Real-time Forecast Combinations for the Oil Price[*]

Anthony Garratt[†], Shaun P. Vahey[‡], Yunyi Zhang[§]

September 13, 2018

Appendix to Garratt, Vahey and Zhang (2018)

(I) Shorter evaluation sample, 1992:01–2012:09

Our results from the narrow replication, using the evaluation sample examined by Baumeister and Kilian (2015) are shown in Tables A-1a and A-1b. These results use the same WTI and RAC measures considered by those authors. The results confirm the main findings of their paper. Equal weight point combinations have lower MSPE ratios and higher success ratios than inverse MSPE weights for most horizons. The corresponding recursive MSPE and success ratios for the Brent measure, with the same 1992:01 to 2012:09 evaluation sample are displayed in Table A-1c.

Table A-1a. Forecast Accuracy for RAC, Evaluation 1992:01-2012:09

			Rolling weights based on windows of length		
MH	Equal weight	Recursive weights	36	24	12
			Real U.S. refiners' acquisition cost for oil imports		
			Recursive MSPE ratios		
1	**0.928****(0.028)	**0.933****(0.039)	**0.935****(0.045)	**0.928****(0.033)	**0.925****(0.030)
3	**0.922****(0.008)	**0.925****(0.009)	**0.925****(0.009)	**0.920****(0.005)	**0.925****(0.005)
6	**0.985**(0.172)	**0.989**(0.241)	**0.990**(0.254)	**0.991**(0.282)	**0.990**(0.251)
9	**0.980**(0.111)	**0.985**(0.182)	**0.983**(0.156)	**0.986**(0.212)	**0.988**(0.257)
12	**0.941****(0.001)	**0.946****(0.003)	**0.949****(0.006)	**0.947****(0.004)	**0.942****(0.002)
15	**0.932****(0.000)	**0.942****(0.002)	**0.955****(0.022)	**0.954****(0.018)	**0.970***(0.095)
18	**0.974***(0.073)	**0.994**(0.380)	1.023(0.854)	1.030(0.908)	1.055(0.983)
21	1.006(0.636)	1.028(0.947)	1.054(0.995)	1.062(0.996)	1.099(1.000)
24	**0.987**(0.224)	**0.997**(0.427)	**1.000**(0.499)	1.005(0.592)	1.046(0.962)
			Success ratios		
1	**0.562****(0.050)	**0.546**(0.119)	**0.546**(0.119)	**0.542**(0.153)	**0.546**(0.129)
3	**0.575****(0.034)	**0.583****(0.017)	**0.579****(0.026)	**0.591****(0.010)	**0.579****(0.026)
6	**0.545**(0.201)	**0.520**(0.487)	**0.520**(0.487)	**0.516**(0.531)	**0.512**(0.558)
9	**0.539**(0.171)	**0.548***(0.085)	**0.560***(0.051)	**0.539**(0.146)	**0.544**(0.113)
12	**0.639****(0.000)	**0.634****(0.000)	**0.643****(0.000)	**0.630****(0.000)	**0.664****(0.000)
15	**0.617****(0.000)	**0.574****(0.007)	**0.557****(0.038)	**0.553****(0.047)	**0.562****(0.048)
18	**0.573****(0.001)	**0.543****(0.010)	**0.522**(0.100)	0.491(0.363)	0.500(0.290)
21	**0.563****(0.006)	**0.515***(0.052)	**0.546****(0.027)	**0.533**(0.116)	0.498(0.502)
24	**0.553****(0.048)	**0.518**(0.105)	**0.549***(0.079)	**0.544**(0.156)	**0.531**(0.264)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey, Leybourne, and Newbold (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. * denotes significance at the 10% level and ** at the 5% level.

