# Online Appendix to:
# Real-time Forecast Combinations for the Oil Price[*]

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

July 27, 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.

---

[†]University of Warwick
[‡]Warwick and CAMA (ANU)
[§]University of Warwick

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

| | | | 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**$^{**}$(0.032) | **0.936**$^{**}$(0.044) | **0.938**$^{**}$(0.050) | **0.930**$^{**}$(0.036) | **0.928**$^{**}$(0.033) |
| 3 | **0.922**$^{**}$(0.009) | **0.925**$^{**}$(0.010) | **0.925**$^{**}$(0.011) | **0.920**$^{**}$(0.005) | **0.927**$^{**}$(0.005) |
| 6 | **0.983**(0.139) | **0.987**(0.208) | **0.989**(0.229) | **0.990**(0.256) | **0.989**(0.227) |
| 9 | **0.977**$^{*}$(0.082) | **0.982**(0.145) | **0.981**(0.131) | **0.985**(0.185) | **0.986**(0.233) |
| 12 | **0.938**$^{**}$(0.000) | **0.944**$^{**}$(0.001) | **0.948**$^{**}$(0.003) | **0.946**$^{**}$(0.002) | **0.943**$^{**}$(0.001) |
| 15 | **0.928**$^{**}$(0.000) | **0.939**$^{**}$(0.001) | **0.952**$^{**}$(0.011) | **0.952**$^{**}$(0.009) | **0.969**$^{*}$(0.078) |
| 18 | **0.969**$^{**}$(0.036) | **0.990**(0.277) | 1.018(0.809) | 1.026(0.883) | 1.053(0.984) |
| 21 | 1.002(0.543) | 1.023(0.921) | 1.049(0.992) | 1.058(0.995) | 1.101(1.000) |
| 24 | **0.981**(0.133) | **0.991**(0.296) | **0.994**(0.373) | **0.999**(0.488) | 1.039(0.939) |
| | | | Success ratios | | |
| 1 | **0.558**$^{*}$(0.064) | **0.550**$^{*}$(0.093) | **0.550**$^{*}$(0.093) | **0.546**(0.122) | **0.554**$^{*}$(0.084) |
| 3 | **0.587**$^{**}$(0.013) | **0.583**$^{**}$(0.018) | **0.583**$^{**}$(0.018) | **0.587**$^{**}$(0.014) | **0.579**$^{**}$(0.028) |
| 6 | **0.553**(0.135) | **0.533**(0.324) | **0.537**(0.271) | **0.516**(0.531) | **0.520**(0.419) |
| 9 | **0.548**(0.112) | **0.560**$^{**}$(0.046) | **0.564**$^{**}$(0.041) | **0.552**$^{*}$(0.085) | **0.552**$^{*}$(0.077) |
| 12 | **0.660**$^{**}$(0.000) | **0.647**$^{**}$(0.000) | **0.639**$^{**}$(0.000) | **0.639**$^{**}$(0.000) | **0.664**$^{**}$(0.000) |
| 15 | **0.626**$^{**}$(0.000) | **0.591**$^{**}$(0.001) | **0.574**$^{**}$(0.012) | **0.570**$^{**}$(0.016) | **0.574**$^{**}$(0.015) |
| 18 | **0.565**$^{**}$(0.003) | **0.543**$^{**}$(0.012) | **0.513**(0.177) | 0.496(0.381) | 0.496(0.326) |
| 21 | **0.581**$^{**}$(0.001) | **0.502**(0.124) | **0.550**$^{**}$(0.027) | **0.537**(0.114) | **0.502**(0.498) |
| 24 | **0.558**$^{**}$(0.033) | **0.522**$^{*}$(0.088) | **0.549**$^{*}$(0.079) | **0.540**(0.182) | **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

