Online Appendix for "Futures prices are useful predictors of the spot price of crude oil"

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1. REAL-TIME DATA

This section describes the real-time data used in the empirical exercises. All forecasts are implemented in real-time for variables in levels unless otherwise indicated. The 2021M5 vintage is used to construct the final ex-post revised data target for the consumer price index (CPI) and U.S. refiners acquisition cost of crude oil, imported (RAC). An overview of all series is provided in Table 1.

Crude oil prices: Crude-oil price data for WTI, Brent, and RAC are obtained from the U.S. Energy Information Administration (EIA). Real-time data for RAC is obtained from Benmoussa et al. (2020), which extends the series previously computed in Baumeister and Kilian (2012). For Brent and WTI, the monthly average is a simple average of daily closing prices consistent with that reported by the EIA. The monthly closing price is the closing price on the last trading day of the month.

Consumer price index: The price index is the seasonally adjusted U.S. consumer price index obtained from the FRASER database of the Federal Reserve Bank of St. Louis and the real-time database of the Philadelphia Federal Reserve. Missing real-time observations for CPI are nowcasted using the average historical growth rate from 1986M7, unless otherwise indicated.

Table 1: Descriptive Statistics and Data Sources

Series	Measure	Mean	Std. Dev.	Source
WTI Spot Price	Monthly Average	49.1	29.0	U.S. EIA
Brent Spot Price	Monthly Average	50.7	32.6	U.S. EIA
U.S. Refiner Acquisition Cost, Imported	Monthly Average	46.7	29.7	U.S. EIA
WTI Spot Price	End of Month	49.3	29.2	U.S. EIA
Brent Spot Price	End of Month	50.8	32.8	U.S. EIA
U.S. Refiner Acquisition Cost, Imported	End of Month	46.9	29.9	U.S. EIA, Imputed
Consumer Price Index	Index	199.9	36.7	FRB of St. Louis
WTI Futures Price, First Contract	End of Month	49.3	29.2	Haver Analytics
Brent Futures Price, First Contract	End of Month	51.3	32.8	Haver Analytics
WTI Volume, First Contract	Daily average	10333.0	8985.8	Bloomberg
Brent Volume, First Contract	Daily average	5064.8	4291.3	Bloomberg
WTI Open Interest, First Contract	Daily average	9005.4	4473.9	Bloomberg
Brent Open Interest, First Contract	Daily average	7157.2	5042.2	Bloomberg

Note: All prices are in nominal levels and refer to the 2021M5 data vintage. The sample period is 1991M12–2021M1. The end-of-month price for the U.S. refiner acquisition cost, imported, is imputed using the WTI price following Benmoussa et al. (2020). EIA stands for Energy Information Administration and FRB stands for Federal Reserve Board.

Futures prices: Daily closing prices of futures for WTI (CL1...CL60) and Brent (CO1...CO60) crude oil are obtained from Haver Analytics. This data is identical to the daily closing price data provided by the EIA and Bloomberg (PX_LAST). The monthly average is a simple average of daily closing prices. The monthly closing price is the closing price on the last trading day of the month.

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Futures volume and open interest: Daily crude-oil futures volume and open interest for WTI and Brent are obtained from Bloomberg. Open interest is defined as the number of outstanding agreements for the selected contracts (OPEN_INT). Volume is the total number of contracts traded within a day (PX_VOLUME). To account for differences in the number of trading days across months, volume and open interest are reported as daily averages.

Oil-market variables: The real-time data for the world crude-oil production and OECD petroleum inventories are obtained from the EIA. Real-time vintages start in 1973M1 and use the vintages of Baumeister and Kilian (2012) from 1991M12 to 2010M12. Vintages from 2011M01 onwards use the updated data provided by Benmoussa et al. (2020), which is publicly available and updated monthly. For the VAR and AR forecasts, the WTI crude oil price is backcasted using the growth rate of the RAC to 1973M1.

EIA forecasts: The EIA's monthly forecasts for the nominal price of WTI are from the Short-Term Energy Outlook (STEO). The forecasts are collected from publicly available Excel files that accompany the monthly STEO beginning in 2004M7. Forecasts for the vintages 2000M10 to 2004M7 are provided graphically in the STEO PDF file and a machine reader (Rohatgi, 2021) is used to extract the data for the forecasts. Although the EIA began reporting forecasts in 1979, not all STEOs report the forecasts graphically before 2000M10. We thus begin our sample in 2000M10 when monthly forecasts began to be regularly reported. Qualitatively similar results are obtained for forecasts starting after 2004M7.

2. RECURSIVE ESTIMATES OF THE SLOPE PARAMETER IN THE REGRESSION-BASED FUTURES-SPREAD MODEL

This section reports the recursive estimates of the slope parameter $\hat{\beta}$ in the futures-spread regressions of Section 4.2. The estimates are based on real-time, least squares estimates of the model restricting $\hat{\alpha}$ to zero (row "EoM, $\hat{\beta}$" in Table 2). Figure 1 reports the evolution of the point estimates for β across the sample. The graph shows that all estimates are positive, but less than one.

Figure 1: Recursive estimates of the slope parameter in the regression-based futures spread model
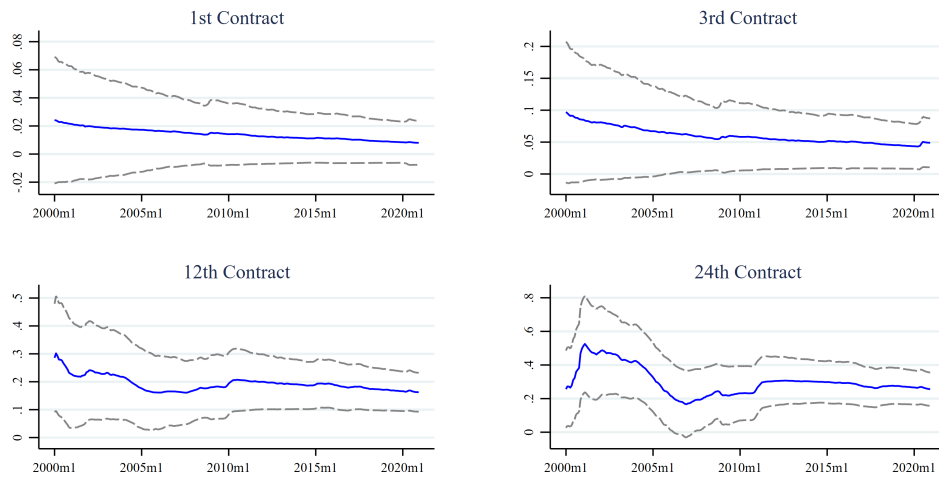
Notes: Evolution of the recursively estimated slope parameter, $\hat{\beta}$, of the model "EoM, $\hat{\beta}$" in Table 2. Dashed gray lines represent the 95 percent heteroskedasticity and autocorrelation consistent confidence intervals. The estimation period begins in 1986M7 except for the 24th contract, for which the estimation period begins in 1995M5. Estimates are reported from 2000M1 onward to reduce starting point effects.

REFERENCES

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