Table A-1b. Forecast Accuracy for WTI, Evaluation 1992:01-2012:09

MH	Equal weight	Recursive weights	Rolling weights based on windows of length		
			36	24	12
			Recursive MSPE ratios		
1	**0.904****(0.007)	**0.908****(0.008)	**0.909****(0.009)	**0.909****(0.011)	**0.906****(0.011)
3	**0.923****(0.010)	**0.926****(0.010)	**0.927****(0.012)	**0.927****(0.010)	**0.931****(0.011)
6	**0.988**(0.242)	**0.992**(0.314)	**0.993**(0.323)	**0.994**(0.363)	**0.998**(0.442)
9	**0.982**(0.146)	**0.988**(0.236)	**0.983**(0.170)	**0.987**(0.228)	**0.990**(0.296)
12	**0.948****(0.004)	**0.955****(0.011)	**0.954****(0.013)	**0.950****(0.007)	**0.943****(0.003)
15	**0.942****(0.002)	**0.956****(0.015)	**0.966***(0.070)	**0.966***(0.064)	**0.945****(0.009)
18	**0.973***(0.070)	**0.998**(0.465)	1.026(0.883)	1.043(0.963)	1.069(0.989)
21	1.004(0.599)	1.033(0.966)	1.056(0.993)	1.067(0.995)	1.082(0.998)
24	**0.979**(0.146)	1.000(0.505)	1.001(0.526)	1.009(0.648)	1.054(0.969)
			Success ratios		
1	**0.542**(0.201)	**0.546**(0.187)	**0.538**(0.267)	**0.550**(0.165)	**0.554**(0.131)
3	**0.551**(0.158)	**0.543**(0.220)	**0.543**(0.220)	**0.547**(0.198)	**0.530**(0.407)
6	**0.525**(0.425)	**0.516**(0.549)	**0.512**(0.593)	0.500(0.699)	0.488(0.827)
9	**0.552***(0.082)	**0.552***(0.075)	**0.564****(0.039)	**0.560***(0.054)	**0.535**(0.169)
12	**0.584****(0.005)	**0.563****(0.034)	**0.580****(0.012)	**0.592****(0.004)	**0.592****(0.003)
15	**0.587****(0.004)	**0.570****(0.016)	**0.557****(0.049)	**0.566****(0.035)	**0.566****(0.016)
18	**0.582****(0.001)	**0.556****(0.004)	**0.530***(0.073)	**0.522**(0.133)	**0.522**(0.133)
21	**0.581****(0.003)	**0.511***(0.062)	**0.533***(0.051)	**0.528**(0.177)	**0.511**(0.324)
24	**0.540**(0.108)	0.482(0.433)	**0.531**(0.185)	**0.518**(0.430)	**0.527**(0.301)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. $*$ denotes significance at the 10% level and $**$ at the 5% level.

Table A-1c. Forecast Accuracy for Brent, Evaluation 1992:01-2012:09

MH	Equal weight	Recursive weights	Rolling weights based on windows of length		
			36	24	12
			Recursive MSPE ratios		
1	**0.956**(0.110)	**0.935****(0.019)	**0.933****(0.019)	**0.936****(0.024)	**0.948***(0.086)
3	**0.941****(0.024)	**0.940****(0.017)	**0.938****(0.014)	**0.943****(0.021)	**0.945****(0.022)
6	**0.995**(0.394)	1.001(0.517)	1.005(0.632)	1.005(0.620)	1.008(0.689)
9	**0.983**(0.176)	**0.990**(0.278)	**0.990**(0.280)	**0.996**(0.395)	**0.996**(0.410)
12	**0.952****(0.003)	**0.961****(0.015)	**0.965****(0.022)	**0.966****(0.022)	**0.956****(0.010)
15	**0.947****(0.001)	**0.961****(0.013)	**0.972***(0.066)	**0.979**(0.112)	**0.980**(0.117)
18	**0.986**(0.203)	1.011(0.737)	1.032(0.963)	1.045(0.995)	1.077(1.000)
21	1.018(0.898)	1.044(0.998)	1.062(1.000)	1.068(1.000)	1.096(1.000)
24	1.014(0.799)	1.030(0.962)	1.039(0.985)	1.046(0.996)	1.101(1.000)
			Success ratios		
1	**0.514**(0.199)	**0.530**(0.110)	**0.530**(0.120)	**0.534***(0.099)	**0.550****(0.029)
3	**0.538**(0.134)	**0.522**(0.263)	**0.543**(0.104)	**0.538**(0.125)	**0.543**(0.104)
6	0.496(0.552)	0.480(0.727)	0.480(0.743)	0.471(0.764)	0.488(0.615)
9	**0.506**(0.315)	**0.510**(0.261)	**0.506**(0.315)	0.490(0.498)	0.498(0.352)
12	**0.567****(0.005)	**0.571****(0.005)	**0.576****(0.003)	**0.563****(0.006)	**0.584****(0.001)
15	**0.583****(0.001)	**0.596****(0.000)	**0.604****(0.000)	**0.587****(0.000)	**0.609****(0.000)
18	**0.543****(0.002)	**0.543****(0.000)	**0.500***(0.052)	0.483(0.221)	0.466(0.389)
21	**0.528****(0.003)	**0.502****(0.006)	**0.507****(0.021)	0.463(0.427)	0.445(0.621)
24	0.491(0.253)	0.456(0.461)	0.500(0.120)	0.442(0.870)	0.451(0.819)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. $*$ denotes significance at the 10% level and $**$ at the 5% level.

(II) Longer evaluation sample, 1992:01–2017:12, for RAC and WTI measures

We also present the forecast accuracy of RAC and WTI for the extended 1992:01 to 2017:12 evaluation sample in Tables A-2a and A-2b, respectively.

