

Modelling Volatility Co-movements in a Changing Environment

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Introduction

- Anthropogenic climate change is due to the burning of fossil fuels.
- Transition towards low-carbon economies entails a shift away from fossil fuels.
- Pricing transition risk, geopolitical by nature, implies carbon-intensive asset prices to be all responsive to climate change news.
- This is a new approach for modelling the co-movements of carbon-intensive asset return volatilities and how they globally respond to climate change news.

The major oil & gas dataset

Company	Country	Company	Country
ExxonMobil	United States	Shell	The Netherlands
ConocoPhillips	United States		United Kingdom
Chevron	United States	BP	United Kingdom
Occidental	United States	Total	France
Halliburton	United States	Schlumberger	France
EOG	United States	Eni	Italy
Devon	United States	Equinor	Norway
CNOOC	China	Repsol	Spain
PetroChina	China	Canadian Natural	
Sinopec	China	Resources	Canada
Petrobras	Brazil	Suncor	Canada

Daily prices of shares traded in the New York Stock Exchange from April 4, 1983 until October 31, 2019.

Consider the vector of returns $\boldsymbol{r}_t = (r_{1t}, \ldots, r_{nt})'$ given by

$$\begin{aligned} \boldsymbol{f}_t &= \boldsymbol{w}'_{t-1}\boldsymbol{r}_t \\ \boldsymbol{r}_t &= r^f + \mathbf{B}\boldsymbol{f}_t + \text{diag}(\sqrt{\boldsymbol{h}_t})\boldsymbol{e}_t, \end{aligned} \tag{1}$$

where $\boldsymbol{f}_t$ includes the Fama and French (1992) factors, $\boldsymbol{e}_t = (e_{1t}, \ldots, e_{nt})'$, and $\boldsymbol{h}_t = (h_{1t}, \ldots, h_{nt})'$ is a vector of GARCH(1,1) processes.

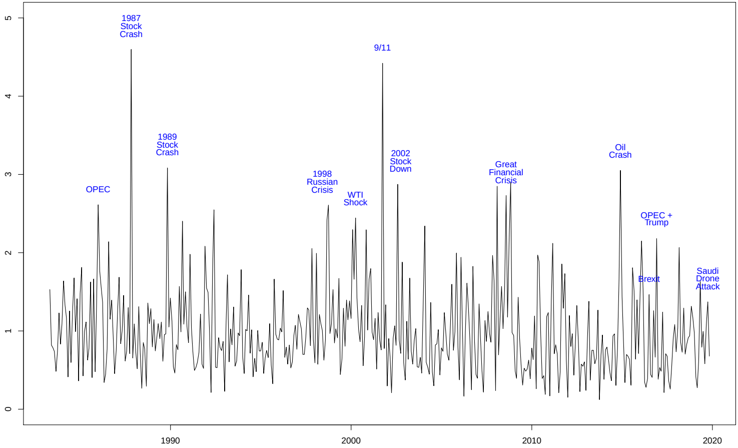
Let $x_{it} = s_i x_t + 1 - s_i$, where x_t denotes the multiplicative volatility factor as in Engle and Martins (*in preparation*) and s_i the ith asset's factor loading. Then assume

$$\boldsymbol{e}_t = \sqrt{\boldsymbol{x}_t} \odot \boldsymbol{\epsilon}_t, \tag{2}$$

where $\epsilon_{it} \sim \mathcal{N}(0,1)$, $\boldsymbol{x}_t = (x_{1t}, \ldots, x_{nt})'$, and $\boldsymbol{\epsilon}_t = (\epsilon_{1t}, \ldots, \epsilon_{nt})'$.

$(1) - (2)$ satisfy $\mathbb{E}_{t-1}(\boldsymbol{e}_t\boldsymbol{e}'_t) = \mathbb{I}$ and (2) implies $\mathbb{E}_{t-1}[\boldsymbol{e}^2_t(\boldsymbol{e}^2_t)'] = \Psi$.

The monthly global oil & gas volatility factor

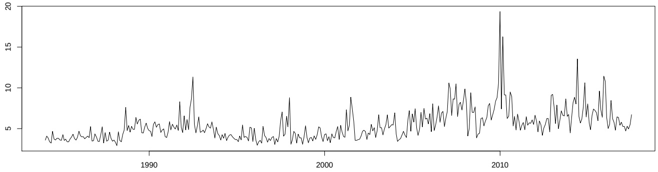


- Monthly index [$1984/01 - 2017/06$] .
- Textual analysis of WSJ using a fixed climate change vocabulary from authoritative texts.
- Distinction between positive and negative news using sentiment analysis [$2008/06 - 2017/06$]

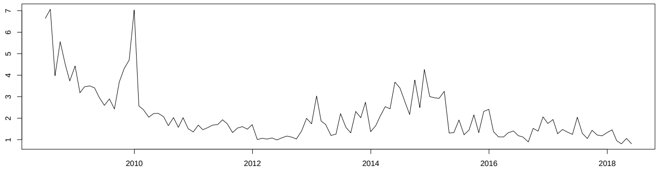
Converted into climate change volatility shocks as follows:

$$e^2_{CC,t} - 1 = \frac{(CC_t - \mu - \rho CC_{t-1})^2 - h_{CC,t}}{h_{CC,t}}, \quad (3)$$

where CC_t denotes the climate change news index of Engle et al. (2020).



(a) General CC news index.



(b) Bad CC news index.

The oil & gas volatility factor and climate change news

	(1)	(2)	(3)
allCC	-0.029^{**}	-0.028^{*}	-0.034^{**}
	(0.014)	(0.015)	(0.013)
badCC	0.050^{**}	0.043^{*}	-0.013
	(0.023)	(0.024)	(0.027)
SP500	0.375^{***}	0.374^{***}	0.406^{***}
	(0.101)	(0.106)	(0.095)
WTI	0.603^{***}	0.623^{***}	0.503^{***}
	(0.097)	(0.102)	(0.095)
SP500 × allCC		-0.028	
		(0.055)	
WTI × allCC		0.002	
		(0.055)	
SP500 × badCC			-0.303^{***}
			(0.073)
WTI × badCC			0.075^{*}
			(0.038)
Observations	107	107	107
R^2	0.481	0.486	0.561
$\hat{\sigma}$	0.432	0.434	0.401
$\chi^2_{AR}(2)$	4.176	3.979	2.009
	(0.124)	(0.137)	(0.366)
$\chi^2_{ARCH}(1)$	0.217	0.252	0.133
	(0.641)	(0.616)	(0.716)

Final remarks

- Climate change news have a significant impact on the volatilities of carbon-intensive asset returns at the global scale.
- Bad news seems to
    - Make carbon-intensive asset returns more volatile,
    - Enlarge the effect of oil price shocks.

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