| | | | Real WTI price | | |
|---|---|---|---|---|---|
| | | | Rolling weights based on windows of length | | |
| MH | Equal weight | Recursive weights | 36 | 24 | 12 |
| | | | Recursive MSPE ratios | | |
| 1 | **0.907**$^{**}$(0.008) | **0.911**$^{**}$(0.009) | **0.912**$^{**}$(0.011) | **0.912**$^{**}$(0.012) | **0.909**$^{**}$(0.013) |
| 3 | **0.923**$^{**}$(0.011) | **0.927**$^{**}$(0.012) | **0.929**$^{**}$(0.014) | **0.928**$^{**}$(0.011) | **0.934**$^{**}$(0.013) |
| 6 | **0.986**(0.214) | **0.991**(0.289) | **0.992**(0.309) | **0.994**(0.350) | **0.997**(0.419) |
| 9 | **0.980**(0.127) | **0.986**(0.208) | **0.982**(0.158) | **0.986**(0.217) | **0.989**(0.281) |
| 12 | **0.946**$^{**}$(0.002) | **0.954**$^{**}$(0.007) | **0.953**$^{**}$(0.008) | **0.949**$^{**}$(0.005) | **0.945**$^{**}$(0.003) |
| 15 | **0.939**$^{**}$(0.001) | **0.952**$^{**}$(0.007) | **0.962**$^{**}$(0.042) | **0.963**$^{**}$(0.041) | **0.943**$^{**}$(0.005) |
| 18 | **0.968**$^{**}$(0.035) | **0.993**(0.351) | 1.020(0.843) | 1.038(0.954) | 1.065(0.988) |
| 21 | 1.000(0.496) | 1.029(0.948) | 1.051(0.991) | 1.062(0.994) | 1.081(0.998) |
| 24 | **0.973**$^{*}$(0.080) | **0.994**(0.373) | **0.995**(0.403) | 1.003(0.554) | 1.048(0.958) |
| | | | Success ratios | | |
| 1 | **0.550**(0.135) | **0.554**(0.124) | **0.550**(0.150) | **0.558**(0.102) | **0.558**(0.102) |
| 3 | **0.555**(0.124) | **0.551**(0.150) | **0.543**(0.210) | **0.547**(0.198) | **0.538**(0.306) |
| 6 | **0.529**(0.366) | **0.520**(0.487) | **0.508**(0.635) | **0.508**(0.584) | 0.484(0.843) |
| 9 | **0.544**(0.130) | **0.560**$^{**}$(0.049) | **0.568**$^{**}$(0.031) | **0.556**$^{*}$(0.073) | **0.535**(0.181) |
| 12 | **0.588**$^{**}$(0.004) | **0.571**$^{**}$(0.014) | **0.584**$^{**}$(0.009) | **0.601**$^{**}$(0.001) | **0.601**$^{**}$(0.001) |
| 15 | **0.583**$^{**}$(0.005) | **0.583**$^{**}$(0.003) | **0.566**$^{**}$(0.028) | **0.566**$^{**}$(0.031) | **0.562**$^{**}$(0.024) |
| 18 | **0.573**$^{**}$(0.003) | **0.556**$^{**}$(0.004) | **0.534**$^{*}$(0.060) | **0.513**(0.221) | **0.509**(0.231) |
| 21 | **0.572**$^{**}$(0.002) | **0.502**(0.106) | **0.537**$^{*}$(0.050) | **0.515**(0.261) | **0.511**(0.324) |
| 24 | **0.549**$^{*}$(0.065) | 0.496(0.290) | **0.531**(0.168) | **0.527**(0.325) | **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