Table A-2a. Forecast Accuracy for RAC, Evaluation 1992:01 to 2017:12

| | Real U.S. refiners' acquisition cost for oil imports | | | | |
| | | | Rolling weights based on windows of length | | |
MH	Equal weight	Recursive weights	36	24	12
			Recursive MSPE ratios		
1	**0.931****(0.015)	**0.935****(0.022)	**0.939****(0.029)	**0.932****(0.020)	**0.928****(0.016)
3	**0.923****(0.002)	**0.925****(0.002)	**0.930****(0.004)	**0.922****(0.001)	**0.921****(0.001)
6	**0.977****(0.048)	**0.983***(0.099)	**0.984**(0.100)	**0.979***(0.058)	**0.971****(0.025)
9	**0.971****(0.015)	**0.978***(0.058)	**0.974****(0.030)	**0.972****(0.029)	**0.969****(0.026)
12	**0.936****(0.000)	**0.945****(0.000)	**0.941****(0.000)	**0.930****(0.000)	**0.921****(0.000)
15	**0.932****(0.000)	**0.944****(0.000)	**0.944****(0.001)	**0.935****(0.000)	**0.927****(0.000)
18	**0.944****(0.000)	**0.963****(0.009)	**0.974***(0.078)	**0.972***(0.079)	**0.951****(0.042)
21	**0.972****(0.022)	**0.998**(0.429)	**0.998**(0.456)	1.001(0.528)	**0.994**(0.419)
24	**0.970****(0.024)	1.012(0.798)	**0.989**(0.248)	**0.991**(0.293)	1.006(0.586)
			Success ratios		
1	**0.558****(0.042)	**0.545***(0.095)	**0.564****(0.024)	**0.554***(0.053)	**0.561****(0.033)
3	**0.597****(0.002)	**0.594****(0.002)	**0.600****(0.001)	**0.606****(0.000)	**0.606****(0.000)
6	**0.573****(0.021)	**0.547**(0.150)	**0.550**(0.111)	**0.554***(0.081)	**0.554***(0.077)
9	**0.549***(0.068)	**0.556****(0.038)	**0.582****(0.003)	**0.569****(0.012)	**0.569****(0.011)
12	**0.645****(0.000)	**0.631****(0.000)	**0.654****(0.000)	**0.645****(0.000)	**0.681****(0.000)
15	**0.614****(0.000)	**0.581****(0.004)	**0.570****(0.012)	**0.584****(0.003)	**0.581****(0.004)
18	**0.586****(0.001)	**0.556****(0.016)	**0.536***(0.092)	**0.508**(0.348)	**0.515**(0.258)
21	**0.565****(0.012)	**0.517**(0.217)	**0.545***(0.064)	**0.551****(0.039)	**0.507**(0.429)
24	**0.561****(0.026)	**0.505**(0.432)	**0.547***(0.081)	**0.547***(0.084)	**0.529**(0.181)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. $*$ denotes significance at the 10% level and $**$ at the 5% level.

Table A-2b. Forecast Accuracy for WTI, Evaluation 1992:01 to 2017:12

			Real WTI price		
			Rolling weights based on windows of length		
MH	Equal weight	Recursive weights	36	24	12
			Recursive MSPE ratios		
1	**0.907****(0.002)	**0.910****(0.002)	**0.912****(0.003)	**0.912****(0.004)	**0.909****(0.004)
3	**0.923****(0.002)	**0.925****(0.002)	**0.929****(0.004)	**0.927****(0.003)	**0.927****(0.002)
6	**0.979***(0.079)	**0.984**(0.138)	**0.984**(0.131)	**0.984**(0.119)	**0.988**(0.208)
9	**0.973****(0.027)	**0.980***(0.082)	**0.974****(0.039)	**0.974****(0.043)	**0.979***(0.092)
12	**0.942****(0.000)	**0.950****(0.001)	**0.942****(0.000)	**0.931****(0.000)	**0.935****(0.000)
15	**0.937****(0.000)	**0.949****(0.001)	**0.944****(0.001)	**0.934****(0.000)	**0.917****(0.000)
18	**0.944****(0.000)	**0.963****(0.011)	**0.970***(0.056)	**0.972***(0.092)	**0.982**(0.248)
21	**0.970****(0.023)	**0.994**(0.340)	**0.991**(0.313)	**0.991**(0.340)	**0.987**(0.309)
24	**0.956****(0.005)	**0.995**(0.361)	**0.967****(0.035)	**0.964****(0.034)	**0.990**(0.377)
			Success ratios		
1	**0.558***(0.059)	**0.561***(0.052)	**0.545**(0.155)	**0.551**(0.109)	**0.574****(0.019)
3	**0.577****(0.012)	**0.565****(0.037)	**0.571****(0.021)	**0.571****(0.022)	**0.565****(0.044)
6	**0.544**(0.169)	**0.541**(0.213)	**0.541**(0.205)	**0.534**(0.235)	**0.521**(0.436)
9	**0.572****(0.011)	**0.572****(0.011)	**0.582****(0.005)	**0.572****(0.013)	**0.559****(0.030)
12	**0.618****(0.000)	**0.601****(0.000)	**0.608****(0.000)	**0.621****(0.000)	**0.598****(0.001)
15	**0.614****(0.000)	**0.594****(0.001)	**0.594****(0.001)	**0.607****(0.000)	**0.597****(0.001)
18	**0.593****(0.000)	**0.583****(0.001)	**0.573****(0.004)	**0.559****(0.019)	**0.563****(0.012)
21	**0.599****(0.000)	**0.534***(0.066)	**0.555****(0.022)	**0.558****(0.029)	**0.551****(0.048)
24	**0.554****(0.042)	0.488(0.642)	**0.547***(0.071)	**0.529**(0.195)	**0.536**(0.118)

 NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. ∗ denotes significance at the 10% level and ∗∗ at the 5% level.

