	3.840^{a}	3.957	4.021	3.910	3.857	3.986	3.924^{a}	4.637	5.013	4.849	4.096	4.376^{a}	4.492^{a}
ANN	3.984	4.071	4.004	3.936	4.037	4.001^{a}	4.179	4.235	4.205	4.082	4.135	4.134^{a}	4.621	5.000	4.898	4.125	4.263^{a}	4.358^{a}
HAR-ANN	3.868^{b}	3.996^{b}	3.899^{b}	3.854^{b}	3.972^{b}	3.914^{a,b}	4.056^{b}	4.119^{b}	4.055^{b}	3.950^{b}	4.062^{b}	4.031^{a,b}	4.597^{b}	4.993^{b}	4.874^{b}	4.101^{b}	4.317^{a,b}	4.423^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	**2.706**	**2.728**	**2.671**	**2.745**	**2.761**	**2.683**^{a}	**4.502**	**4.661**	**4.531**	**4.382**	**4.603**	**4.560**^{a}	**5.148**	**5.352**	**5.140**	**4.826**	**4.992**^{a}	**5.026**^{a}
HAR	4.811	4.813	4.699	4.796	4.835	4.846^{a}	5.058	5.087	4.940	4.989	5.112	4.987^{a}	5.748	6.245	5.971	5.161	5.635^{a}	5.685^{a}
ANN	4.939	4.937	4.884	4.881	4.965	4.961^{a}	5.378	5.382	5.445	5.264	5.318	5.270^{a}	**5.624**	6.155	5.802	**5.143**	**5.376**^{a}	**5.362**^{a}
HAR-ANN	4.851^{b}	4.868^{b}	4.785^{b}	4.814^{b}	4.900^{b}	4.892^{a,b}	5.226^{b}	5.225^{b}	5.167^{b}	5.106^{b}	5.207^{b}	5.140^{a,b}	5.675^{b}	6.205^{b}	5.883^{b}	**5.168**^{b}	5.492^{a,b}	5.507^{a,b}

Table 6: **After November 2010**: MME(U)/MME(O) in %. The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	45.93	46.47	45.39	45.93^a	47.02^a	46.47^a	**37.34**	**36.59**	**37.15**	**37.34**^{b}	**38.09**^{a}	**35.83**^{a}	**35.06**	**33.40**	**35.81**^{b}	**41.37**	**38.96**^{b}	**37.66**^{b}
HAR	41.77	43.04	40.87	41.77^a	42.68^a	42.31^a	36.59	36.96	38.27	**35.65**^{a,b}	38.27^a	38.09^a	37.11^b	35.44^b	**38.59**^{b}	43.04	**40.26**^{b}	**39.33**^{b}
ANN	**40.51**^{b}	**41.05**^{b}	**39.24**	**40.69**^{a,b}	**41.05**^{a,b}	**39.78**^{a}	**35.65**	**35.27**^{b}	**35.65**^{b}	**35.65**^{b}	**36.59**^{a,b}	**37.34**^{a,b}	**38.22**^{b}	**36.18**^{b}	**38.78**^{b}	**41.56**^{a,b}	**39.33**^{a,b}	**38.96**^{a,b}
HAR-ANN	**40.69**^{b}	**42.13**^{b}	40.87^b	**41.05**^{a,b}	**41.95**^{a,b}	41.05^{a,b}	36.21^b	36.40^b	36.21^b	**35.27**^{a,b}	37.34^{a,b}	36.96^{a,b}	**35.99**^{b}	**35.44**^{b}	**38.96**^{b}	42.86^b	**39.15**^{b}	**38.22**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	56.60	55.15	55.15	54.43^a	55.52^a	53.71^a	**33.40**^{b}	**32.27**^{b}	**34.52**^{b}	**33.21**^{a}	**33.02**^{a,b}	**30.96**^{a,b}	42.86	43.97	43.97	**41.19**^{b}	41.37	40.07
HAR	**38.34**^{b}	**37.61**^{b}	**38.52**^{b}	**38.52**^{a,b}	**35.80**^{a,b}	**35.08**^{a,b}	**29.83**^{b}	**29.83**^{b}	**31.33**^{b}	28.71^a	**29.27**^{a,b}	**27.77**^{a,b}	**39.52**^{b}	**36.55**	**38.40**^{b}	**39.70**^{b}	**39.52**	**37.85**
ANN	**36.17**^{b}	**35.80**^{b}	**37.61**^{b}	**36.17**^{a,b}	**35.08**^{a,b}	**34.00**^{a,b}	**28.71**^{b}	**27.77**^{b}	**30.58**^{b}	**26.64**^{a,b}	**29.46**^{a,b}	**27.39**^{a,b}	**40.45**^{b}	37.85^b	**38.78**^{b}	**39.33**^{b}	**40.63**^{b}	**41.19**^{b}
HAR-ANN	**37.07**^{b}	**36.53**^{b}	**37.25**^{b}	**37.25**^{a,b}	**35.44**^{a,b}	**35.08**^{a,b}	**29.46**^{b}	**29.27**^{b}	**31.14**^{b}	**27.95**^{a,b}	**29.46**^{a,b}	**27.20**^{a,b}	**41.00**^{b}	**36.73**^{b}	**38.22**^{b}	**39.52**^{b}	**39.70**^{b}	**39.33**^{b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	60.58	58.95	61.48	58.41^a	58.41^a	57.14^a	**29.83**^{b}	**27.58**^{b}	**30.02**	**28.71**^{a,b}	**28.14**^{a,b}	**27.39**^{a}	**40.82**^{b}	41.00	42.30	**38.78**^{b}	**39.52**^{a,b}	**37.85**^{a,b}
HAR	**32.73**^{b}	**34.54**^{a,b}	**35.26**^{a,b}	**32.37**^{a,b}	**33.82**^{a,b}	**32.55**^{a,b}	**26.64**^{b}	**26.45**^{b}	27.95^b	**25.70**^{a,b}	**24.39**^{a,b}	27.20^{a,b}	**37.66**^{b}	**33.40**^{b}	**35.44**	**35.81**^{b}	**35.44**^{b}	**34.51**^{b}
ANN	**33.09**^{b}	**34.36**^{b}	**35.26**^{a,b}	**32.73**^{a,b}	**33.45**^{a,b}	**32.73**^{a,b}	**25.14**^{b}	**24.39**^{b}	**24.20**^{b}	**24.77**^{a,b}	**24.95**^{a,b}	**24.95**^{a,b}	**40.07**^{b}	**34.51**^{b}	**38.40**	**37.85**^{b}	**38.59**^{b}	**38.22**^{b}
HAR-ANN	**33.09**^{b}	**34.18**^{b}	**34.90**^{a,b}	**32.73**^{a,b}	**33.27**^{a,b}	**32.19**^{a,b}	**24.20**^{b}	**24.95**^{b}	**26.08**^{b}	**25.33**^{a,b}	**24.02**^{a,b}	**24.58**^{a,b}	**38.40**^{b}	**34.32**^{b}	**36.55**^{b}	**35.62**^{b}	**36.55**^{b}	**36.92**^{b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**54.07**	**53.53**	**54.61**	**54.07**	**52.98**	**53.53**^{a}	**62.66**	**63.41**	**62.85**	**62.66**	**61.91**	**64.17**^{a}	64.94	66.60	64.19	**58.63**	61.04^a	62.34^a
HAR	58.23	56.96	59.13	58.23	57.32	57.69^a	**63.41**	**63.04**	**61.73**	**64.35**	**61.73**	**61.91**^{a}	**62.89**^{b}	64.56	**61.41**^{b}	**56.96**	**59.74**^{a,b}	**60.67**^{a,b}
ANN	59.49	58.95	60.76	59.31	58.95	60.22^a	64.35^b	64.73^b	64.35	64.35^b	63.41^b	62.66^{a,b}	**61.78**^{b}	**63.82**^{b}	**61.22**^{b}	58.44	**60.67**^{b}	**61.04**^{b}
HAR-ANN	59.31^b	57.87^b	59.13^b	58.95^b	58.05^b	58.95^{a,b}	63.79^b	63.60^b	63.79^b	64.73^b	62.66^b	63.04^{a,b}	**64.01**^{b}	**64.56**^{b}	**61.04**^{b}	57.14^b	**60.85**^{b}	**61.78**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**43.40**	**44.85**	**44.85**	**45.57**	**44.48**	**46.29**^{a}	**66.60**	**67.73**	**65.48**	**66.79**	**66.98**	**69.04**^{a}	**57.14**	**56.03**	**56.03**	**58.81**	**58.63**^{a}	**59.93**^{a}
HAR	61.66	62.39	61.48	61.48	64.20	64.92^a	70.17	70.17	68.67	71.29	70.73	72.23^a	60.48	63.45	61.60	60.30	60.48^a	62.15^a
ANN	63.83	64.20	62.39	63.83	64.92	66.00^a	71.29	72.23	69.42	73.36	70.54	72.61^a	59.55	62.15	61.22	60.67	59.37^a	58.81^a
HAR-ANN	62.93^b	63.47^b	62.75^b	62.75^b	64.56^b	64.92^{a,b}	70.54^b	70.73^b	68.86^b	72.05^b	70.54^b	72.80^{a,b}	59.00^b	63.27^b	61.78^b	60.48^b	60.30^{a,b}	60.67^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	**39.42**	**41.05**	**38.52**	**41.59**	**41.59**	**42.86**^{a}	**70.17**	**72.42**	**69.98**	**71.29**	**71.86**	**72.61**^{a}	**59.18**	**59.00**	**57.70**	**61.22**	**60.48**^{a}	**62.15**^{a}
HAR	67.27	65.46	64.74	67.63	66.18	67.45^a	73.36	73.55	72.05	74.30	75.61	72.80^a	62.34	66.60	64.56	64.19	64.56^a	65.49^a
ANN	66.91	65.64	64.74	67.27	66.55	67.27^a	74.86	75.61	75.80	75.23	75.05	75.05^a	**59.93**	65.49	61.60	**62.15**	**61.41**^{a}	**61.78**^{a}
HAR-ANN	66.91^b	65.82^b	65.10^b	67.27^b	66.73^b	67.81^{a,b}	75.80^b	75.05^b	73.92^b	74.67^b	75.98^b	75.42^{a,b}	61.60^b	65.68^b	63.45^b	**64.38**^{b}	63.45^{a,b}	63.08^{a,b}