| | | | Real Brent price | | |
|---|---|---|---|---|---|
| | | | Rolling weights based on windows of length | | |
| MH | Equal weight | Recursive weights | 36 | 24 | 12 |
| | | | Recursive MSPE ratios | | |
| 1 | **0.956**(0.107) | **0.935**$^{**}$(0.018) | **0.933**$^{**}$(0.017) | **0.936**$^{**}$(0.022) | **0.948**$^{*}$(0.084) |
| 3 | **0.942**$^{**}$(0.027) | **0.941**$^{**}$(0.021) | **0.939**$^{**}$(0.016) | **0.943**$^{**}$(0.023) | **0.947**$^{**}$(0.026) |
| 6 | **0.992**(0.350) | **0.999**(0.472) | 1.004(0.590) | 1.004(0.587) | 1.007(0.658) |
| 9 | **0.981**(0.152) | **0.988**(0.244) | **0.989**(0.256) | **0.995**(0.373) | **0.995**(0.392) |
| 12 | **0.949**$^{**}$(0.002) | **0.959**$^{**}$(0.009) | **0.963**$^{**}$(0.014) | **0.965**$^{**}$(0.014) | **0.957**$^{**}$(0.009) |
| 15 | **0.943**$^{**}$(0.000) | **0.957**$^{**}$(0.005) | **0.969**$^{**}$(0.036) | **0.976**$^{*}$(0.071) | **0.979**$^{*}$(0.093) |
| 18 | **0.981**(0.119) | 1.005(0.631) | 1.026(0.944) | 1.041(0.993) | 1.075(1.000) |
| 21 | 1.014(0.842) | 1.040(0.996) | 1.058(1.000) | 1.064(1.000) | 1.098(1.000) |
| 24 | 1.008(0.688) | 1.025(0.932) | 1.034(0.971) | 1.041(0.993) | 1.096(1.000) |
| | | | Success ratios | | |
| 1 | **0.522**(0.128) | **0.526**(0.133) | **0.534**$^{*}$(0.094) | **0.534**$^{*}$(0.089) | **0.558**$^{**}$(0.016) |
| 3 | **0.522**(0.263) | **0.518**(0.284) | **0.530**(0.174) | **0.530**(0.163) | **0.538**(0.125) |
| 6 | **0.508**(0.406) | 0.484(0.673) | 0.471(0.832) | 0.471(0.764) | 0.488(0.597) |
| 9 | **0.506**(0.355) | 0.498(0.414) | 0.485(0.540) | 0.465(0.753) | 0.490(0.455) |
| 12 | **0.592**$^{**}$(0.000) | **0.592**$^{**}$(0.001) | **0.584**$^{**}$(0.001) | **0.584**$^{**}$(0.001) | **0.597**$^{**}$(0.000) |
| 15 | **0.604**$^{**}$(0.000) | **0.591**$^{**}$(0.000) | **0.587**$^{**}$(0.000) | **0.587**$^{**}$(0.000) | **0.609**$^{**}$(0.000) |
| 18 | **0.543**$^{**}$(0.001) | **0.539**$^{**}$(0.001) | **0.504**$^{**}$(0.035) | 0.483(0.195) | 0.474(0.284) |
| 21 | **0.541**$^{**}$(0.001) | **0.515**$^{**}$(0.002) | 0.493$^{**}$(0.050) | 0.463(0.427) | 0.450(0.582) |
| 24 | 0.500(0.136) | 0.456(0.461) | **0.504**$^{*}$(0.087) | 0.451(0.782) | 0.456(0.749) |