(III) The inclusion of futures-based forecasts

Analysing the effect of including the futures-based forecasts, in Table A-3a and A-3b we compare the the forecast accuracy of equal weight combinations with and without futures-based forecasts for the 1992:01-2012:09 and 1992:01-2017:12 sample periods at horizons 18 to 24 months for RAC and WTI. As with Brent in the main text, the inclusion of futures-based forecasts at these horizons reduces MSPE ratios and raises the success ratios. Table A-4 additionally presents the effect of including the futures-based forecasts for the Brent measure in the 1992:01-2012:09 evaluation sample.

Table A-3a: Forecast Accuracy for RAC, Equal Weight Combinations, Excluding and Including Futures-based Forecasts (FUTURES)

	Real RAC price			
	1992:01-2012:09		1992:01-2017:12	
MH	Excluding FUTURES	Including FUTURES	Excluding FUTURES	Including FUTURES
	Recursive MSPE ratios			
18	1.013(0.706)	**0.974***(0.073)	1.000(0.502)	**0.944****(0.000)
19	1.029(0.887)	**0.989**(0.269)	1.009(0.727)	**0.952****(0.001)
20	1.044(0.967)	1.004(0.586)	1.026(0.956)	**0.964****(0.008)
21	1.044(0.966)	1.006(0.636)	1.036(0.992)	**0.972****(0.022)
22	1.036(0.923)	1.000(0.505)	1.036(0.990)	**0.971****(0.020)
23	1.022(0.805)	**0.991**(0.293)	1.034(0.979)	**0.968****(0.015)
24	1.014(0.704)	**0.987**(0.224)	1.035(0.979)	**0.970****(0.024)
	Success ratios			
18	**0.522**(0.665)	**0.573****(0.001)	**0.508**(0.567)	**0.586****(0.001)
19	**0.524**(0.546)	**0.580****(0.000)	**0.537**(0.155)	**0.595****(0.000)
20	**0.557**(0.198)	**0.609****(0.000)	**0.546**(0.136)	**0.614****(0.000)
21	**0.502**(0.894)	**0.563****(0.006)	0.479(0.937)	**0.565****(0.012)
22	**0.518**(0.836)	**0.566****(0.009)	0.485(0.902)	**0.560****(0.021)
23	**0.546**(0.577)	**0.555****(0.026)	**0.507**(0.714)	**0.552****(0.044)
24	**0.540**(0.693)	**0.553****(0.048)	**0.509**(0.737)	**0.561****(0.026)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. ∗ denotes significance at the 10% level and ∗∗ at the 5% level.

Table A-3b: Forecast Accuracy for WTI, Equal Weight Combinations, Excluding and Including Futures-based Forecasts (FUTURES)

	Real WTI price			
	1992:01-2012:09		1992:01-2017:12	
MH	Excluding FUTURES	Including FUTURES	Excluding FUTURES	Including FUTURES
	Recursive MSPE ratios			
18	1.011(0.678)	**0.973***(0.070)	**0.999**(0.476)	**0.944****(0.000)
19	1.022(0.820)	**0.985**(0.206)	1.008(0.693)	**0.952****(0.001)
20	1.035(0.922)	**0.998**(0.466)	1.021(0.906)	**0.963****(0.007)
21	1.040(0.942)	1.004(0.599)	1.032(0.973)	**0.970****(0.023)
22	1.027(0.846)	**0.995**(0.398)	1.028(0.947)	**0.966****(0.013)
23	1.012(0.667)	**0.985**(0.210)	1.022(0.882)	**0.960****(0.007)
24	1.002(0.534)	**0.979**(0.146)	1.017(0.808)	**0.956****(0.005)
	Success ratios			
18	**0.526**(0.542)	**0.582****(0.001)	**0.522**(0.443)	**0.593****(0.000)
19	**0.528**(0.387)	**0.593****(0.000)	**0.534**(0.216)	**0.609****(0.000)
20	**0.535**(0.411)	**0.587****(0.000)	**0.539**(0.226)	**0.590****(0.000)
21	0.498(0.910)	**0.581****(0.003)	**0.503**(0.818)	**0.599****(0.000)
22	**0.526**(0.753)	**0.570****(0.007)	**0.509**(0.768)	**0.584****(0.002)
23	**0.529**(0.687)	**0.551****(0.048)	**0.514**(0.651)	**0.569****(0.012)
24	**0.531**(0.720)	**0.540**(0.108)	**0.505**(0.735)	**0.554****(0.042)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. ∗ denotes significance at the 10% level and ∗∗ at the 5% level.