Table 7: **Whole period**: MME(U)/MME(O). The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use $(^a)$ to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and $(^b)$ to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	2.585	2.587	2.686	2.518	2.549^{a}	2.527^{a}	$\mathbf{2.066}^{b}$	$\mathbf{2.076}^{b}$	$\mathbf{2.178}^{b}$	$\mathbf{1.962}^{a,b}$	$\mathbf{2.067}^{a}$	$\mathbf{2.032}^{a,b}$	**2.949**	**2.991**	$\mathbf{3.044}^{b}$	$\mathbf{2.647}^{b}$	$\mathbf{2.827}^{b}$	$\mathbf{2.768}^{b}$
HAR	**2.312**	**2.326**	$\mathbf{2.406}^{b}$	$\mathbf{2.234}^{b}$	$\mathbf{2.274}^{a}$	$\mathbf{2.246}^{a,b}$	$\mathbf{2.075}^{b}$	$\mathbf{2.091}^{b}$	$\mathbf{2.185}^{b}$	$\mathbf{1.963}^{a,b}$	$\mathbf{2.064}^{a,b}$	$\mathbf{2.047}^{a,b}$	2.950^{b}	2.987^{b}	$\mathbf{3.061}^{b}$	$\mathbf{2.652}^{b}$	$\mathbf{2.824}^{b}$	$\mathbf{2.783}^{b}$
ANN	2.333^{b}	2.344^{b}	2.425^{b}	$\mathbf{2.233}^{b}$	$2.301^{a,b}$	$\mathbf{2.255}^{a,b}$	$\mathbf{2.068}^{b}$	$\mathbf{2.097}^{b}$	$\mathbf{2.176}^{b}$	$\mathbf{1.960}^{a,b}$	$2.086^{a,b}$	$\mathbf{2.046}^{a,b}$	$\mathbf{2.942}^{b}$	$\mathbf{2.976}^{b}$	$\mathbf{3.071}^{b}$	$\mathbf{2.648}^{b}$	$\mathbf{2.840}^{a,b}$	$\mathbf{2.808}^{a,b}$
HAR-ANN	$\mathbf{2.308}^{b}$	$\mathbf{2.322}^{b}$	$\mathbf{2.400}^{b}$	$\mathbf{2.223}^{b}$	$\mathbf{2.280}^{a,b}$	$\mathbf{2.244}^{a,b}$	$\mathbf{2.059}^{b}$	$\mathbf{2.083}^{b}$	$\mathbf{2.169}^{b}$	$\mathbf{1.954}^{a,b}$	$\mathbf{2.062}^{a,b}$	$\mathbf{2.034}^{a,b}$	$\mathbf{2.919}^{b}$	$\mathbf{2.948}^{b}$	$\mathbf{3.048}^{b}$	$\mathbf{2.649}^{b}$	$\mathbf{2.823}^{b}$	$\mathbf{2.788}^{b}$
				$h=5$						$h=5$						$h=5$		
ARFIMA	4.098	4.102	4.203	3.955	4.027^{a}	3.918^{a}	2.744	2.764	2.849	2.609^{a}	2.736^{a}	2.672^{a}	4.269	4.374	4.401	3.725	3.944	3.972
HAR	**2.923**	$\mathbf{2.979}^{b}$	**2.981**	$\mathbf{2.853}^{a,b}$	$\mathbf{2.903}^{a,b}$	$\mathbf{2.812}^{a,b}$	**2.523**	**2.563**	**2.592**	$\mathbf{2.425}^{a,b}$	$\mathbf{2.503}^{a}$	$\mathbf{2.448}^{a}$	**3.766**	**3.833**	**3.811**	**3.463**	**3.587**	**3.620**
ANN	2.991^{b}	$\mathbf{3.004}^{b}$	3.060^{b}	$\mathbf{2.887}^{a,b}$	$\mathbf{2.943}^{a,b}$	$2.877^{a,b}$	2.632^{b}	2.662^{b}	2.701	$\mathbf{2.475}^{a,b}$	2.644^{a}	$2.591^{a,b}$	3.882	3.940^{b}	3.954	3.572	3.695	3.753
HAR-ANN	$\mathbf{2.941}^{b}$	$\mathbf{2.978}^{b}$	$\mathbf{2.998}^{b}$	$\mathbf{2.855}^{a,b}$	$\mathbf{2.906}^{a,b}$	$\mathbf{2.821}^{a,b}$	$\mathbf{2.566}^{b}$	$\mathbf{2.593}^{b}$	$\mathbf{2.638}^{b}$	$\mathbf{2.435}^{a,b}$	$2.556^{a,b}$	$\mathbf{2.497}^{a,b}$	3.805^{b}	$\mathbf{3.858}^{b}$	3.864^{b}	3.502^{b}	3.626^{b}	3.669^{b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	5.292	5.297	5.421	5.154	5.212^{a}	5.076^{a}	3.205	**3.228**	3.297	$\mathbf{3.015}^{a}$	$\mathbf{3.196}^{a}$	$\mathbf{3.159}^{a}$	5.275	5.377	5.442	4.559	4.875	4.819
HAR	**3.415**	$\mathbf{3.489}^{b}$	**3.510**	$\mathbf{3.367}^{b}$	$\mathbf{3.413}^{a,b}$	$\mathbf{3.342}^{a,b}$	**2.924**	**2.959**	**2.978**	$\mathbf{2.828}^{a}$	$\mathbf{2.924}^{a}$	$\mathbf{2.903}^{a,b}$	**4.584**	**4.578**	**4.579**	**4.176**	**4.396**	**4.289**
ANN	3.547^{b}	3.559^{b}	3.635^{b}	$\mathbf{3.429}^{a,b}$	$\mathbf{3.482}^{a,b}$	$\mathbf{3.430}^{a,b}$	3.003^{b}	3.095^{b}	3.078^{b}	$2.941^{a,b}$	$3.053^{a,b}$	$3.116^{a,b}$	4.686^{b}	4.780^{b}	4.728^{b}	$4.245^{a,b}$	$4.519^{a,b}$	$4.428^{a,b}$
HAR-ANN	$\mathbf{3.459}^{b}$	$\mathbf{3.491}^{b}$	$\mathbf{3.546}^{b}$	$\mathbf{3.366}^{b}$	$\mathbf{3.424}^{b}$	$\mathbf{3.360}^{a,b}$	$\mathbf{2.921}^{b}$	$\mathbf{2.999}^{b}$	$\mathbf{2.977}^{b}$	$\mathbf{2.848}^{a,b}$	$\mathbf{2.963}^{a,b}$	$\mathbf{2.965}^{a,b}$	$\mathbf{4.597}^{b}$	$\mathbf{4.631}^{b}$	$\mathbf{4.609}^{b}$	$\mathbf{4.175}^{b}$	$\mathbf{4.411}^{b}$	$\mathbf{4.326}^{b}$
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**2.465**	**2.494**	**2.611**	**2.335**	**2.431**	$\mathbf{2.385}^{a}$	$\mathbf{2.749}^{b}$	**2.749**	**2.869**	**2.552**	**2.670**	$\mathbf{2.655}^{a}$	3.950	4.101	4.034	$\mathbf{3.146}^{b}$	$\mathbf{3.503}^{a,b}$	$\mathbf{3.536}^{a,b}$
HAR	2.789	2.838	2.932	2.637	2.786	2.731^{a}	$\mathbf{2.735}^{b}$	$\mathbf{2.718}^{b}$	**2.841**	**2.543**	$\mathbf{2.649}^{b}$	$\mathbf{2.622}^{a}$	3.833	3.994	3.930	$\mathbf{3.133}^{b}$	$\mathbf{3.475}^{a,b}$	$\mathbf{3.503}^{a,b}$
ANN	2.776	2.824	2.943	2.661	2.775	2.750^{a}	$\mathbf{2.771}^{b}$	2.756^{b}	2.902^{b}	2.584^{b}	2.679^{b}	2.669^{a}	**3.747**	**3.891**	$\mathbf{3.882}^{b}$	$\mathbf{3.159}^{b}$	$\mathbf{3.479}^{a,b}$	$\mathbf{3.522}^{a,b}$
HAR-ANN	2.775^{b}	2.829^{b}	2.932^{b}	2.650^{b}	2.773^{b}	$2.740^{a,b}$	$\mathbf{2.750}^{b}$	$\mathbf{2.731}^{b}$	2.873^{b}	2.566^{b}	$\mathbf{2.656}^{b}$	$2.648^{a,b}$	3.780^{b}	3.929^{b}	$\mathbf{3.896}^{b}$	$\mathbf{3.142}^{b}$	$\mathbf{3.477}^{a,b}$	$\mathbf{3.512}^{a,b}$
				$h=5$						$h=5$						$h=5$		
ARFIMA	**2.448**	**2.519**	**2.501**	**2.425**	**2.502**	$\mathbf{2.466}^{a}$	**3.377**	**3.451**	**3.400**	**3.317**	**3.424**	$\mathbf{3.433}^{a}$	**4.448**	**4.515**	**4.400**	**4.109**	$\mathbf{4.311}^{a}$	$\mathbf{4.279}^{a}$
HAR	3.645	3.686	3.741	3.568	3.693	3.678^{a}	3.677	3.714	3.732	3.545	3.691	3.661^{a}	4.852	4.994	4.993	4.401	4.719^{a}	4.705^{a}
ANN	3.688	3.731	3.789	3.639	3.724	3.700^{a}	3.728	3.776	3.826	3.660	3.734	3.717^{a}	4.774	4.931	4.936	4.344	4.598^{a}	4.599^{a}
HAR-ANN	3.652^{b}	3.705^{b}	3.750^{b}	3.593^{b}	3.701^{b}	$3.672^{a,b}$	3.685^{b}	3.739^{b}	3.770^{b}	3.587^{b}	3.706^{b}	$3.672^{a,b}$	4.783^{b}	4.948^{b}	4.947^{b}	4.356^{b}	$4.641^{a,b}$	$4.651^{a,b}$
				$h=10$						$h=10$						$h=10$		
ARFIMA	**2.712**	**2.777**	**2.737**	**2.713**	**2.777**	$\mathbf{2.767}^{a}$	**4.167**	**4.308**	**4.176**	**4.135**	**4.267**	$\mathbf{4.289}^{a}$	**5.338**	**5.497**	**5.231**	**5.070**	$\mathbf{5.249}^{a}$	$\mathbf{5.163}^{a}$
HAR	4.555	4.564	4.617	4.438	4.544	4.596^{a}	4.567	**4.573**	4.560	4.499	**4.553**	4.624^{a}	6.089	6.269	6.142	5.579	5.958	5.871
ANN	4.524	4.549	4.589	4.401	4.524	4.591^{a}	4.669	4.681	4.767	4.612	4.651	4.700^{a}	5.819	6.019	5.856	5.447	5.636^{a}	5.587^{a}
HAR-ANN	4.517^{b}	4.528^{b}	4.600^{b}	4.401^{b}	4.516^{b}	$4.585^{a,b}$	4.602^{b}	4.600^{b}	4.633^{b}	4.524^{b}	4.584^{b}	$4.642^{a,b}$	5.942^{b}	6.128^{b}	5.987^{b}	5.512^{b}	$5.793^{a,b}$	$5.720^{a,b}$

Table 8: **Whole period**: MME(U)/MME(O) in %. The Model Confidence Set (MSC) is used to compare the errors row-wise (across forecasting models) as well as column-wise (across realized measures). We use (^{a}) to denote the volatility measures that belong to the $\widehat{\mathcal{M}}^*_{10\%}$ and (^{b}) to denote the forecasting models that belong to the $\widehat{\mathcal{M}}^*_{10\%}$. Moreover, each of the forecasting models is benchmarked to the rest of the competing models using the Superior Predictive Ability (SPA) test. Cases where the null hypothesis that the benchmark model is the best forecasting model cannot be rejected are set in bold. Note that numbers are multiplied by $\times 10^2$.

