Stock-Oil Comovement: A Present-Value Approach

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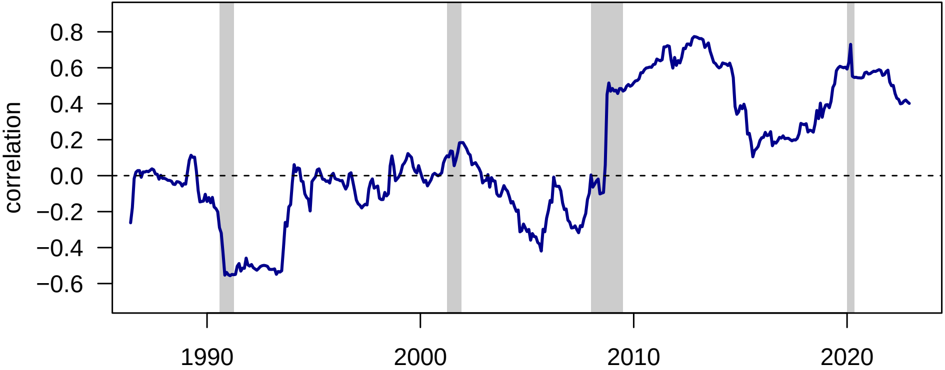
Motivating Evidence



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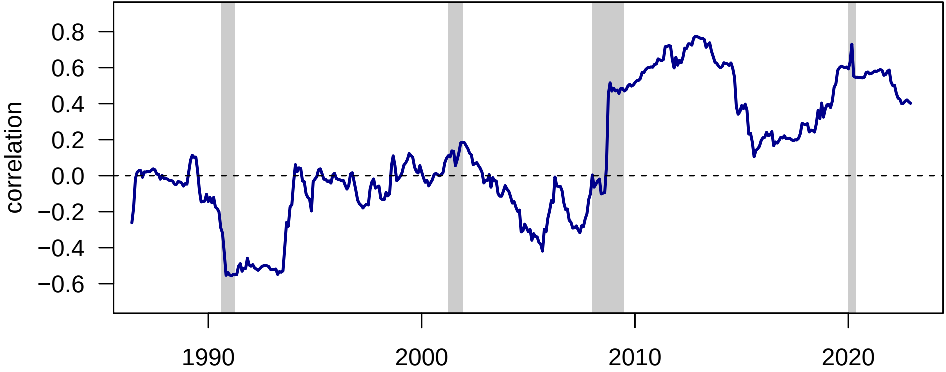

"[. . .] The tendency of stocks to fall along with oil prices is surprising. The usual presumption is that a decline in oil prices is good news for the economy, at least for net oil importers like the United States and China[. . .]"

Ben Bernanke (2016)

This Paper in One Slide

- We investigate the sources of time variation in the stock-oil correlation over the period 1983–2022.
- We derive a novel Campbell-Shiller-type oil futures return decomposition.
- We find that a key reason for the structural change in the stock-oil correlation is a shift in the correlation between cash-flow news for the two assets.
- The U.S. oil production is a relevant driver of both the stock-oil correlation and the cash-flow news correlation.

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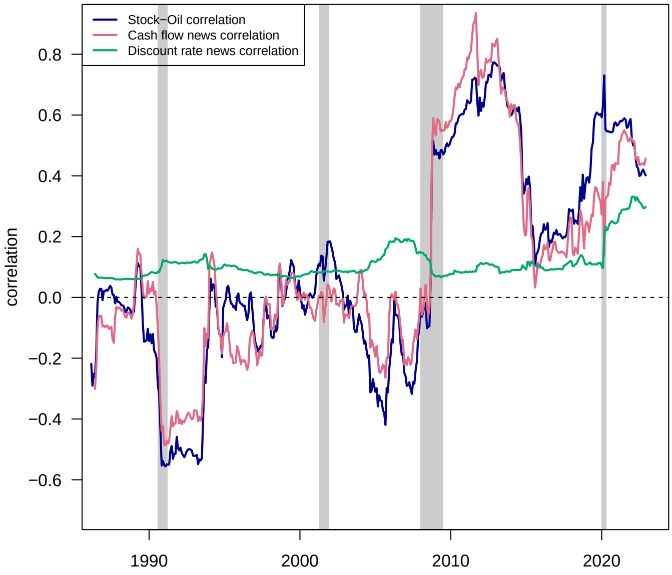
- We find that a key reason for the structural change in the stock-oil correlation is a shift in the correlation between cash-flow news for the two assets.
- The U.S. oil production is a relevant driver of both the stock-oil correlation and the cash-flow news correlation.
- Why do we care?
    - Novel evidence offering support for a view that the real economy is key for stock-oil dynamics.
    - Implications for investors: reduced diversification benefits.