Table A-4: Forecast Accuracy for Brent, Equal Weight Combinations, Excluding and Including Futures-based Forecasts (FUTURES)

	Real Brent price			
	1992:01-2012:09			
	Recursive MSPE ratios		**Success ratios**	
MH	Excluding FUTURES	Including FUTURES	Excluding FUTURES	Including FUTURES
9	**0.998**(0.468)	**0.983**(0.176)	0.490(0.644)	**0.506**(0.315)
10	**0.992**(0.365)	**0.975***(0.071)	**0.504**(0.491)	**0.537****(0.050)
11	**0.979**(0.188)	**0.961****(0.012)	**0.540**(0.148)	**0.573****(0.004)
12	**0.974**(0.131)	**0.952****(0.003)	**0.546***(0.087)	**0.567****(0.005)
13	**0.974**(0.130)	**0.949****(0.001)	**0.515**(0.384)	**0.578****(0.003)
14	**0.972**(0.120)	**0.945****(0.001)	**0.538**(0.169)	**0.568****(0.005)
15	**0.976**(0.154)	**0.947****(0.001)	**0.549***(0.075)	**0.583****(0.001)
16	**0.989**(0.323)	**0.957****(0.006)	**0.534**(0.142)	**0.577****(0.001)
17	1.008(0.631)	**0.973****(0.047)	**0.511**(0.280)	**0.536****(0.009)
18	1.023(0.837)	**0.986**(0.203)	**0.530***(0.067)	**0.543****(0.002)
19	1.036(0.941)	1.001(0.513)	**0.515***(0.093)	**0.524****(0.004)
20	1.048(0.983)	1.012(0.787)	**0.526***(0.099)	**0.522****(0.005)
21	1.054(0.991)	1.018(0.898)	**0.524**(0.203)	**0.528****(0.003)
22	1.051(0.984)	1.018(0.884)	**0.504**(0.477)	**0.531****(0.007)
23	1.043(0.958)	1.013(0.787)	**0.511**(0.386)	**0.515***(0.051)
24	1.041(0.945)	1.014(0.799)	0.491(0.672)	0.491(0.253)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. ∗ denotes significance at the 10% level and ∗∗ at the 5% level.

(IV) Global Real Economic Activity Indexes

Hamilton (2018) proposes an alternative measure of global economic activity to Kilian (2009). Two rea series are plotted in Figure A-1, see the online dataset documentation.

If we use Hamilton's global economic activity measure in the VAR, the forecast performance is fairly similar, and the influence on the forecast produced using the equal-weight combination is negligible. The results are presented in Tables A-5, A-6, and A-7 for the three real oil prices measures.
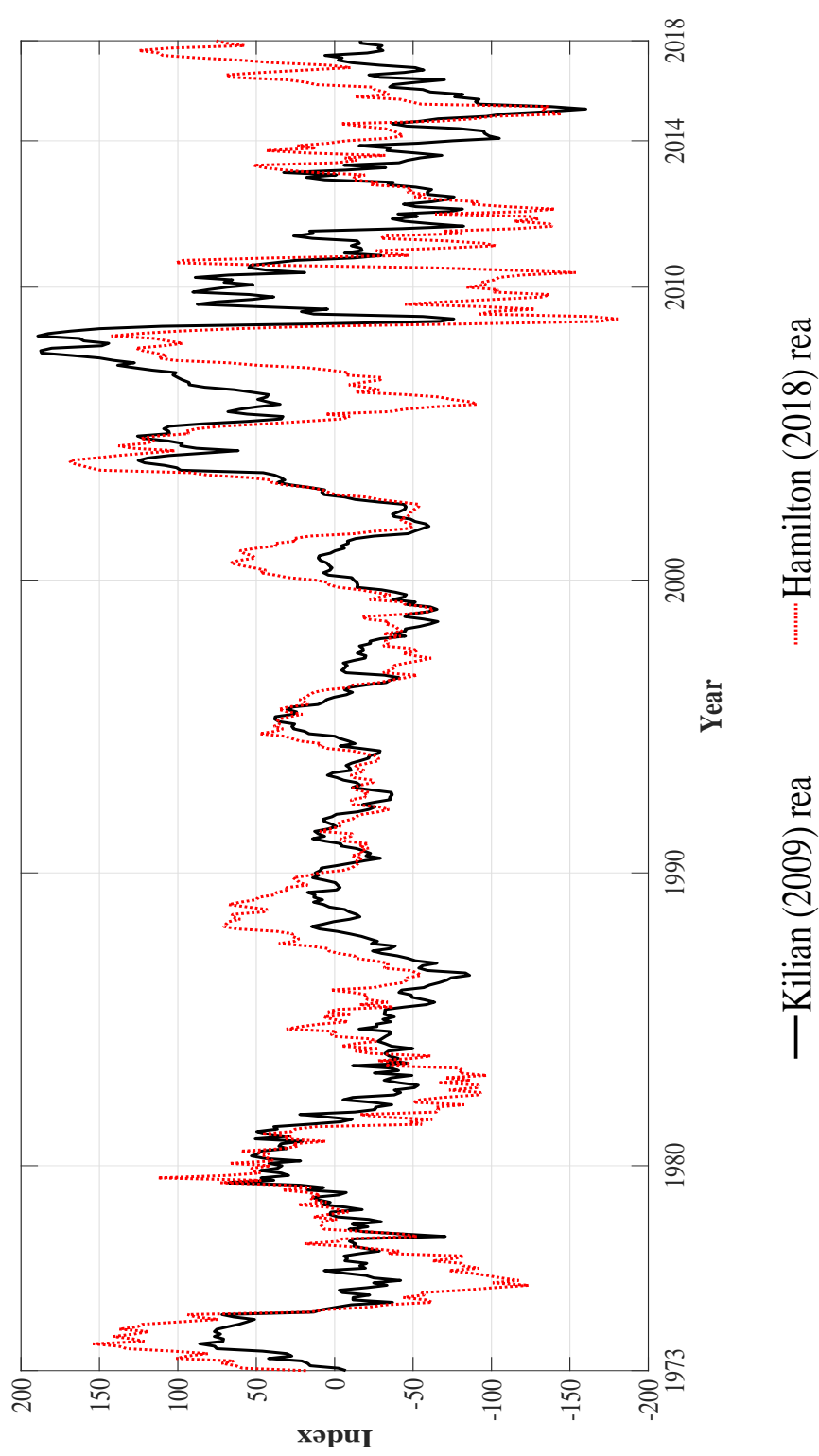
Figure A-1: Kilian (2009) and Hamilton (2018) Measures of rea