	Crude Oil						**Heating Oil**						**Natural Gas**					
	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV	TSRV	RV	RK	JWTSRV	CBV	MedRV
MME(U)				$h=1$						$h=1$						$h=1$		
ARFIMA	47.95	47.82	47.27	49.29	48.38^a	49.05^a	**40.07**^{b}	**40.63**^{b}	**40.69**^{b}	**41.00**^{a,b}	**41.99**^{a}	**40.94**^{a,b}	**39.10**	**39.28**	**39.65**^{b}	**43.67**^{b}	**42.37**^{b}	**40.83**^{b}
HAR	**43.41**	**42.86**	**42.55**^{b}	**44.51**^{b}	**43.10**^{a}	**43.47**^{a,b}	**40.57**^{b}	**41.37**^{b}	**41.00**^{b}	**40.88**^{a,b}	**41.92**^{a,b}	**41.99**^{a,b}	40.21^b	39.47^b	**40.83**^{b}	**43.73**^{b}	**42.62**^{b}	**41.75**^{b}
ANN	43.96^b	43.35^b	42.37^b	**43.23**^{b}	43.41^{a,b}	**43.10**^{a,b}	**40.32**^{b}	**40.75**^{b}	**40.63**^{b}	**40.51**^{a,b}	42.36^{a,b}	**41.37**^{a,b}	**41.75**^{b}	**40.33**^{b}	**41.51**^{b}	**43.67**^{b}	**42.80**^{a,b}	**41.63**^{a,b}
HAR-ANN	**43.47**^{b}	**42.98**^{b}	**42.55**^{b}	**43.59**^{b}	**43.53**^{a,b}	**43.16**^{a,b}	**40.01**^{b}	**40.81**^{b}	**40.32**^{b}	**40.26**^{a,b}	**41.99**^{a,b}	**41.06**^{a,b}	**40.40**^{b}	**39.35**^{b}	**41.45**^{b}	**44.04**^{b}	**42.31**^{b}	**41.51**^{b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	60.54	58.94	59.74	59.07	58.39^a	58.08^a	41.29	40.73	42.83	41.29^a	41.66^a	39.74^a	45.02	46.44	46.32	45.26	44.77	45.08
HAR	**43.15**	**43.45**^{b}	**42.84**	**42.90**^{a,b}	**41.73**^{a,b}	**40.75**^{a,b}	**38.13**	**38.57**	**38.50**	**37.95**^{a,b}	**37.52**^{a}	**37.02**^{a}	**41.24**	**41.36**	**40.12**	**42.54**	**40.50**	**41.24**
ANN	43.09^b	**42.53**^{b}	42.96^b	**42.47**^{a,b}	**42.16**^{a,b}	41.61^{a,b}	38.88^b	39.06^b	39.49^b	**37.95**^{a,b}	39.43^a	38.32^{a,b}	42.54	42.66^b	42.11	43.53	42.35	43.22
HAR-ANN	**43.15**^{b}	**42.90**^{b}	**42.84**^{b}	**42.59**^{a,b}	**41.92**^{a,b}	**41.55**^{a,b}	**38.94**^{b}	**38.50**^{b}	**39.12**^{b}	**38.26**^{a,b}	38.01^{a,b}	**37.45**^{a,b}	**42.41**^{b}	**41.73**^{b}	41.18^b	43.03^b	41.80^b	41.98^b
				$h=10$						$h=10$						$h=10$		
ARFIMA	63.56	61.78	63.56	62.64	61.41^a	60.60^a	39.24	**38.00**	40.30	**38.13**^{a}	**38.87**^{a}	**37.57**^{a}	46.71	46.09	48.01	44.47	45.16	44.78
HAR	**39.40**	**40.32**	**40.75**	**40.26**^{b}	**40.07**^{a,b}	**38.78**^{a,b}	**36.58**	**35.77**	**37.14**	**34.97**^{a}	**35.71**^{a}	**34.66**^{a,b}	**39.75**	**39.57**	**39.75**	**39.63**	**39.32**	**39.63**
ANN	41.49^b	41.68^b	42.54^b	**41.43**^{a,b}	**41.37**^{a,b}	**40.20**^{a,b}	36.27^b	36.70^b	36.33^b	36.27^{a,b}	37.26^{a,b}	36.33^{a,b}	42.30^b	41.99^b	41.99^b	40.99^{a,b}	42.55^{a,b}	42.11^{a,b}
HAR-ANN	**40.57**^{b}	**41.00**^{b}	**41.00**^{b}	**40.63**^{b}	**40.69**^{b}	**39.27**^{a,b}	**35.71**^{b}	**36.14**^{b}	**36.45**^{b}	**35.59**^{a,b}	**36.39**^{a,b}	**35.03**^{a,b}	**40.81**^{b}	**40.50**^{b}	**40.31**^{b}	**40.06**^{b}	**40.37**^{b}	**40.75**^{b}
MME(O)				$h=1$						$h=1$						$h=1$		
ARFIMA	**52.05**	**52.18**	**52.73**	**50.71**	**51.62**	**50.95**^{a}	**59.93**^{b}	**59.37**	**59.31**	**59.00**	**58.01**	**59.06**^{a}	60.90	60.72	60.35	**56.33**^{b}	**57.63**^{a,b}	**59.17**^{a,b}
HAR	56.59	57.14	57.45	55.49	56.90	56.53^a	**59.43**^{b}	**58.63**^{b}	**59.00**	**59.12**	**58.08**^{b}	**58.01**^{a}	59.79	60.53	59.17	**56.27**^{b}	**57.38**^{a,b}	**58.25**^{a,b}
ANN	56.04	56.65	57.63	56.77	56.59	56.90^a	**59.68**^{b}	59.25^b	59.37^b	59.49^b	57.64^b	58.63^a	**58.25**	**59.67**	**58.49**^{b}	**56.33**^{b}	**57.20**^{a,b}	**58.37**^{a,b}
HAR-ANN	56.53^b	57.02^b	57.45^b	56.41^b	56.47^b	56.84^{a,b}	**59.99**^{b}	**59.19**^{b}	59.68^b	59.74^b	**58.01**^{b}	58.94^{a,b}	59.60^b	60.65^b	**58.55**^{b}	**55.96**^{b}	**57.69**^{a,b}	**58.49**^{a,b}
				$h=5$						$h=5$						$h=5$		
ARFIMA	**39.46**	**41.06**	**40.26**	**40.93**	**41.61**	**41.92**^{a}	**58.71**	**59.27**	**57.17**	**58.71**	**58.34**	**60.26**^{a}	**54.98**	**53.56**	**53.68**	**54.74**	**55.23**^{a}	**54.92**^{a}
HAR	56.85	56.55	57.16	57.10	58.27	59.25^a	61.87	61.43	61.50	62.05	62.48	62.98^a	58.76	58.64	59.88	57.46	59.50^a	58.76^a
ANN	56.91	57.47	57.04	57.53	57.84	58.39^a	61.12	60.94	60.51	62.05	60.57	61.68^a	57.46	57.34	57.89	56.47	57.65^a	56.78^a
HAR-ANN	56.85^b	57.10^b	57.16^b	57.41^b	58.08^b	58.45^{a,b}	61.06^b	61.50^b	60.88^b	61.74^b	61.99^b	62.55^{a,b}	57.59^b	58.27^b	58.82^b	56.97^b	58.20^{a,b}	58.02^{a,b}
				$h=10$						$h=10$						$h=10$		
ARFIMA	**36.44**	**38.22**	**36.44**	**37.36**	**38.59**	**39.40**^{a}	**60.76**	**62.00**	**59.70**	**61.87**	**61.13**	**62.43**^{a}	**53.29**	**53.91**	**51.99**	**55.53**	**54.84**^{a}	**55.22**^{a}
HAR	60.60	59.68	59.25	59.74	59.93	61.22^a	63.42	**64.23**	62.86	65.03	**64.29**	65.34^a	60.25	60.43	60.25	60.37	60.68	60.37
ANN	58.51	58.32	57.46	58.57	58.63	59.80^a	63.73	63.30	63.67	63.73	62.74	63.67^a	57.70	58.01	58.01	59.01	57.45^a	57.89^a
HAR-ANN	59.43^b	59.00^b	59.00^b	59.37^b	59.31^b	60.73^{a,b}	64.29^b	63.86^b	63.55^b	64.41^b	63.61^b	64.97^{a,b}	59.19^b	59.50^b	59.69^b	59.94^b	59.63^{a,b}	59.25^{a,b}

Table 9: **Before September 2008**. MZ Parameters, bolded are cases where joint hypothesis $(\alpha, \beta) = (1, 0)$ is rejected using HAC errors.

H	Model	TSRV	RV	RK	JWTSRV	CBV	MedRV
Crude Oil							
1	ARFIMA	(**0.842**, **0.003**)	(**0.834**, **0.003**)	(**0.854**, **0.003**)	(**0.847**, **0.003**)	(**0.853**, **0.003**)	(**0.845**, **0.003**)
	HAR	(0.968, 0.001)	(0.973, 0.001)	(0.979, 0.000)	(0.962, 0.001)	(0.972, 0.001)	(0.969, 0.001)
	HAR-ANN	(0.975, 0.001)	(0.976, 0.000)	(0.990, 0.000)	(0.966, 0.001)	(0.974, 0.000)	(0.967, 0.001)
	ANN	(0.958, 0.001)	(0.950, 0.001)	(0.968, 0.001)	(0.951, 0.001)	(0.948, 0.001)	(0.941, 0.001)
5	ARFIMA	(**0.943**, **0.004**)	(**0.934**, **0.004**)	(**0.954**, **0.004**)	(**0.931**, **0.004**)	(**0.940**, **0.004**)	(**0.929**, **0.004**)
	HAR	(0.966, 0.002)	(0.971, 0.002)	(0.982, 0.001)	(0.964, 0.002)	(0.972, 0.001)	(0.973, 0.001)
	HAR-ANN	(0.972, 0.002)	(0.975, 0.001)	(0.990, 0.001)	(0.962, 0.002)	(0.976, 0.001)	(0.970, 0.001)
	ANN	(0.963, 0.002)	(0.958, 0.002)	(0.979, 0.001)	(0.945, 0.002)	(0.964, 0.001)	(0.939, 0.002)
10	ARFIMA	(**0.960**, **0.006**)	(**0.936**, **0.007**)	(**0.971**, **0.006**)	(**0.947**, **0.006**)	(**0.940**, **0.007**)	(**0.933**, **0.007**)
	HAR	(0.950, 0.004)	(0.927, 0.005)	(0.973, 0.003)	(0.953, 0.003)	(0.930, 0.004)	(0.927, 0.004)
	HAR-ANN	(0.954, 0.003)	(0.931, 0.004)	(0.982, 0.002)	(0.949, 0.003)	(0.929, 0.004)	(0.916, 0.004)
	ANN	(0.938, 0.004)	(0.909, 0.005)	(0.968, 0.002)	(0.926, 0.004)	(0.908, 0.005)	(0.859, 0.007)
Heating Oil							
1	ARFIMA	(0.930, 0.001)	(0.934, 0.001)	(0.982, 0.000)	(0.928, 0.001)	(0.922, 0.001)	(0.916, 0.001)
	HAR	(0.903, 0.001)	(0.899, 0.002)	(0.918, 0.001)	(0.910, 0.001)	(0.886, 0.002)	(0.896, 0.001)
	HAR-ANN	(0.895, 0.001)	(0.886, 0.002)	(0.905, 0.001)	(0.893, 0.001)	(0.866, 0.002)	(0.872, 0.002)
	ANN	(0.863, 0.002)	(0.838, 0.002)	(0.859, 0.002)	(0.864, 0.002)	(0.818, 0.002)	(0.827, 0.002)
5	ARFIMA	(1.029, −0.001)	(1.002, 0.000)	(1.103, −0.003)	(0.976, 0.001)	(0.989, 0.000)	(0.951, 0.002)
	HAR	(0.871, 0.004)	(0.837, 0.006)	(0.892, 0.004)	(0.858, 0.004)	(0.828, 0.006)	(0.811, 0.006)
	HAR-ANN	(**0.856**, **0.005**)	(0.811, 0.006)	(0.877, 0.004)	(0.835, 0.005)	(0.796, 0.007)	(0.783, 0.007)
	ANN	(0.822, 0.006)	(0.755, 0.008)	(0.834, 0.005)	(0.801, 0.006)	(0.748, 0.008)	(0.741, 0.008)
10	ARFIMA	(1.065, −0.002)	(0.979, 0.001)	(1.158, −0.007)	(0.977, 0.001)	(0.970, 0.001)	(0.853, 0.006)
	HAR	(0.836, 0.008)	(**0.767**, **0.011**)	(0.867, 0.007)	(0.787, 0.009)	(0.761, 0.011)	(0.686, 0.014)
	HAR-ANN	(0.823, 0.008)	(0.739, 0.012)	(0.846, 0.007)	(0.769, 0.010)	(0.734, 0.012)	(0.663, 0.015)
	ANN	(0.792, 0.010)	(**0.689**, **0.014**)	(0.801, 0.009)	(0.739, 0.011)	(0.693, 0.014)	(**0.627**, **0.016**)
Natural gas							
1	ARFIMA	(1.052, −0.001)	(1.058, −0.002)	(1.061, −0.001)	(1.032, −0.001)	(1.030, −0.001)	(1.017, −0.001)
	HAR	(1.011, −0.000)	(1.015, −0.001)	(1.015, −0.001)	(1.001, −0.000)	(1.006, −0.000)	(0.989, 0.000)
	HAR-ANN	(1.010, −0.000)	(1.008, −0.000)	(1.010, −0.000)	(1.015, −0.000)	(1.001, −0.000)	(0.991, −0.000)
	ANN	(0.986, 0.000)	(0.985, 0.000)	(0.978, 0.000)	(1.019, −0.001)	(0.978, 0.000)	(0.979, 0.000)
5	ARFIMA	(1.170, −0.008)	(1.176, −0.009)	(1.197, −0.009)	(1.118, −0.005)	(1.131, −0.006)	(1.117, −0.005)
	HAR	(1.023, −0.002)	(1.024, −0.002)	(1.034, −0.003)	(1.015, −0.001)	(1.028, −0.002)	(1.009, −0.001)
	HAR-ANN	(1.017, −0.002)	(1.005, −0.001)	(1.041, −0.003)	(1.008, −0.001)	(1.028, −0.002)	(1.002, −0.001)
	ANN	(0.983, −0.000)	(0.947, 0.002)	(1.024, −0.002)	(0.979, 0.000)	(1.001, −0.001)	(0.966, 0.001)
10	ARFIMA	(1.192, −0.013)	(1.197, −0.014)	(1.226, −0.015)	(1.146, −0.010)	(1.155, −0.011)	(1.139, −0.009)
	HAR	(1.020, −0.003)	(1.015, −0.003)	(1.035, −0.005)	(1.023, −0.003)	(1.028, −0.004)	(0.998, −0.002)
	HAR-ANN	(1.006, −0.002)	(0.973, 0.000)	(0.998, −0.002)	(1.022, −0.003)	(1.024, −0.003)	(0.984, −0.000)
	ANN	(0.961, 0.001)	(0.880, 0.007)	(0.912, 0.005)	(0.996, −0.001)	(0.984, −0.000)	(0.937, 0.003)

