Climate Change Risks, Stock Returns, and the Oil Sector

Michael Donadelli* Patrick Grüning** Steffen Hitzemann***

*Ca' Foscari University of Venice, Research Center SAFE **Bank of Lithuania, Vilnius University

***Rutgers Business School

12th Conference on the Economics of Energy and Climate Toulouse, 18-19 June 2019

The views expressed herein are solely those of the authors and do not necessarily reflect the views of the Bank of

Lithuania or the Eurosystem.

Motivation

Climate change has dramatic long-term consequences for the global economy, which should be priced by the market

- Negative effect on temperature-sensitive firms
- Negative effect on "dirty" (greenhouse gas emitting) firms due to environmental policies

Our Paper

Focus on the pricing of climate change risks in the oil sector

- Advantage: fossil fuel firms are clearly "dirty" (negatively affected by environmental policies), no need for statistical categorization
- Empirical analysis: Do we see appropriate discounts for climate risks in the oil sector?

Economic model: What would asset pricing theory predict?

Motivation: Carbon Risk Portfolio Returns



Returns of a portfolio with large exposure to carbon risk (Source: Görgen et al. 2018)

Motivation: Dirty-Minus-Clean Portfolio Returns



Returns of a portfolio that buys "dirty" firms and sells "clean" firms (own results)

Empirical Analysis: Oil-Minus-Market Returns



Returns of a portfolio that buys oil sector firms (Fama-French classification) and sells the market (without oil)

Empirical Analysis: Motivation

- No clear picture based on oil-minus-market returns
- Price-dividend ratio relatively high, fell only since 2008 (coincident with bust of commodity price boom)

- Thorough empirical analysis needed (along the lines of Chen, Hou, and Stulz, 2015 or Minton, Stulz, and Taboada, 2019, for example)
 - Use market-to-book ratios as a valuation measure
 - Employ panel regression setup to control for market-wide valuation trends and other important variables
 - Analyze whether the oil sector's valuation has changed within the last 10–20 years (e.g., since 2005, coincident with the introduction of the Kyoto protocol)

Empirical Analysis: Price-Dividend Ratios



Log price-dividend ratio of the U.S. oil sector

Empirical Analysis: Regressions with 2005 dummies

	(1)	(2)	(3)	(4)	(5)	(6)
	mtob	mtob	mtob	mtob	mtob	mtob
oil₋dummy	-0.558**	-0.550**	-0.481*	-0.558**	-0.550**	-0.481*
	(-2.31)	(-2.17)	(-1.90)	(-2.31)	(-2.17)	(-1.90)
since2005_dummy	1.133***	1.208***	2.115***	1.132***	1.206***	2.113***
	(4.14)	(4.43)	(6.68)	(4.14)	(4.42)	(6.67)
oil_ia_dummy_2005	-1.120***	-1.248***	-0.872**	-1.119***	-1.246***	-0.870**
	(-3.15)	(-3.46)	(-2.44)	(-3.14)	(-3.45)	(-2.44)
cash_ratio		0.0262**	0.0226**		0.0261**	0.0226**
		(2.28)	(2.23)		(2.28)	(2.23)
debt_assets		5.082***	6.723***		5.085***	6.725***
		(8.29)	(9.29)		(8.30)	(9.29)
logat			-0.564***			-0.563***
			(-12.17)			(-12.17)
rd_sale_1000				0.262	0.410	0.343
				(1.34)	(1.61)	(1.57)
Ν	164184	164184	163995	164184	164184	163995

Empirical Analysis: Regressions with 1997 dummies

	(1)	(2)	(3)	(4)	(5)	(6)
	mtob	mtob	mtob	mtob	mtob	mtob
oil₋dummy	-0.287	-0.193	-0.130	-0.287	-0.193	-0.130
	(-0.99)	(-0.66)	(-0.43)	(-0.99)	(-0.66)	(-0.43)
since1997_dummy	1.207***	1.368***	2.177***	1.206***	1.367***	2.176***
-	(5.15)	(5.65)	(8.18)	(5.15)	(5.64)	(8.18)
oil_ia_dummy_1997	-1.186***	-1.456***	-1.102***	-1.185***	-1.455***	-1.101***
2	(-3.43)	(-4.13)	(-3.05)	(-3.42)	(-4.12)	(-3.05)
cash_ratio		0.0260**	0.0223**		0.0259**	0.0223**
		(2.30)	(2.26)		(2.30)	(2.26)
debt_assets		5.237***	7.023***		5.240***	7.026***
		(8.57)	(9.92)		(8.58)	(9.92)
logat			-0.589***			-0.589***
			(-13.70)			(-13.70)
rd_sale_1000				0.264	0.411	0.359
				(1.39)	(1.65)	(1.67)
Ν	164184	164184	163995	164184	164184	163995

Empirical Analysis: Results

- Valuation of U.S. oil firms has declined since 2005 relative to other firms
- Analysis with yearly dummies confirms that the 'break point' is around the year 2005
- Findings would be in line with
 - Lower expected future cash flows due to stricter climate policies, which are not fully reflected by book equity
 - Higher (future) risk premia leading to a current devaluation
- What would a quantitative asset pricing model suggest?

Economic Model: Setup



Economic Model: Results

Temperature increases due to climate change lead to

- negative asset returns, especially in the temperature-sensitive sector
- an increase of the stochastic discount factor ("bad" times for the aggregate economy)
- \rightarrow positive temperature risk premia
- Stricter climate policy (with the goal of avoiding future climate disasters) leads to
 - negative asset returns in the oil sector and the dirty production sector
 - a decrease of the stochastic discount factor ("good" times for the aggregate economy)
 - \rightarrow negative (!) climate policy risk premia for oil firms (and other dirty firms)

Economic Model: Effect of Temperature Shock



Economic Model: Effect of Temperature Shock



Economic Model: Effect of Temperature Shock



Economic Model: Effect of Climate Policy Shock



Economic Model: Effect of Climate Policy Shock



Economic Model: Effect of Climate Policy Shock



Summary of Results and Outlook

- Quantitative asset pricing view
 - Strict climate policies have a negative current impact on oil firm valuations
 - On the other hand, oil firms pay off well when climate policy is weak (a "bad" state for the economy, leading to future disasters)
 - → The Baker, Hollifield, and Osambela (2019) Paradox applies: In terms of risk premia, oil stocks should be traded at higher valuations as they provide a "hedge" against too weak climate policies (and the related environmental damages)
- Asset pricing perspective: current devaluation of oil firms is due to ongoing tightening of climate policies/expectations (as opposed to risk premia)
- Future research: Do other factors, such as investment trends (environmental, social, and corporate governance; low carbon investing), also play a role?