Stock-Oil Correlation Dynamics and Its Components



Oil Return Decomposition (I)

- We start from the cost of carry model:

$$F_t^{(n)} = S_t(1+\rho)^n(1+U_t)^n - C_t^{(n)} \tag{1}$$

where $F_t^{(n)}$ is the futures price at time t with delivery at time $t+n$, S_t is the oil spot price at time t, ρ is the risk-free interest rate, U_t the rate for storage costs, and $C_t^{(n)}$ is the income from convenience yield.

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- Two key methodological contributions:
  1. Time-varying storage costs $\rightarrow U_t$
  2. Term structure of oil futures returns $\rightarrow F_t^{(n)}$

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- From Eq. (1), excess return on the futures contract that matures at time $t+1$ is defined as:

$$R_{t+1}^{(n),oil} = \frac{F_{t+1}^{(n-1)}}{F_t^{(n)}} = \frac{S_{t+1}(1+\rho)^{n-1}(1+U_t)^{n-1} - C_{t+1}^{(n-1)}}{S_t(1+\rho)^n(1+U_t)^n - C_t^{(n)}} \;,\; n = 1,\dots,N$$

Oil Return Decomposition (II)

- Taking logs, we have:

$$r_{t+1}^{(n),oil} = \ln R_{t+1}^{(n),oil} = f_{t+1}^{(n-1)} - s_t - \ln\left((1+\rho)^n(1+U_t)^n - \frac{C_t^{(n)} + \underline{C}}{S_t} + \frac{\underline{C}}{S_t}\right) \tag{2}$$

- For all maturities we get a decomposition of the form:

$$r_{t+1}^{(n),oil} - E_t(r_{t+1}^{(n),oil}) = N_{CF,t+1}^{(n),oil} - N_{Store,t+1}^{(n),oil} - N_{DR,t+1}^{(n),oil} \tag{3}$$

Oil Return Decomposition: $n = 1$

$$
\begin{aligned}
r_{t+1}^{(1),oil} - E_t(r_{t+1}^{(1),oil}) &= \underbrace{(E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \theta_{x1}^{j-1} \Delta\tilde{c}_{t+j}^{(1)}\right]}_{N_{CF,t+1}^{oil}} \\
&- \underbrace{\phi_{U1}(E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \theta_{x1}^{j} U_{t+j}\right]}_{N_{Store,t+1}^{oil}} \\
&- \underbrace{(E_{t+1} - E_t)\left[\sum_{j=0}^{\infty} \theta_{x1}^{j+1} r_{t+1+j|t+2+j}^{(1)oil}\right]}_{N_{DR,t+1}^{oil}} \\
&= N_{CF,t+1}^{oil} - N_{Store,t+1}^{oil} - N_{DR,t+1}^{oil}
\end{aligned}
$$

Decomposing the Stock-Oil Comovement

- We use the news components to decompose the stock-oil comovement:

$$
\begin{aligned}
Cov_{t-1}(r_t^{oil}, r_t^{eq}) =& Cov_{t-1}\left(-N_{DR,t}^{oil}, N_{CF,t}^{eq}\right) + Cov_{t-1}\left(-N_{DR,t}^{oil}, -N_{DR,t}^{eq}\right) \\
&+ Cov_{t-1}\left(-N_{Store,t}^{oil}, N_{CF,t}^{eq}\right) + Cov_{t-1}\left(-N_{Store,t}^{oil}, -N_{DR,t}^{eq}\right) \\
&+ Cov_{t-1}\left(N_{CF,t}^{oil}, N_{CF,t}^{eq}\right) + Cov_{t-1}\left(N_{CF,t}^{oil}, -N_{DR,t}^{eq}\right) \qquad (4)
\end{aligned}
$$

- Finally, we express the stock-oil comovement in terms of correlations as:

$$
\varrho_{t-1}^{*}(N_{x,t}, N_{y,t}) := \frac{Cov_{t-1}(N_{x,t}, N_{y,t})}{\sqrt{\mathbb{V}_{t-1}(r_t^{eq})\mathbb{V}_{t-1}(r_t^{oil})}}
$$

VAR: State Variables and Implementation

- Following, e.g., Campbell and Vuolteenaho (2004), we use a VAR to produce expectations and obtain news components for stocks and oil. *Basis*: ratio of the spot price to the futures price.
- To overcome some of the limitations of the VAR-based decomposition (e.g., Chen and Zhao, 2009), we consider many variables and different lags and "let the data speak."
- State variables:
  - Endogenous: equity returns, oil futures returns, storage costs
  - Exogenous: pd, CAPE, term spread, default spread, values spread, yield spread, inflation, T-bill, basis, hedging pressure, Bakshi, Gao, and Rossi (2019)'s commodity factors, Ludvigson and Ng (2009)'s PCs