Table 10: **September 2008 − November 2010**. MZ Parameters, bolded are cases where joint hypothesis $(\alpha, \beta) = (1, 0)$ is rejected using HAC errors.

H	Model	TSRV	RV	RK	JWTSRV	CBV	MedRV
Crude Oil							
1	ARFIMA	(1.045, −0.001)	(1.035, −0.000)	(1.037, −0.000)	(1.058, −0.001)	(1.048, −0.001)	(1.047, −0.001)
	HAR	(0.970, 0.000)	(0.967, 0.000)	(0.964, 0.000)	(0.973, 0.000)	(0.968, 0.000)	(0.969, 0.000)
	HAR-ANN	(0.978, 0.000)	(0.978, 0.000)	(0.978, 0.000)	(0.974, 0.000)	(0.978, 0.000)	(0.980, 0.000)
	ANN	(0.979, 0.000)	(0.980, 0.000)	(0.979, 0.000)	(0.970, 0.000)	(0.981, 0.000)	(0.983, 0.000)
5	ARFIMA	(1.113, −0.003)	(**1.109**, **−0.003**)	(**1.109**, **−0.002**)	(1.118, −0.003)	(1.117, −0.003)	(**1.117**, **−0.003**)
	HAR	(0.952, 0.001)	(0.952, 0.001)	(0.950, 0.001)	(0.951, 0.001)	(0.950, 0.001)	(0.948, 0.001)
	HAR-ANN	(0.970, 0.001)	(0.970, 0.001)	(0.972, 0.001)	(0.965, 0.001)	(0.966, 0.001)	(0.969, 0.001)
	ANN	(0.982, 0.000)	(0.983, 0.000)	(0.987, 0.000)	(0.974, 0.001)	(0.977, 0.001)	(0.983, 0.000)
10	ARFIMA	(1.152, −0.005)	(1.150, −0.005)	(1.152, −0.005)	(1.155, −0.006)	(1.156, −0.005)	(1.157, −0.005)
	HAR	(0.934, 0.003)	(0.936, 0.003)	(0.932, 0.003)	(0.934, 0.003)	(0.932, 0.003)	(0.928, 0.003)
	HAR-ANN	(0.954, 0.002)	(0.952, 0.002)	(0.954, 0.002)	(0.950, 0.002)	(0.949, 0.002)	(0.949, 0.002)
	ANN	(0.969, 0.001)	(0.965, 0.002)	(0.970, 0.001)	(0.963, 0.002)	(0.962, 0.002)	(0.964, 0.001)
Heating Oil							
1	ARFIMA	(1.052, −0.001)	(1.056, −0.001)	(1.039, −0.001)	(**1.058**, **−0.001**)	(1.058, −0.001)	(1.064, −0.001)
	HAR	(0.983, 0.000)	(0.983, 0.000)	(0.977, 0.000)	(0.986, 0.000)	(0.983, 0.000)	(0.991, −0.000)
	HAR-ANN	(1.004, −0.000)	(1.007, −0.000)	(0.998, −0.000)	(1.001, −0.000)	(1.004, −0.000)	(1.013, −0.000)
	ANN	(1.014, −0.000)	(1.022, −0.000)	(1.004, −0.000)	(1.010, −0.000)	(1.019, −0.000)	(1.026, −0.000)
5	ARFIMA	(1.114, −0.004)	(1.121, −0.004)	(1.107, −0.004)	(1.110, −0.004)	(1.115, −0.004)	(1.122, −0.004)
	HAR	(0.973, 0.000)	(0.970, 0.000)	(0.972, 0.000)	(0.971, 0.001)	(0.966, 0.001)	(0.975, 0.000)
	HAR-ANN	(1.002, −0.001)	(1.000, −0.000)	(1.002, −0.001)	(0.992, −0.000)	(0.991, −0.000)	(1.010, −0.001)
	ANN	(1.023, −0.001)	(1.024, −0.001)	(1.022, −0.001)	(1.006, −0.000)	(1.012, −0.001)	(1.037, −0.002)
10	ARFIMA	(1.161, −0.008)	(1.172, −0.009)	(1.158, −0.008)	(1.151, −0.008)	(1.162, −0.008)	(1.167, −0.008)
	HAR	(0.966, 0.001)	(0.966, 0.001)	(0.963, 0.001)	(0.962, 0.001)	(0.961, 0.001)	(0.966, 0.001)
	HAR-ANN	(0.996, −0.001)	(0.995, −0.001)	(0.993, −0.001)	(0.987, 0.000)	(0.987, −0.000)	(0.999, −0.001)
	ANN	(1.016, −0.001)	(1.018, −0.002)	(1.010, −0.001)	(1.004, −0.001)	(1.009, −0.001)	(1.024, −0.002)
Natural gas							
1	ARFIMA	(0.939, 0.002)	(0.894, 0.003)	(0.915, 0.002)	(0.979, 0.001)	(0.973, 0.001)	(0.978, 0.001)
	HAR	(0.934, 0.002)	(0.924, 0.002)	(0.921, 0.002)	(0.978, 0.001)	(0.967, 0.001)	(0.972, 0.001)
	HAR-ANN	(0.961, 0.001)	(0.960, 0.001)	(0.957, 0.001)	(0.976, 0.001)	(0.970, 0.001)	(0.964, 0.001)
	ANN	(0.947, 0.002)	(0.942, 0.002)	(0.934, 0.002)	(0.964, 0.001)	(0.962, 0.001)	(0.942, 0.002)
5	ARFIMA	(1.110, −0.004)	(1.094, −0.003)	(1.106, −0.003)	(1.014, 0.000)	(1.053, −0.001)	(1.073, −0.002)
	HAR	(0.929, 0.005)	(0.899, 0.007)	(0.923, 0.005)	(0.987, 0.001)	(0.960, 0.003)	(0.965, 0.002)
	HAR-ANN	(0.921, 0.006)	(0.911, 0.007)	(0.923, 0.006)	(0.984, 0.001)	(0.960, 0.003)	(0.978, 0.002)
	ANN	(0.898, 0.007)	(0.903, 0.007)	(0.905, 0.007)	(0.966, 0.002)	(0.939, 0.004)	(0.961, 0.003)
10	ARFIMA	(1.112, −0.005)	(1.037, 0.002)	(1.110, −0.004)	(1.021, 0.000)	(1.045, −0.000)	(1.067, −0.002)
	HAR	(0.885, 0.011)	(0.808, 0.018)	(0.884, 0.011)	(0.962, 0.003)	(0.915, 0.008)	(0.919, 0.007)
	HAR-ANN	(0.870, 0.013)	(0.815, 0.018)	(0.895, 0.011)	(0.945, 0.005)	(0.939, 0.006)	(0.913, 0.008)
	ANN	(0.815, 0.018)	(0.773, 0.022)	(0.864, 0.014)	(0.907, 0.008)	(0.917, 0.008)	(0.864, 0.012)

Table 11: **After November 2010**. MZ Parameters, bolded are cases where joint hypothesis $(\alpha, \beta) = (1, 0)$ is rejected using HAC errors.