Table A-5: Forecast Accuracy for RAC, VAR & Equal Weight Combination, using Kilian (2009) and Hamilton (2018) rea

| | Evaluation 1992:01 to 2012:09 | | | | Evaluation 1992:01 to 2017:12 | | | |
| | VAR | | Equal Weight Combination | | VAR | | Equal Weight Combination | |
MH	Kilian	Hamilton	Kilian	Hamilton	Kilian	Hamilton	Kilian	Hamilton
				Recursive MSPE ratios				
1	**0.990**(0.465)	1.011(0.529)	**0.928**(0.028)	**0.921**(0.031)	**0.988**(0.452)	1.007(0.523)	**0.931**(0.015)	**0.925**(0.019)
3	1.051(0.678)	1.081(0.689)	**0.922**(0.008)	**0.911**(0.011)	1.014(0.558)	1.049(0.641)	**0.923**(0.002)	**0.916**(0.004)
6	1.186(0.988)	1.183(0.983)	0.985(0.172)	0.982(0.145)	1.105(0.926)	1.112(0.934)	**0.977**(0.048)	**0.978**(0.059)
9	1.232(1.000)	1.271(1.000)	0.980(0.111)	0.986(0.176)	1.119(0.986)	1.158(0.998)	**0.971**(0.015)	**0.978**(0.036)
12	1.231(1.000)	1.282(1.000)	**0.941**(0.001)	**0.947**(0.002)	1.089(0.953)	1.143(0.996)	**0.936**(0.000)	**0.944**(0.000)
15	1.257(1.000)	1.283(1.000)	**0.932**(0.000)	**0.935**(0.000)	1.074(0.894)	1.108(0.969)	**0.932**(0.000)	**0.938**(0.000)
18	1.322(1.000)	1.327(1.000)	**0.974**(0.073)	**0.974**(0.072)	1.062(0.829)	1.084(0.914)	**0.944**(0.000)	**0.949**(0.000)
21	1.369(1.000)	1.383(1.000)	1.006(0.636)	1.009(0.706)	1.044(0.735)	1.078(0.870)	**0.972**(0.022)	**0.978**(0.056)
24	1.385(1.000)	1.385(1.000)	0.987(0.224)	0.987(0.225)	1.034(0.675)	1.059(0.801)	**0.970**(0.024)	**0.975**(0.042)
				Success ratios				
1	**0.546**(0.083)	**0.558**(0.041)	**0.562**(0.050)	**0.566**(0.038)	**0.558**(0.022)	**0.564**(0.014)	**0.558**(0.042)	**0.567**(0.019)
3	**0.526**(0.214)	**0.522**(0.248)	**0.575**(0.034)	**0.583**(0.019)	**0.532**(0.113)	**0.526**(0.169)	**0.597**(0.002)	**0.606**(0.000)
6	0.475(0.743)	0.426(0.993)	0.545(0.201)	**0.566**(0.091)	0.495(0.500)	0.469(0.868)	**0.573**(0.021)	**0.590**(0.005)
9	0.444(0.949)	0.427(0.994)	0.539(0.171)	0.523(0.419)	0.480(0.700)	0.464(0.896)	**0.549**(0.068)	**0.543**(0.117)
12	**0.521**(0.167)	0.475(0.857)	**0.639**(0.000)	**0.634**(0.000)	**0.578**(0.001)	**0.538**(0.070)	**0.645**(0.000)	**0.638**(0.000)
15	**0.515**(0.261)	0.455(0.968)	**0.617**(0.000)	**0.591**(0.007)	**0.560**(0.006)	0.510(0.332)	**0.614**(0.000)	**0.594**(0.001)
18	**0.513**(0.315)	0.470(0.919)	**0.573**(0.001)	**0.565**(0.009)	**0.569**(0.004)	**0.539**(0.075)	**0.586**(0.001)	**0.569**(0.007)
21	**0.502**(0.533)	0.476(0.926)	**0.563**(0.006)	**0.546**(0.058)	**0.565**(0.005)	**0.551**(0.028)	**0.565**(0.012)	**0.551**(0.047)
24	0.500(0.649)	0.491(0.835)	**0.553**(0.048)	0.544(0.123)	**0.561**(0.011)	**0.547**(0.042)	**0.561**(0.026)	**0.554**(0.051)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. * denotes significance at the 10% level and ** at the 5% level.