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 | **0.933**$^{**}$(0.017) | **0.937**$^{**}$(0.024) | **0.941**$^{**}$(0.032) | **0.934**$^{**}$(0.022) | **0.930**$^{**}$(0.018) |
| 3 | **0.922**$^{**}$(0.002) | **0.925**$^{**}$(0.003) | **0.930**$^{**}$(0.004) | **0.922**$^{**}$(0.001) | **0.922**$^{**}$(0.001) |
| 6 | **0.975**$^{**}$(0.035) | **0.981**$^{*}$(0.075) | **0.982**$^{*}$(0.080) | **0.978**$^{**}$(0.045) | **0.969**$^{**}$(0.019) |
| 9 | **0.969**$^{**}$(0.011) | **0.977**$^{**}$(0.043) | **0.973**$^{**}$(0.023) | **0.971**$^{**}$(0.023) | **0.968**$^{**}$(0.023) |
| 12 | **0.934**$^{**}$(0.000) | **0.943**$^{**}$(0.000) | **0.940**$^{**}$(0.000) | **0.929**$^{**}$(0.000) | **0.921**$^{**}$(0.000) |
| 15 | **0.929**$^{**}$(0.000) | **0.941**$^{**}$(0.000) | **0.941**$^{**}$(0.000) | **0.933**$^{**}$(0.000) | **0.925**$^{**}$(0.000) |
| 18 | **0.941**$^{**}$(0.000) | **0.959**$^{**}$(0.004) | **0.971**$^{**}$(0.047) | **0.968**$^{*}$(0.051) | **0.949**$^{**}$(0.035) |
| 21 | **0.969**$^{**}$(0.014) | **0.994**(0.324) | **0.994**(0.363) | **0.998**(0.449) | **0.995**(0.425) |
| 24 | **0.966**$^{**}$(0.014) | 1.007(0.692) | **0.985**(0.163) | **0.986**(0.213) | 1.001(0.519) |
| | | | Success ratios | | |
| 1 | **0.558**$^{**}$(0.042) | **0.554**$^{**}$(0.047) | **0.567**$^{**}$(0.017) | **0.561**$^{**}$(0.031) | **0.574**$^{**}$(0.010) |
| 3 | **0.603**$^{**}$(0.001) | **0.600**$^{**}$(0.001) | **0.603**$^{**}$(0.001) | **0.610**$^{**}$(0.000) | **0.594**$^{**}$(0.002) |
| 6 | **0.580**$^{**}$(0.011) | **0.564**$^{**}$(0.047) | **0.564**$^{**}$(0.040) | **0.550**$^{*}$(0.098) | **0.560**$^{**}$(0.044) |
| 9 | **0.559**$^{**}$(0.032) | **0.566**$^{**}$(0.019) | **0.582**$^{**}$(0.004) | **0.576**$^{**}$(0.007) | **0.569**$^{**}$(0.013) |
| 12 | **0.661**$^{**}$(0.000) | **0.645**$^{**}$(0.000) | **0.645**$^{**}$(0.000) | **0.651**$^{**}$(0.000) | **0.681**$^{**}$(0.000) |
| 15 | **0.621**$^{**}$(0.000) | **0.594**$^{**}$(0.001) | **0.587**$^{**}$(0.002) | **0.594**$^{**}$(0.001) | **0.584**$^{**}$(0.002) |
| 18 | **0.576**$^{**}$(0.002) | **0.556**$^{**}$(0.017) | **0.529**(0.142) | **0.512**(0.326) | **0.512**(0.293) |
| 21 | **0.579**$^{**}$(0.003) | **0.507**(0.340) | **0.548**$^{*}$(0.055) | **0.551**$^{**}$(0.042) | **0.514**(0.350) |
| 24 | **0.564**$^{**}$(0.019) | **0.512**(0.341) | **0.550**$^{*}$(0.063) | **0.540**(0.123) | **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 | **0.910**\*\*(0.002) | **0.912**\*\*(0.002) | **0.915**\*\*(0.003) | **0.915**\*\*(0.004) | **0.912**\*\*(0.004) |
| 3 | **0.922**\*\*(0.003) | **0.925**\*\*(0.003) | **0.930**\*\*(0.004) | **0.928**\*\*(0.003) | **0.929**\*\*(0.002) |
| 6 | **0.977**\*(0.064) | **0.982**(0.115) | **0.983**(0.114) | **0.982**(0.104) | **0.987**(0.177) |
| 9 | **0.972**\*\*(0.023) | **0.979**\*(0.069) | **0.974**\*\*(0.035) | **0.973**\*\*(0.039) | **0.978**\*(0.090) |
| 12 | **0.940**\*\*(0.000) | **0.948**\*\*(0.000) | **0.942**\*\*(0.000) | **0.930**\*\*(0.000) | **0.936**\*\*(0.000) |
| 15 | **0.934**\*\*(0.000) | **0.945**\*\*(0.000) | **0.942**\*\*(0.000) | **0.932**\*\*(0.000) | **0.914**\*\*(0.000) |
| 18 | **0.940**\*\*(0.000) | **0.959**\*\*(0.005) | **0.966**\*\*(0.033) | **0.968**\*(0.060) | **0.978**(0.197) |
| 21 | **0.967**\*\*(0.013) | **0.990**(0.240) | **0.987**(0.237) | **0.988**(0.274) | **0.985**(0.276) |
| 24 | **0.952**\*\*(0.003) | **0.989**(0.239) | **0.962**\*\*(0.018) | **0.960**\*\*(0.021) | **0.986**(0.331) |
| | | | Success ratios | | |
| 1 | **0.561**\*\*(0.045) | **0.564**\*\*(0.040) | **0.554**\*(0.083) | **0.561**\*(0.052) | **0.571**\*\*(0.024) |
| 3 | **0.571**\*\*(0.021) | **0.565**\*\*(0.035) | **0.568**\*\*(0.026) | **0.571**\*\*(0.022) | **0.568**\*\*(0.033) |
| 6 | **0.554**\*(0.087) | **0.544**(0.176) | **0.537**(0.236) | **0.541**(0.162) | **0.511**(0.548) |
| 9 | **0.566**\*\*(0.020) | **0.576**\*\*(0.009) | **0.579**\*\*(0.007) | **0.569**\*\*(0.018) | **0.559**\*\*(0.032) |
| 12 | **0.621**\*\*(0.000) | **0.608**\*\*(0.000) | **0.611**\*\*(0.000) | **0.631**\*\*(0.000) | **0.608**\*\*(0.000) |
| 15 | **0.607**\*\*(0.000) | **0.604**\*\*(0.000) | **0.597**\*\*(0.001) | **0.604**\*\*(0.000) | **0.594**\*\*(0.001) |
| 18 | **0.590**\*\*(0.000) | **0.583**\*\*(0.001) | **0.580**\*\*(0.002) | **0.556**\*\*(0.026) | **0.553**\*\*(0.028) |
| 21 | **0.592**\*\*(0.000) | **0.527**(0.103) | **0.558**\*\*(0.020) | **0.548**\*(0.054) | **0.555**\*\*(0.036) |
| 24 | **0.561**\*\*(0.025) | **0.502**(0.457) | **0.547**\*(0.069) | **0.536**(0.136) | **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 | 1.007(0.615) | **0.969**$^{**}$(0.036) | **0.996**(0.385) | **0.941**$^{**}$(0.000) |
| 19 | 1.023(0.845) | **0.985**(0.180) | 1.005(0.639) | **0.948**$^{**}$(0.000) |
| 20 | 1.038(0.953) | **0.999**(0.482) | 1.022(0.932) | **0.961**$^{**}$(0.004) |
| 21 | 1.039(0.953) | 1.002(0.543) | 1.033(0.986) | **0.969**$^{**}$(0.014) |
| 22 | 1.030(0.892) | **0.996**(0.401) | 1.033(0.983) | **0.968**$^{**}$(0.013) |
| 23 | 1.015(0.733) | **0.986**(0.196) | 1.030(0.966) | **0.965**$^{**}$(0.009) |
| 24 | 1.007(0.605) | **0.981**(0.133) | 1.031(0.964) | **0.966**$^{**}$(0.014) |
| | Success ratios | | | |
| 18 | **0.534**(0.456) | **0.565**$^{**}$(0.003) | **0.522**(0.358) | **0.576**$^{**}$(0.002) |
| 19 | **0.537**(0.366) | **0.589**$^{**}$(0.000) | **0.551**$^{*}$(0.065) | **0.602**$^{**}$(0.000) |
| 20 | **0.561**(0.132) | **0.613**$^{**}$(0.000) | **0.553**$^{*}$(0.082) | **0.618**$^{**}$(0.000) |
| 21 | **0.507**(0.875) | **0.581**$^{**}$(0.001) | 0.486(0.899) | **0.579**$^{**}$(0.003) |
| 22 | **0.518**(0.857) | **0.561**$^{**}$(0.010) | 0.488(0.881) | **0.557**$^{**}$(0.026) |
| 23 | **0.542**(0.650) | **0.555**$^{**}$(0.026) | **0.503**(0.762) | **0.552**$^{**}$(0.044) |
| 24 | **0.535**(0.701) | **0.558**$^{**}$(0.033) | **0.509**(0.715) | **0.564**$^{**}$(0.019) |