H	Model	TSRV	RV	RK	JWTSRV	CBV	MedRV
Crude Oil							
1	ARFIMA	(**0.901**, **0.001**)	(**0.876**, **0.002**)	(**0.879**, **0.002**)	(0.956, 0.001)	(**0.893**, **0.001**)	(**0.903**, **0.001**)
	HAR	(0.932, 0.001)	(0.914, 0.001)	(0.929, 0.001)	(0.976, 0.000)	(0.930, 0.001)	(0.949, 0.000)
	HAR-ANN	(0.907, 0.001)	(0.892, 0.001)	(0.893, 0.001)	(0.953, 0.000)	(0.914, 0.001)	(0.932, 0.001)
	ANN	(0.867, 0.001)	(0.848, 0.002)	(0.832, 0.002)	(0.915, 0.001)	(0.881, 0.001)	(0.899, 0.001)
5	ARFIMA	(**0.876**, **0.005**)	(**0.850**, **0.005**)	(**0.859**, **0.005**)	(**0.930**, **0.003**)	(**0.882**, **0.004**)	(**0.897**, **0.004**)
	HAR	(0.848, 0.004)	(0.825, 0.005)	(0.844, 0.004)	(0.880, 0.003)	(0.831, 0.004)	(0.857, 0.003)
	HAR-ANN	(0.822, 0.005)	(0.811, 0.005)	(0.819, 0.005)	(0.853, 0.004)	(0.805, 0.005)	(0.824, 0.004)
	ANN	(0.774, 0.006)	(0.776, 0.006)	(0.764, 0.006)	(0.796, 0.005)	(0.762, 0.006)	(0.754, 0.006)
10	ARFIMA	(**0.857**, **0.008**)	(**0.828**, **0.009**)	(**0.846**, **0.008**)	(**0.897**, **0.006**)	(**0.842**, **0.008**)	(**0.854**, **0.008**)
	HAR	(0.733, 0.010)	(0.718, 0.011)	(0.751, 0.009)	(0.754, 0.009)	(0.701, 0.011)	(0.716, 0.010)
	HAR-ANN	(0.755, 0.009)	(0.718, 0.011)	(0.735, 0.010)	(0.745, 0.009)	(0.696, 0.011)	(0.716, 0.010)
	ANN	(0.746, 0.009)	(0.689, 0.012)	(0.685, 0.012)	(0.710, 0.011)	(0.669, 0.012)	(0.686, 0.011)
Heating Oil							
1	ARFIMA	(**0.883**, **0.001**)	(**0.856**, **0.001**)	(**0.869**, **0.001**)	(**0.907**, **0.001**)	(**0.887**, **0.001**)	(**0.868**, **0.001**)
	HAR	(**0.921**, **0.000**)	(**0.878**, **0.001**)	(**0.918**, **0.001**)	(**0.943**, **0.000**)	(**0.915**, **0.001**)	(**0.888**, **0.001**)
	HAR-ANN	(**0.899**, **0.001**)	(**0.848**, **0.001**)	(**0.894**, **0.001**)	(**0.926**, **0.000**)	(**0.886**, **0.001**)	(**0.867**, **0.001**)
	ANN	(**0.858**, **0.001**)	(**0.802**, **0.002**)	(**0.842**, **0.001**)	(**0.895**, **0.001**)	(**0.841**, **0.001**)	(**0.832**, **0.001**)
5	ARFIMA	(**0.846**, **0.003**)	(**0.809**, **0.004**)	(**0.824**, **0.003**)	(**0.847**, **0.003**)	(**0.851**, **0.003**)	(**0.837**, **0.003**)
	HAR	(**0.828**, **0.003**)	(**0.767**, **0.004**)	(**0.824**, **0.003**)	(**0.832**, **0.003**)	(**0.809**, **0.003**)	(**0.782**, **0.004**)
	HAR-ANN	(**0.781**, **0.004**)	(**0.743**, **0.005**)	(**0.787**, **0.004**)	(**0.797**, **0.004**)	(**0.769**, **0.004**)	(**0.751**, **0.004**)
	ANN	(**0.711**, **0.006**)	(**0.700**, **0.006**)	(**0.715**, **0.005**)	(**0.737**, **0.005**)	(**0.710**, **0.006**)	(**0.697**, **0.006**)
10	ARFIMA	(**0.817**, **0.005**)	(**0.781**, **0.006**)	(**0.812**, **0.005**)	(**0.816**, **0.004**)	(**0.815**, **0.005**)	(**0.801**, **0.005**)
	HAR	(**0.713**, **0.008**)	(**0.660**, **0.010**)	(**0.755**, **0.006**)	(**0.717**, **0.007**)	(**0.674**, **0.009**)	(**0.642**, **0.010**)
	HAR-ANN	(**0.693**, **0.008**)	(**0.628**, **0.011**)	(**0.742**, **0.007**)	(**0.696**, **0.008**)	(**0.649**, **0.010**)	(**0.633**, **0.010**)
	ANN	(**0.626**, **0.011**)	(**0.558**, **0.013**)	(**0.669**, **0.009**)	(**0.632**, **0.010**)	(**0.593**, **0.012**)	(**0.583**, **0.011**)
Natural gas							
1	ARFIMA	(0.887, 0.002)	(**0.890**, **0.002**)	(0.891, 0.002)	(0.950, 0.001)	(0.903, 0.001)	(**0.900**, **0.001**)
	HAR	(0.924, 0.001)	(0.910, 0.001)	(0.901, 0.002)	(0.936, 0.001)	(0.933, 0.001)	(0.906, 0.001)
	HAR-ANN	(0.969, 0.000)	(0.980, −0.000)	(0.951, 0.001)	(0.938, 0.001)	(0.926, 0.001)	(0.893, 0.001)
	ANN	(0.918, 0.001)	(0.899, 0.001)	(0.907, 0.001)	(0.934, 0.001)	(0.899, 0.002)	(**0.860**, **0.002**)
5	ARFIMA	(1.045, −0.002)	(1.059, −0.003)	(1.021, −0.001)	(1.000, −0.000)	(0.998, −0.000)	(0.971, 0.001)
	HAR	(0.891, 0.004)	(0.852, 0.005)	(0.862, 0.005)	(0.940, 0.002)	(0.933, 0.002)	(0.891, 0.003)
	HAR-ANN	(0.892, 0.004)	(0.837, 0.006)	(0.863, 0.005)	(0.933, 0.002)	(0.910, 0.003)	(0.874, 0.004)
	ANN	(0.865, 0.005)	(0.802, 0.007)	(0.826, 0.007)	(0.908, 0.003)	(0.868, 0.005)	(0.831, 0.006)
10	ARFIMA	(0.984, 0.000)	(0.981, 0.000)	(0.953, 0.002)	(0.980, 0.000)	(0.943, 0.003)	(0.927, 0.003)
	HAR	(0.829, 0.009)	(0.781, 0.012)	(0.797, 0.011)	(0.911, 0.004)	(0.868, 0.006)	(0.840, 0.007)
	HAR-ANN	(0.803, 0.011)	(0.749, 0.014)	(0.766, 0.013)	(0.893, 0.005)	(0.842, 0.008)	(0.819, 0.008)
	ANN	(**0.742**, **0.015**)	(0.686, 0.018)	(**0.707**, **0.017**)	(0.855, 0.007)	(0.792, 0.011)	(**0.772**, **0.011**)

Table 12: **Whole period**. MZ Parameters, bolded are cases where joint hypothesis $(\alpha, \beta) = (1, 0)$ is rejected using HAC errors.

H	Model	TSRV	RV	RK	JWTSRV	CBV	MedRV
Crude Oil							
1	ARFIMA	(**0.979**, **0.001**)	(**0.971**, **0.001**)	(**0.974**, **0.001**)	(**0.998**, **0.000**)	(**0.981**, **0.001**)	(**0.983**, **0.001**)
	HAR	(0.970, 0.000)	(0.966, 0.000)	(0.969, 0.000)	(0.980, 0.000)	(0.968, 0.000)	(0.973, 0.000)
	HAR-ANN	(0.973, 0.000)	(0.970, 0.000)	(0.972, 0.000)	(0.978, 0.000)	(0.973, 0.000)	(0.977, 0.000)
	ANN	(0.966, 0.000)	(0.962, 0.001)	(0.961, 0.001)	(0.968, 0.000)	(0.967, 0.000)	(0.971, 0.000)
5	ARFIMA	(**1.021**, **0.001**)	(**1.014**, **0.001**)	(**1.019**, **0.001**)	(**1.034**, **0.001**)	(**1.025**, **0.001**)	(**1.027**, **0.001**)
	HAR	(0.948, 0.002)	(0.945, 0.002)	(0.949, 0.002)	(0.953, 0.001)	(0.945, 0.002)	(0.948, 0.001)
	HAR-ANN	(0.957, 0.001)	(0.956, 0.001)	(0.961, 0.001)	(0.957, 0.001)	(0.951, 0.001)	(0.955, 0.001)
	ANN	(0.956, 0.001)	(0.958, 0.001)	(0.961, 0.001)	(0.948, 0.001)	(0.948, 0.002)	(0.947, 0.001)
10	ARFIMA	(**1.039**, **0.002**)	(**1.032**, **0.002**)	(**1.041**, **0.002**)	(**1.048**, **0.001**)	(**1.038**, **0.002**)	(**1.040**, **0.001**)
	HAR	(0.923, 0.004)	(0.921, 0.004)	(0.927, 0.003)	(0.926, 0.003)	(0.918, 0.004)	(0.916, 0.003)
	HAR-ANN	(0.941, 0.003)	(0.933, 0.003)	(0.941, 0.003)	(0.935, 0.003)	(0.928, 0.003)	(0.929, 0.003)
	ANN	(0.951, 0.002)	(0.934, 0.003)	(0.942, 0.002)	(0.934, 0.003)	(0.929, 0.003)	(0.930, 0.003)
Heating Oil							
1	ARFIMA	(**1.017**, **−0.000**)	(**1.016**, **−0.000**)	(**1.020**, **−0.000**)	(**1.014**, **−0.000**)	(**1.020**, **−0.000**)	(**1.015**, **−0.000**)
	HAR	(0.999, −0.000)	(0.995, −0.000)	(1.000, −0.000)	(0.999, −0.000)	(0.997, −0.000)	(0.993, −0.000)
	HAR-ANN	(1.006, −0.000)	(1.002, −0.000)	(**1.010**, **−0.000**)	(**1.003**, **−0.000**)	(1.003, −0.000)	(1.000, −0.000)
	ANN	(**1.005**, **−0.000**)	(1.001, −0.000)	(**1.008**, **−0.000**)	(**1.001**, **−0.000**)	(1.001, −0.000)	(1.000, −0.000)
5	ARFIMA	(**1.059**, **−0.002**)	(1.058, −0.002)	(1.066, −0.002)	(**1.043**, **−0.002**)	(**1.060**, **−0.002**)	(1.056, −0.002)
	HAR	(0.996, −0.000)	(0.988, −0.000)	(0.997, −0.000)	(0.991, −0.000)	(0.989, −0.000)	(0.982, 0.000)
	HAR-ANN	(1.006, −0.001)	(1.001, −0.001)	(1.012, −0.001)	(0.997, −0.001)	(0.996, −0.000)	(0.995, −0.000)
	ANN	(1.008, −0.001)	(1.007, −0.001)	(1.016, −0.001)	(0.996, −0.001)	(0.996, −0.000)	(0.999, −0.001)
10	ARFIMA	(**1.085**, **−0.004**)	(**1.084**, **−0.004**)	(**1.098**, **−0.005**)	(**1.065**, **−0.003**)	(**1.085**, **−0.004**)	(**1.078**, **−0.004**)
	HAR	(0.990, −0.001)	(0.984, −0.000)	(0.995, −0.001)	(0.984, −0.000)	(0.982, −0.000)	(0.970, 0.000)
	HAR-ANN	(1.006, −0.001)	(0.995, −0.001)	(1.016, −0.002)	(0.996, −0.001)	(0.993, −0.001)	(0.988, −0.000)
	ANN	(1.010, −0.002)	(0.994, −0.001)	(1.023, −0.002)	(0.995, −0.001)	(0.994, −0.001)	(0.994, −0.001)
Natural gas							
1	ARFIMA	(1.016, −0.001)	(1.023, −0.001)	(1.021, −0.001)	(1.004, −0.000)	(1.002, −0.000)	(1.003, −0.000)
	HAR	(0.995, −0.000)	(0.999, −0.000)	(0.993, 0.000)	(0.988, 0.000)	(0.997, −0.000)	(0.989, 0.000)
	HAR-ANN	(1.010, −0.000)	(1.018, −0.001)	(1.010, −0.000)	(0.995, −0.000)	(0.995, −0.000)	(0.986, 0.000)
	ANN	(0.987, 0.000)	(0.986, 0.000)	(0.985, 0.000)	(0.995, −0.000)	(0.981, 0.000)	(0.970, 0.000)
5	ARFIMA	(**1.148**, **−0.007**)	(**1.168**, **−0.008**)	(**1.158**, **−0.007**)	(1.062, −0.003)	(1.087, −0.004)	(1.091, −0.004)
	HAR	(1.009, −0.001)	(1.010, −0.001)	(1.011, −0.001)	(1.001, −0.000)	(1.011, −0.001)	(1.003, −0.001)
	HAR-ANN	(1.008, −0.001)	(1.004, −0.001)	(1.016, −0.001)	(1.000, −0.000)	(1.006, −0.001)	(1.001, −0.001)
	ANN	(0.987, 0.000)	(0.973, 0.001)	(1.000, −0.000)	(0.985, 0.000)	(0.985, 0.000)	(0.978, 0.001)
10	ARFIMA	(1.170, −0.011)	(**1.187**, **−0.012**)	(**1.184**, **−0.011**)	(1.077, −0.005)	(1.099, −0.006)	(1.108, −0.006)
	HAR	(1.006, −0.001)	(1.004, −0.002)	(1.012, −0.002)	(0.998, −0.001)	(1.003, −0.001)	(0.997, −0.001)
	HAR-ANN	(0.992, −0.000)	(0.981, 0.000)	(0.995, −0.000)	(0.993, −0.000)	(1.000, −0.001)	(0.984, 0.000)
	ANN	(0.949, 0.003)	(0.917, 0.005)	(0.942, 0.004)	(0.971, 0.001)	(0.972, 0.001)	(0.947, 0.003)