Table A-6: Forecast Accuracy for WTI, VAR & Equal Weight Combination, using Kilian (2009) and Hamilton (2018) rea

| | Evaluation 1992:01 to 2012:09 | | | | Evaluation 1992:01 to 2017:12 | | | |
| | VAR | | Equal Weight Combination | | VAR | | Equal Weight Combination | |
MH	Kilian	Hamilton	Kilian	Hamilton	Kilian	Hamilton	Kilian	Hamilton
				Recursive MSPE ratios				
1	1.009(0.533)	1.050(0.630)	**0.904****(0.007)	**0.898****(0.010)	1.001(0.506)	1.036(0.612)	**0.907****(0.002)	**0.903****(0.004)
3	1.041(0.640)	1.103(0.739)	**0.923****(0.010)	**0.916****(0.017)	1.011(0.547)	1.076(0.717)	**0.923****(0.002)	**0.920****(0.007)
6	1.141(0.955)	1.172(0.973)	**0.988**(0.242)	**0.990**(0.301)	1.075(0.846)	1.113(0.930)	**0.979***(0.079)	**0.984**(0.161)
9	1.177(0.999)	1.233(1.000)	**0.982**(0.146)	**0.991**(0.281)	1.094(0.963)	1.145(0.997)	**0.973****(0.027)	**0.982***(0.076)
12	1.176(0.997)	1.245(1.000)	**0.948****(0.004)	**0.957****(0.011)	1.075(0.922)	1.143(0.996)	**0.942****(0.000)	**0.952****(0.001)
15	1.192(0.995)	1.235(0.999)	**0.942****(0.002)	**0.948****(0.005)	1.054(0.813)	1.100(0.957)	**0.937****(0.000)	**0.944****(0.000)
18	1.242(0.998)	1.265(0.999)	**0.973***(0.070)	**0.977***(0.094)	1.041(0.728)	1.076(0.884)	**0.944****(0.000)	**0.951****(0.001)
21	1.280(0.998)	1.311(0.999)	1.004(0.599)	1.011(0.729)	1.029(0.653)	1.072(0.846)	**0.970****(0.023)	**0.979***(0.071)
24	1.301(0.997)	1.313(0.999)	**0.979**(0.146)	**0.982**(0.170)	1.026(0.630)	1.062(0.800)	**0.956****(0.005)	**0.963****(0.012)
				Success ratios				
1	**0.518**(0.329)	**0.506**(0.499)	**0.542**(0.201)	**0.530**(0.348)	**0.535**(0.115)	**0.522**(0.245)	**0.558***(0.059)	**0.558***(0.065)
3	**0.547***(0.076)	**0.518***(0.291)	**0.551**(0.158)	**0.530**(0.377)	**0.545****(0.047)	**0.519**(0.234)	**0.577****(0.012)	**0.558***(0.063)
6	0.484(0.653)	0.443(0.974)	0.525(0.425)	0.553(0.172)	0.498(0.450)	0.472(0.842)	0.544(0.169)	**0.573****(0.026)
9	0.477(0.722)	0.452(0.958)	**0.552***(0.082)	0.523(0.402)	0.487(0.607)	0.464(0.896)	**0.572***(0.011)	0.553(0.068)
12	0.496(0.468)	0.450(0.963)	**0.584****(0.005)	**0.563***(0.064)	**0.532***(0.065)	0.492(0.562)	**0.618****(0.000)	**0.605****(0.000)
15	**0.532**(0.128)	0.481(0.827)	**0.587****(0.004)	**0.579****(0.017)	**0.560****(0.006)	0.510(0.332)	**0.614****(0.000)	**0.607****(0.000)
18	**0.526**(0.190)	0.474(0.887)	**0.582****(0.001)	**0.560****(0.013)	**0.553****(0.014)	0.508(0.336)	**0.593****(0.000)	**0.569****(0.005)
21	**0.520***(0.317)	0.493(0.812)	**0.581****(0.003)	**0.568****(0.016)	**0.555****(0.010)	**0.541***(0.053)	**0.599****(0.000)	**0.579****(0.006)
24	0.496(0.685)	0.487(0.851)	**0.540**(0.108)	**0.531**(0.266)	**0.561****(0.012)	**0.547****(0.044)	**0.554****(0.042)	**0.547**(0.083)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. * denotes significance at the 10% level and ** at the 5% level.