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 | 1.005(0.583) | **0.968**$^{**}$(0.035) | **0.994**(0.357) | **0.940**$^{**}$(0.000) |
| 19 | 1.016(0.757) | **0.980**(0.129) | 1.004(0.596) | **0.949**$^{**}$(0.001) |
| 20 | 1.029(0.890) | **0.994**(0.351) | 1.017(0.861) | **0.959**$^{**}$(0.004) |
| 21 | 1.034(0.920) | 1.000(0.496) | 1.028(0.958) | **0.967**$^{**}$(0.013) |
| 22 | 1.021(0.793) | **0.990**(0.293) | 1.024(0.921) | **0.963**$^{**}$(0.007) |
| 23 | 1.005(0.571) | **0.979**(0.131) | 1.017(0.829) | **0.956**$^{**}$(0.004) |
| 24 | **0.994**(0.420) | **0.973**$^{*}$(0.080) | 1.012(0.731) | **0.952**$^{**}$(0.003) |
| | Success ratios | | | |
| 18 | **0.517**(0.624) | **0.573**$^{**}$(0.003) | **0.519**(0.456) | **0.590**$^{**}$(0.000) |
| 19 | **0.545**(0.201) | **0.593**$^{**}$(0.000) | **0.551**$^{*}$(0.081) | **0.609**$^{**}$(0.000) |
| 20 | **0.539**(0.289) | **0.587**$^{**}$(0.000) | **0.543**(0.162) | **0.590**$^{**}$(0.000) |
| 21 | 0.493(0.938) | **0.572**$^{**}$(0.002) | **0.503**(0.818) | **0.592**$^{**}$(0.000) |
| 22 | **0.522**(0.758) | **0.561**$^{**}$(0.012) | **0.505**(0.788) | **0.577**$^{**}$(0.004) |
| 23 | **0.511**(0.876) | **0.568**$^{**}$(0.011) | **0.507**(0.742) | **0.586**$^{**}$(0.002) |
| 24 | **0.527**(0.780) | **0.549**$^{*}$(0.065) | **0.505**(0.735) | **0.561**$^{**}$(0.025) |