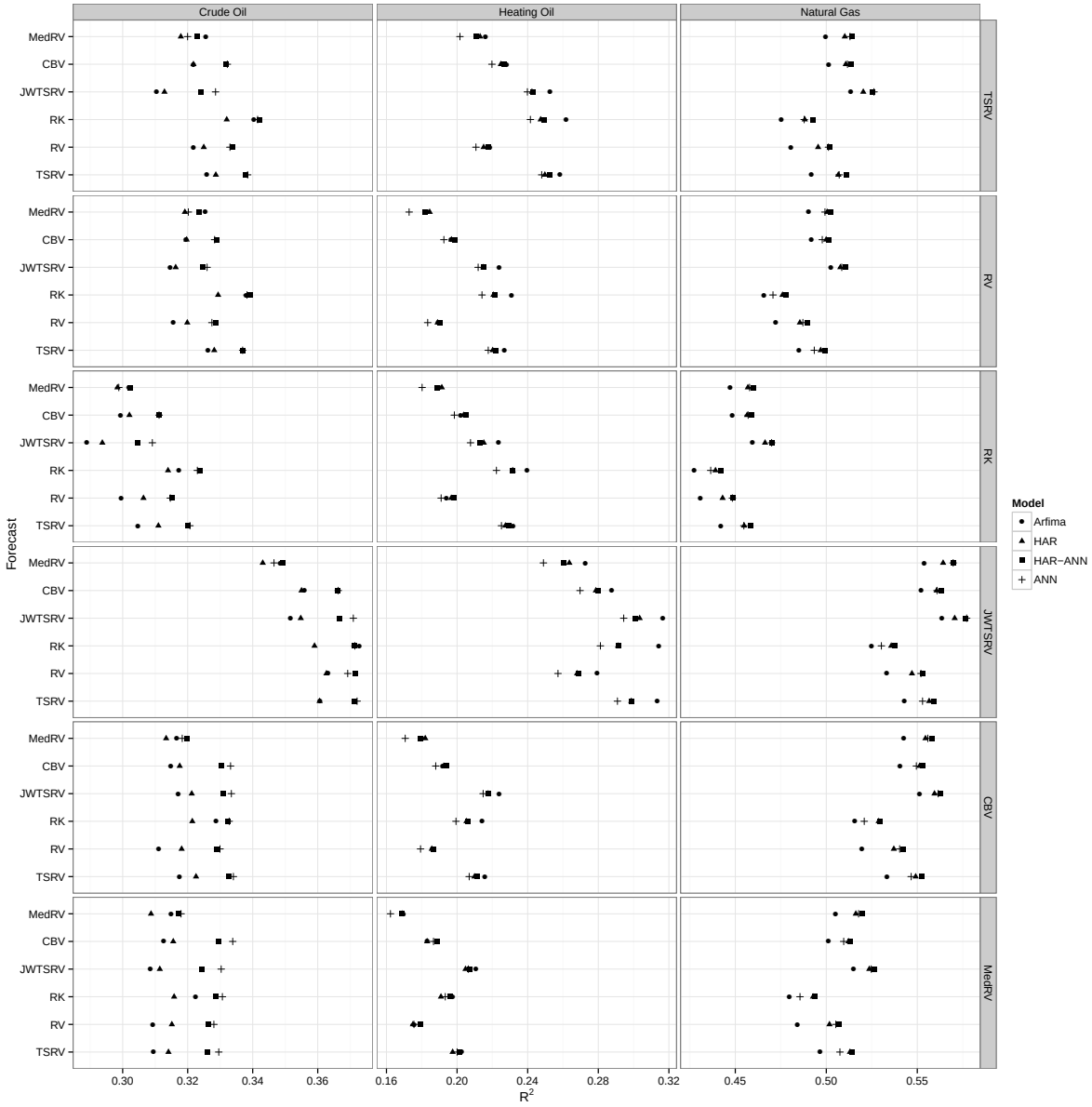

Figure 1: Before September 2008: R^2 from the Mincer Zarnowitz regressions $h = 1$

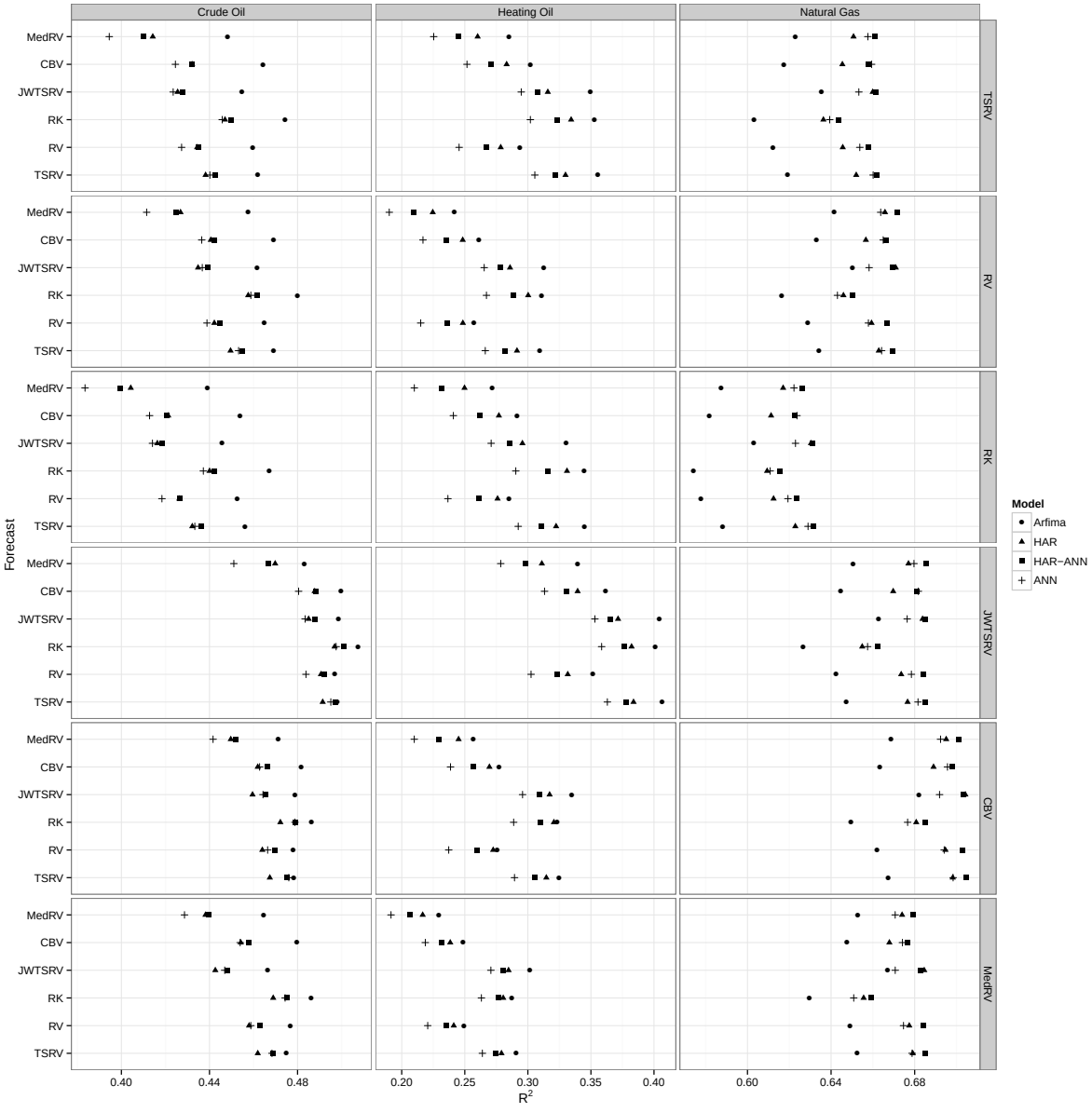

Figure 2: Before September 2008: R^2 from the Mincer Zarnowitz regressions $h = 5$

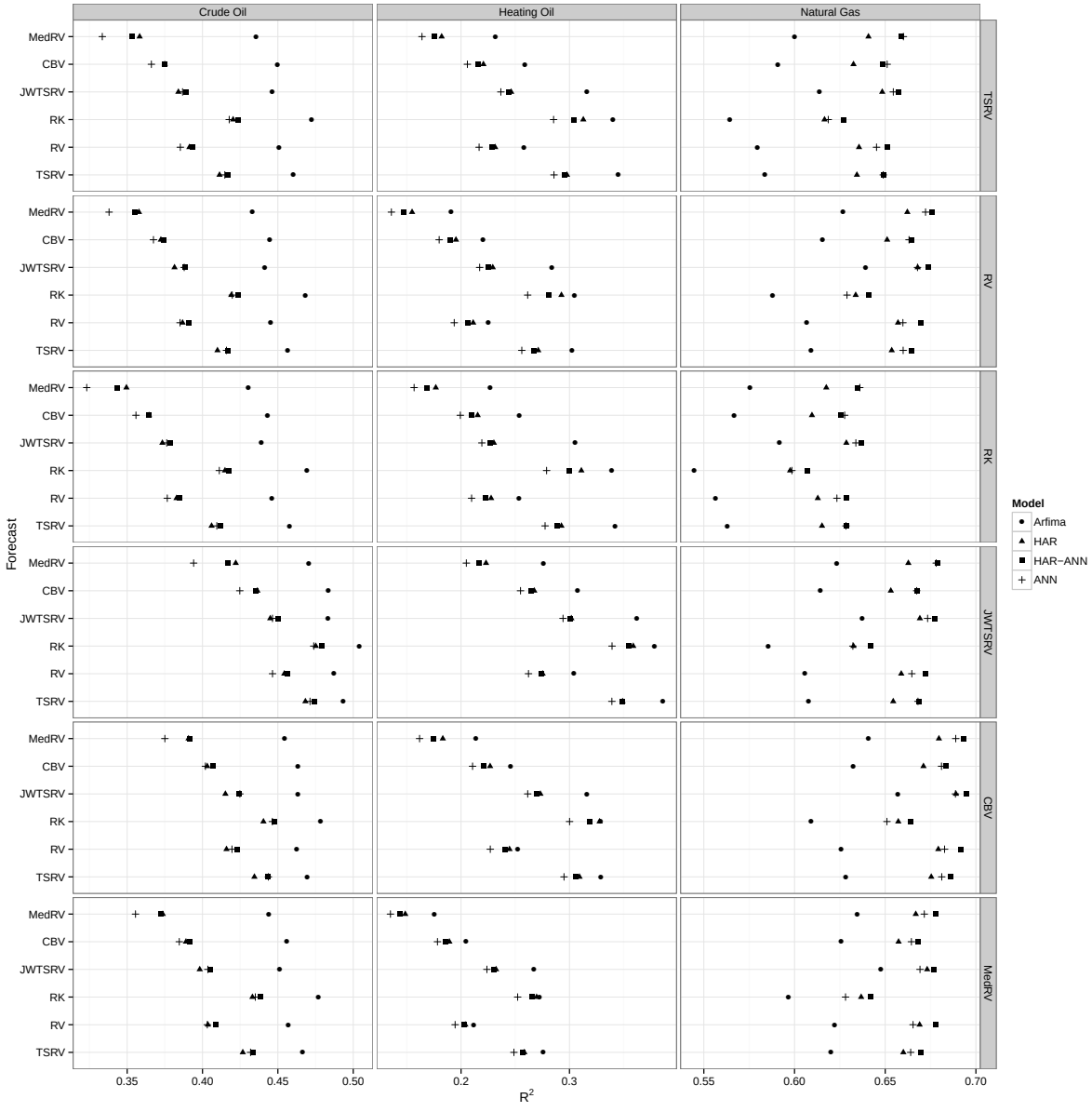

Figure 3: Before September 2008: R^2 from the Mincer Zarnowitz regressions $h = 10$