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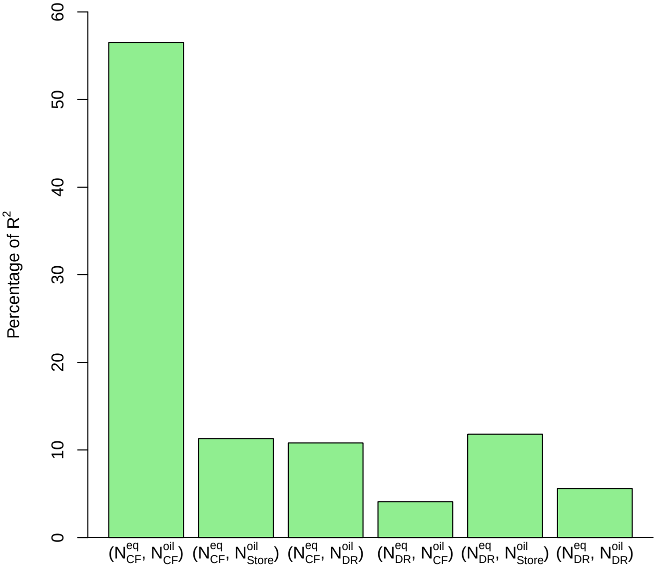
- Our empirical procedure (ML with HQIC) selects: LL PC1 and basis, plus the endogenous variables, and 3 lags for the VAR.

Decomposing Stock–Oil Correlation



Regression Evidence

	$\widehat{\rho}_t\left(r_t^{eq}, r_t^{oil}\right)$								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\widehat{\rho}_t\left(\widehat{N}_{CF,t}^{eq}, \widehat{N}_{CF,t}^{oil}\right)$	0.812***		0.811***	0.817***		0.816***	0.743***		0.742***
	(0.087)		(0.092)	(0.096)		(0.101)	(0.067)		(0.070)
$\widehat{\rho}_t\left(\widehat{N}_{DR,t}^{eq}, \widehat{N}_{DR,t}^{oil}\right)$		0.467	0.032		0.529	0.022		-0.077	-0.031
		(0.739)	(0.095)		(0.669)	(0.098)		(0.904)	(0.073)
Observations	439	439	439	439	439	439	439	439	439
Adjusted R^2	0.901	0.025	0.901	0.902	0.052	0.902	0.910	0.475	0.910
Controls				GFC	GFC	GFC	FINZ	FINZ	FINZ

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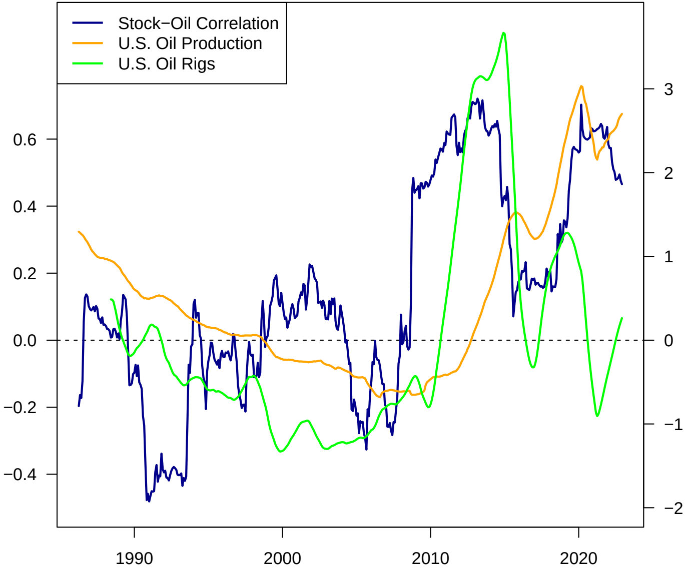
Stock-Oil Correlation and U.S. Oil Production



Implications?

- We quantify the economic implications of the structural correlation change for a mean–variance investor.
- Intuitively, the recent high and positive stock–oil correlation reduces the attractiveness of long positions in oil futures as portfolio diversifiers.
- We consider an investor who allocates 80% of their wealth to the U.S. stock market and the remaining 20% to oil.
- A risk-averse investor would be willing to accept a decrease in the expected return of 4.8% per annum to maintain the pre-2008 stock–oil correlation.