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), Evaluation 1992:01 to 2012:09

| | Recursive MSPE ratios | | Success ratios | |
| --- | --- | --- | --- | --- |
| MH | Excluding FUTURES | Including FUTURES | Excluding FUTURES | Including FUTURES |
| 9 | **0.995**(0.420) | **0.981**(0.152) | 0.494(0.584) | **0.506**(0.355) |
| 10 | **0.989**(0.320) | **0.973**\*(0.057) | 0.500(0.533) | **0.533**\*(0.069) |
| 11 | **0.976**(0.142) | **0.959**\*\*(0.007) | **0.523**(0.320) | **0.582**\*\*(0.001) |
| 12 | **0.970**\*(0.092) | **0.949**\*\*(0.002) | **0.534**(0.214) | **0.592**\*\*(0.000) |
| 13 | **0.970**\*(0.087) | **0.946**\*\*(0.001) | **0.511**(0.446) | **0.578**\*\*(0.004) |
| 14 | **0.968**\*(0.080) | **0.942**\*\*(0.000) | **0.525**(0.262) | **0.576**\*\*(0.003) |
| 15 | **0.971**\*(0.099) | **0.943**\*\*(0.000) | **0.528**(0.230) | **0.604**\*\*(0.000) |
| 16 | **0.984**(0.232) | **0.953**\*\*(0.002) | **0.534**(0.155) | **0.577**\*\*(0.001) |
| 17 | 1.002(0.530) | **0.968**\*\*(0.021) | **0.511**(0.306) | **0.545**\*\*(0.005) |
| 18 | 1.016(0.766) | **0.981**(0.119) | **0.539**\*\*(0.038) | **0.543**\*\*(0.001) |
| 19 | 1.030(0.911) | **0.996**(0.395) | **0.524**\*\*(0.046) | **0.532**\*\*(0.001) |
| 20 | 1.042(0.973) | 1.008(0.695) | **0.548**\*\*(0.009) | **0.539**\*\*(0.000) |
| 21 | 1.049(0.986) | 1.014(0.842) | **0.511**(0.324) | **0.541**\*\*(0.001) |
| 22 | 1.046(0.975) | 1.014(0.820) | **0.509**(0.438) | **0.522**\*\*(0.016) |
| 23 | 1.036(0.933) | 1.007(0.681) | 0.493(0.604) | **0.515**\*\*(0.043) |
| 24 | 1.034(0.912) | 1.008(0.688) | 0.496(0.660) | 0.500(0.136) |

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.

# 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).

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

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