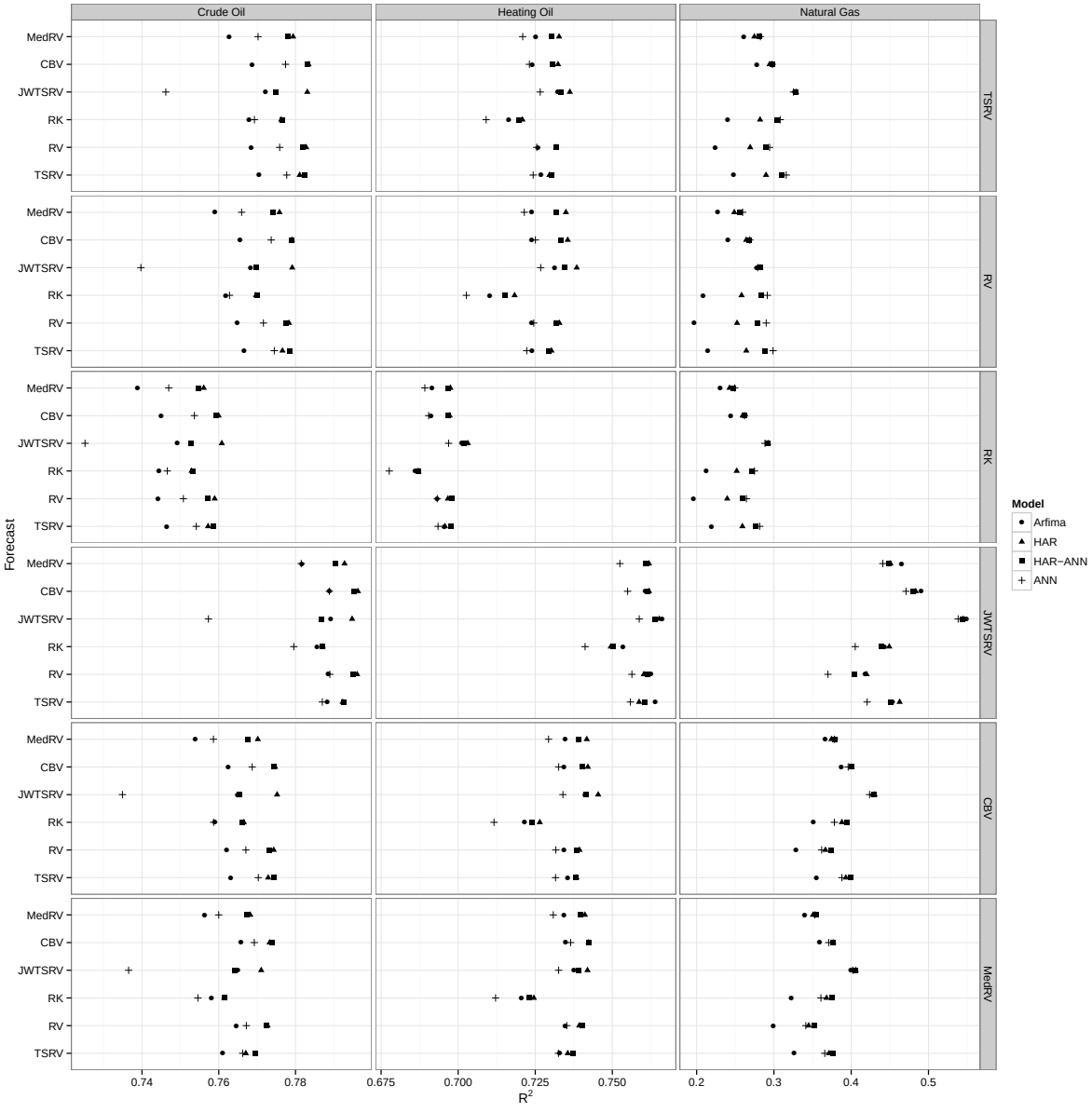

Figure 4: September 2008 – November 2010: R^2 from the Mincer Zarnowitz regressions $h = 1$

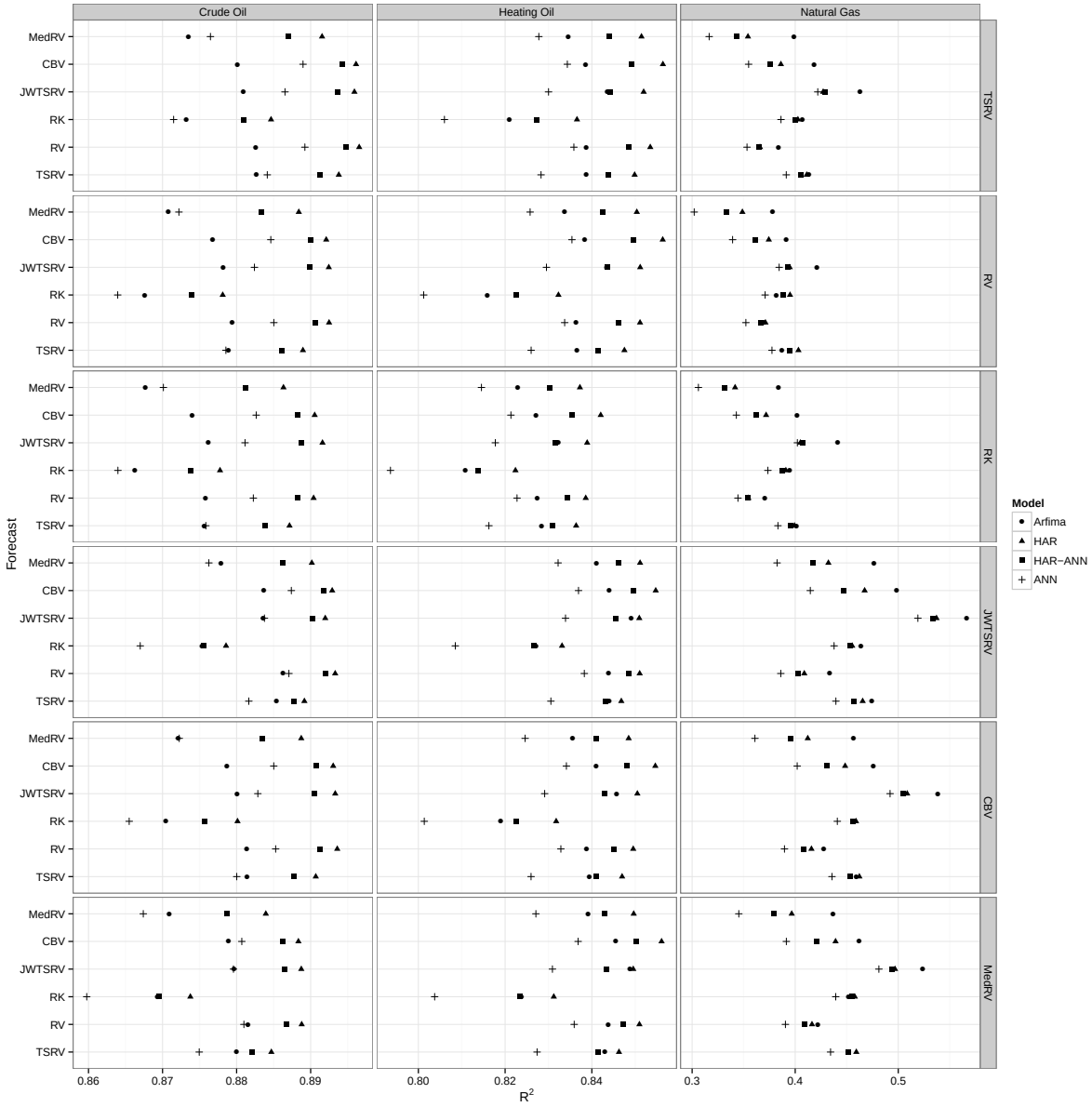

Figure 5: September 2008 – November 2010: R^2 from the Mincer Zarnowitz regressions $h = 5$

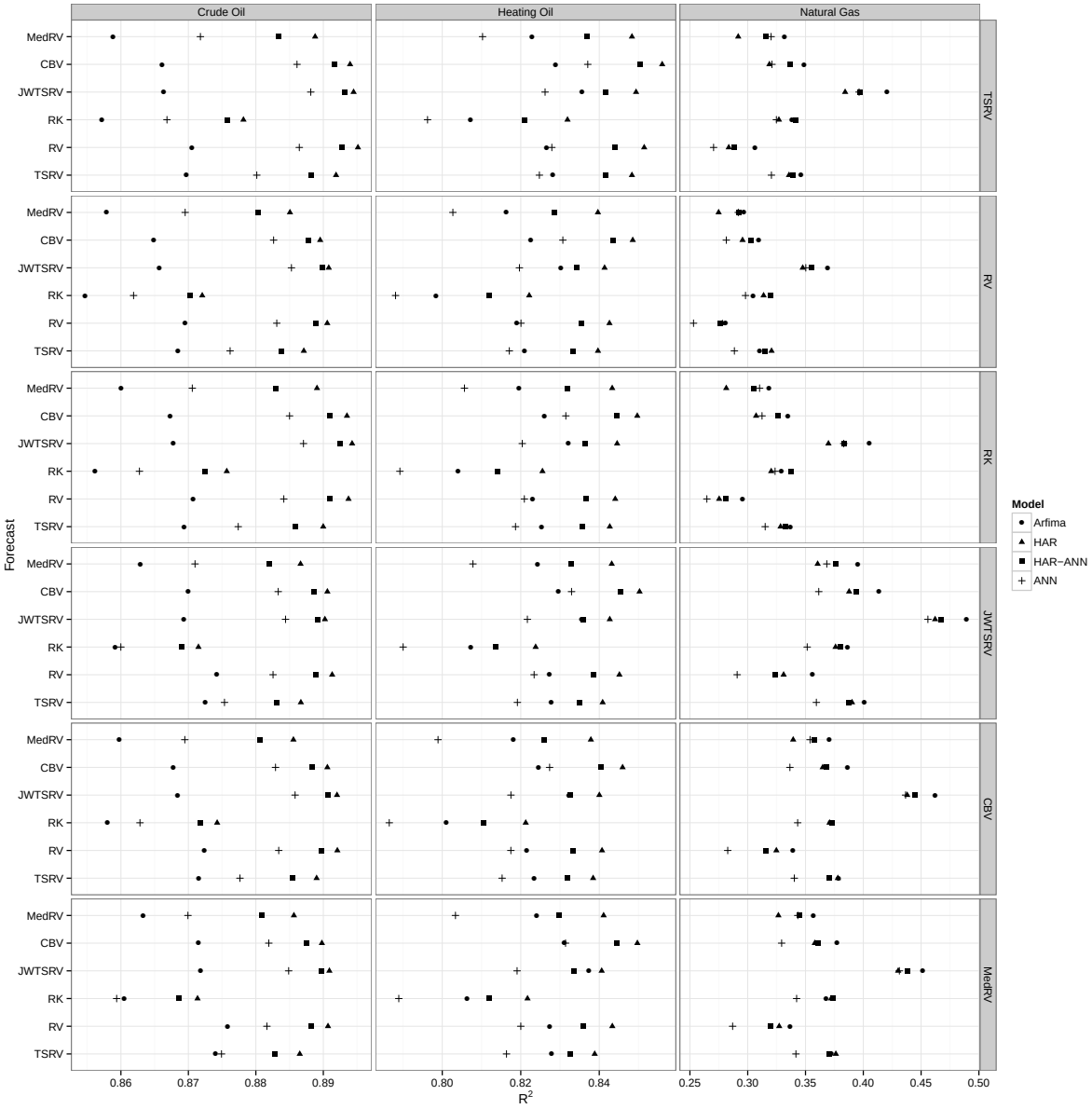

Figure 6: September 2008 – November 2010: R^2 from the Mincer Zarnowitz regressions $h = 10$