Table A-7: Forecast Accuracy for BRENT, VAR & Equal Weight Combination, using Kilian (2009) and Hamilton (2018) rea

| | Evaluation 1992:01 to 2012:09 | | | | Evaluation 1992:01 to 2017:12 | | | |
| | VAR | | Equal Weight Combination | | VAR | | Equal Weight Combination | |
MH	Kilian	Hamilton	Kilian	Hamilton	Kilian	Hamilton	Kilian	Hamilton
				Recursive MSPE ratios				
1	1.017(0.563)	1.083(0.720)	**0.956**(0.110)	**0.953**(0.122)	1.017(0.571)	1.077(0.742)	**0.941****(0.030)	**0.939****(0.039)
3	1.057(0.697)	1.138(0.802)	**0.941****(0.024)	**0.934****(0.031)	1.040(0.665)	1.123(0.823)	**0.935****(0.005)	**0.932****(0.010)
6	1.180(0.986)	1.205(0.989)	**0.995**(0.394)	**0.995**(0.397)	1.111(0.936)	1.144(0.969)	**0.978***(0.093)	**0.981**(0.118)
9	1.219(1.000)	1.261(1.000)	**0.983**(0.176)	**0.990**(0.255)	1.116(0.986)	1.159(0.999)	**0.961****(0.007)	**0.968****(0.011)
12	1.233(1.000)	1.287(1.000)	**0.952****(0.003)	**0.958****(0.005)	1.089(0.953)	1.150(0.997)	**0.929****(0.000)	**0.937****(0.000)
15	1.264(1.000)	1.297(1.000)	**0.947****(0.001)	**0.951****(0.001)	1.074(0.892)	1.118(0.979)	**0.923****(0.000)	**0.930****(0.000)
18	1.315(1.000)	1.326(1.000)	**0.986**(0.203)	**0.988**(0.216)	1.069(0.854)	1.096(0.942)	**0.937****(0.000)	**0.943****(0.000)
21	1.346(1.000)	1.362(1.000)	1.018(0.898)	1.022(0.940)	1.049(0.759)	1.084(0.897)	**0.955****(0.002)	**0.962****(0.004)
24	1.358(1.000)	1.359(1.000)	1.014(0.799)	1.014(0.822)	1.032(0.672)	1.061(0.817)	**0.950****(0.002)	**0.955****(0.002)
				Success ratios				
1	**0.502**(0.510)	0.498(0.575)	**0.514**(0.199)	**0.526***(0.094)	**0.513**(0.341)	**0.506**(0.446)	**0.526**(0.069)	**0.542****(0.017)
3	**0.510**(0.395)	0.498(0.539)	**0.538**(0.134)	**0.522**(0.263)	**0.516**(0.263)	**0.510**(0.352)	**0.561***(0.015)	**0.542***(0.070)
6	0.480(0.694)	0.439(0.983)	0.496(0.552)	0.480(0.743)	0.495(0.507)	0.469(0.867)	**0.534**(0.112)	**0.524**(0.203)
9	0.452(0.915)	0.436(0.989)	**0.506**(0.315)	0.481(0.602)	0.477(0.729)	0.467(0.874)	**0.569****(0.003)	**0.553****(0.015)
12	0.479(0.680)	0.433(0.989)	**0.567****(0.005)	**0.580****(0.002)	**0.538***(0.061)	**0.505**(0.404)	**0.605****(0.000)	**0.608****(0.000)
15	**0.506**(0.370)	0.447(0.978)	**0.583****(0.001)	**0.562****(0.011)	**0.560****(0.009)	**0.510**(0.344)	**0.621****(0.000)	**0.611****(0.000)
18	**0.509**(0.361)	0.466(0.945)	**0.543****(0.002)	**0.552****(0.001)	**0.576****(0.002)	**0.539***(0.073)	**0.586****(0.000)	**0.603****(0.000)
21	**0.502**(0.533)	0.485(0.879)	**0.528****(0.003)	**0.546****(0.000)	**0.572****(0.003)	**0.565****(0.009)	**0.558****(0.004)	**0.579****(0.000)
24	0.478(0.849)	0.469(0.945)	0.491(0.253)	0.491(0.253)	**0.554****(0.025)	**0.540***(0.076)	**0.540***(0.055)	**0.547****(0.031)

NOTES: MH represents monthly forecast horizons. Boldface indicates improvements relative to the no-change forecast. As a rough guide, p-values of a Harvey et al. (1997) small-sample adjustment of the Diebold and Mariano (1995) test are reported in brackets after recursive MSPE ratios. We also report p-values for the Pesaran and Timmermann (2009) test for the null hypothesis of no directional accuracy in brackets after success ratios. * denotes significance at the 10% level and ** at the 5% level.

11

References

Baumeister, C., & Kilian, L. (2015). Forecasting the real price of oil in a changing world: A forecast combination approach. *Journal of Business & Economic Statistics*, *33*(3), 338–351.

Diebold, F. X., & Mariano, R. S. (1995). Comparing predictive accuracy. *Journal of Business & Economic Statistics*, *13*(3).

Garratt, A., Vahey, S. P., & Zhang, Y. (2018). *Real-time forecast combinations for the oil price* (Tech. Rep.). Centre for Applied Macroeconomic Analysis, Crawford School of Public Policy, The Australian National University.

Hamilton, J. D. (2018). Measuring global economic activity. *Working Paper*.

Harvey, D., Leybourne, S., & Newbold, P. (1997). Testing the equality of prediction mean squared errors. *International Journal of forecasting*, *13*(2), 281–291.

Kilian, L. (2009). Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *The American Economic Review*, *99*(3), 1053–1069.

Pesaran, M. H., & Timmermann, A. (2009). Testing dependence among serially correlated multicategory variables. *Journal of the American Statistical Association*, *104*(485), 325–337.