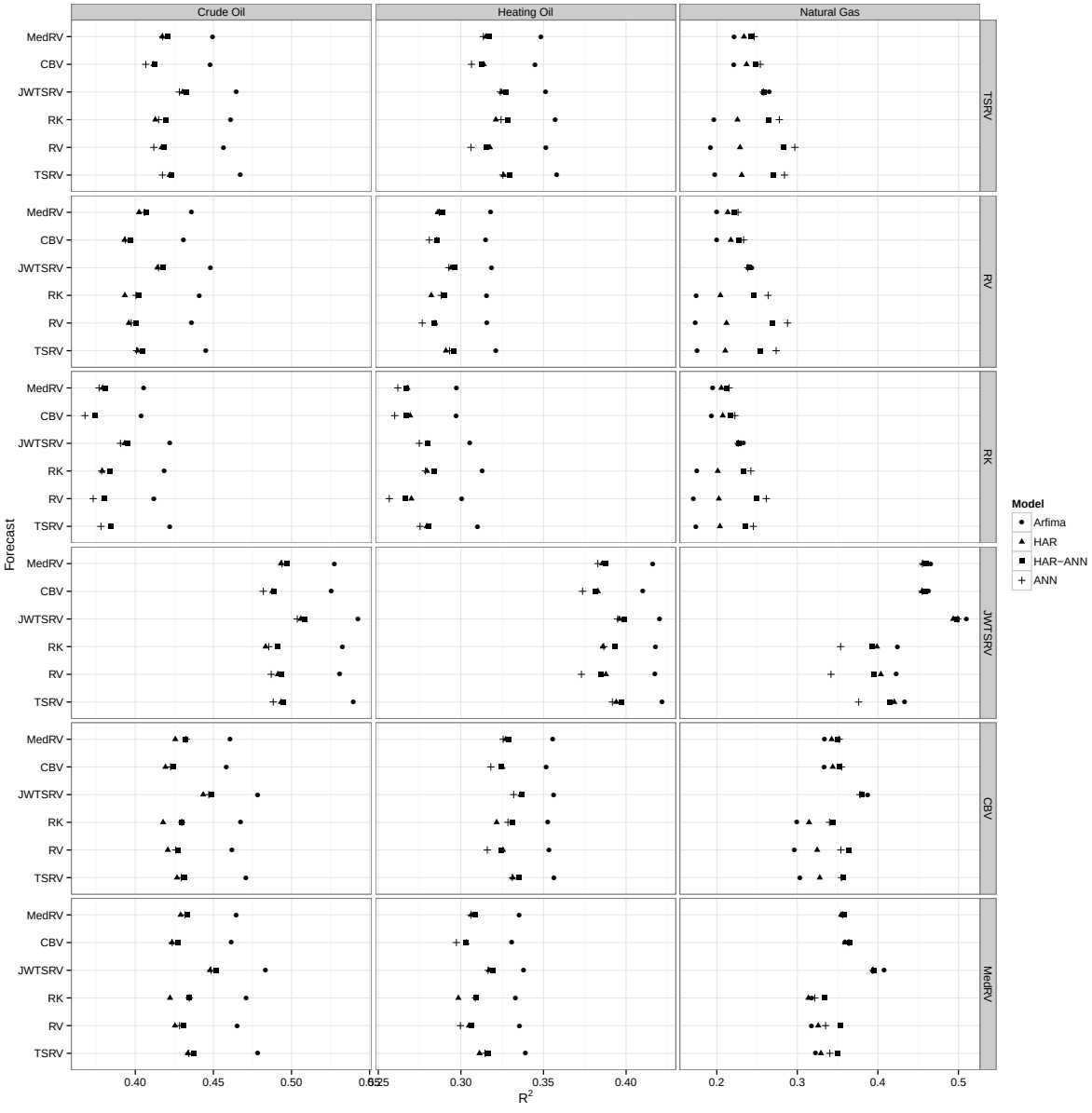

Figure 7: After November 2010: R^2 from the Mincer Zarnowitz regressions $h = 1$

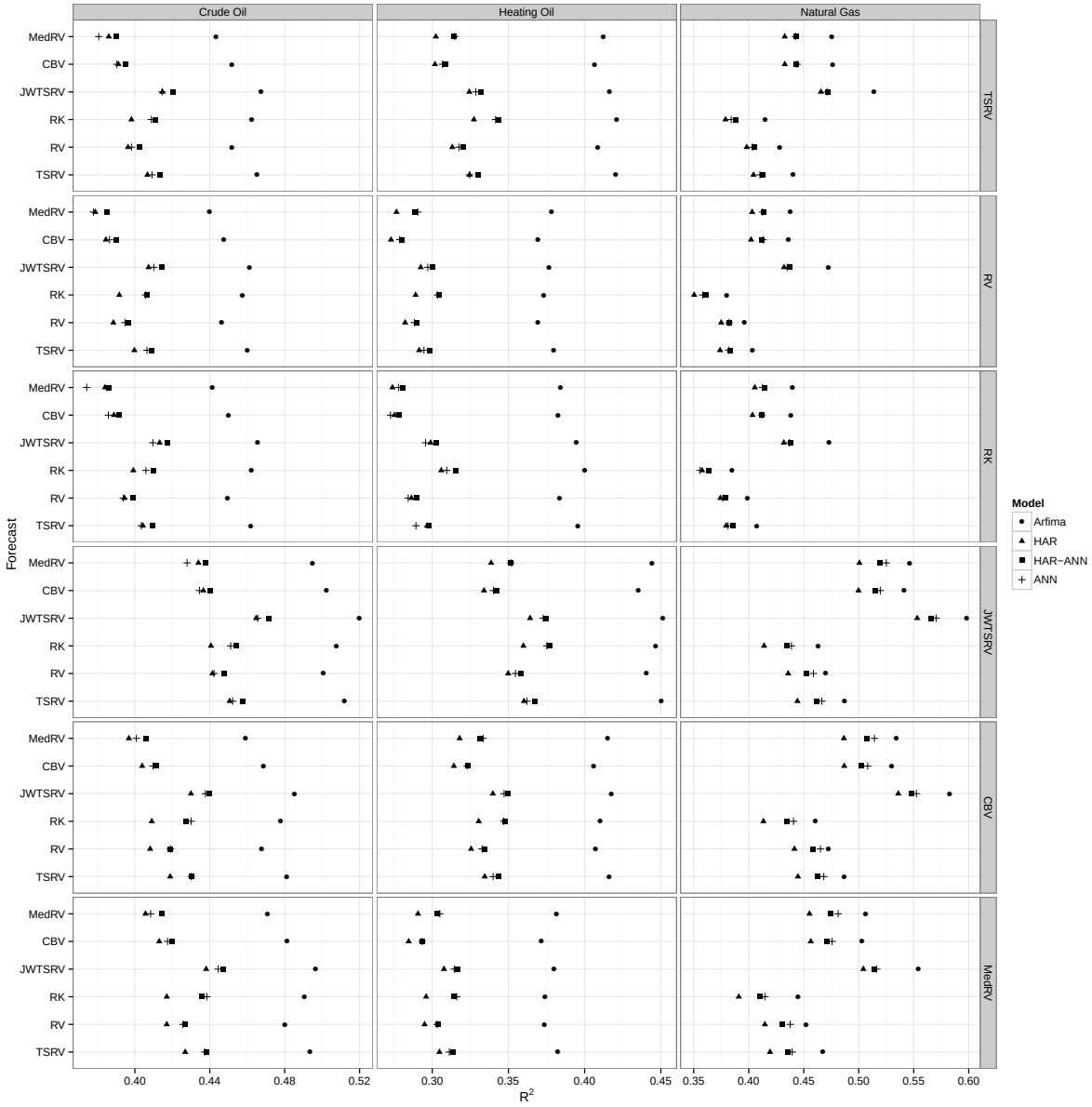

Figure 8: After November 2010: R^2 from the Mincer Zarnowitz regressions $h = 5$

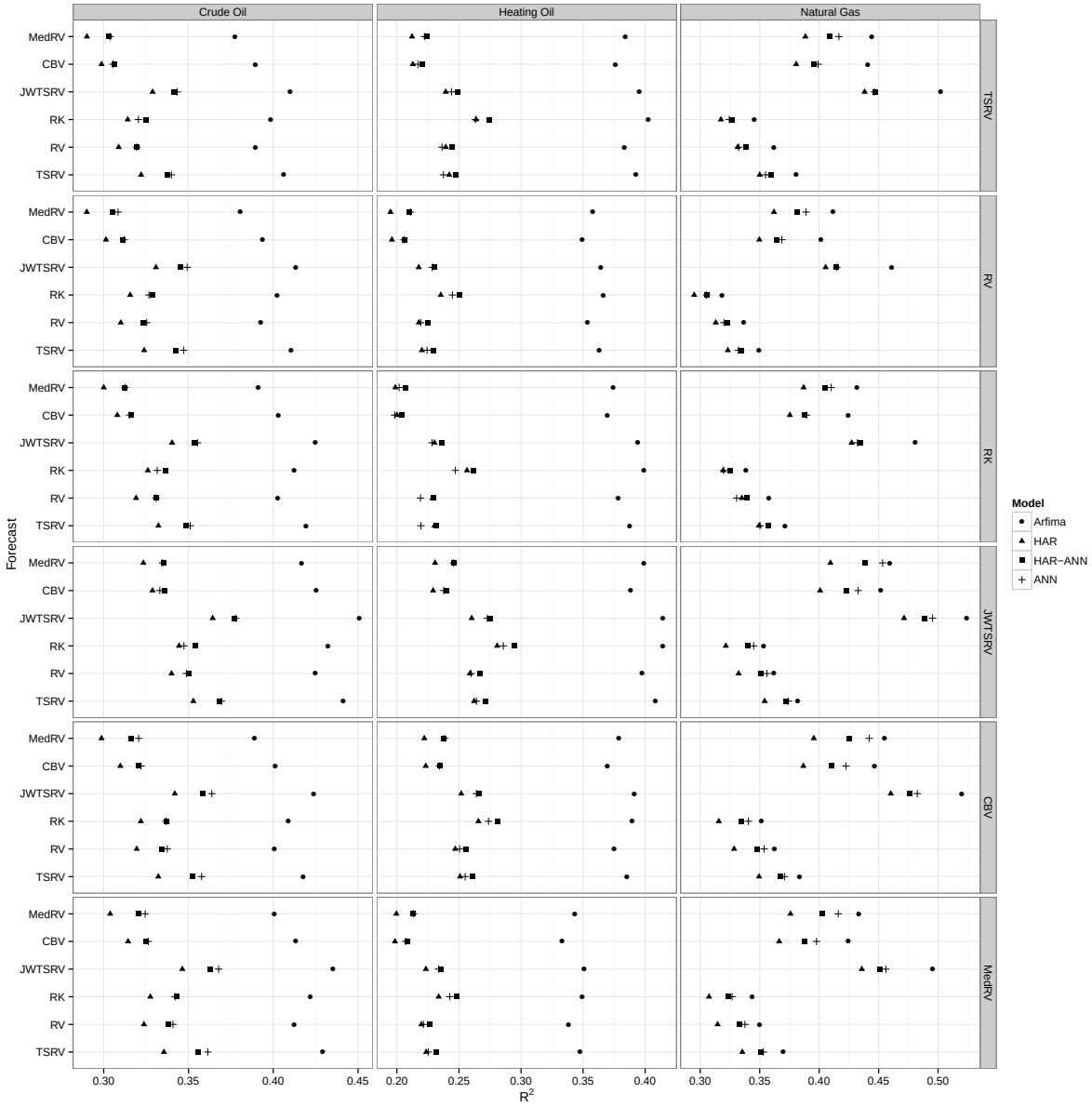

Figure 9: After November 2010: R^2 from the Mincer Zarnowitz regressions $h = 10$