



Minnesota Center for Financial & Actuarial Math

A Pragmatic Approach to Climate Change

Bob Litterman | April 19, 2016

Risk Management Requires Consideration of Worst Case Scenarios



ENERGY & ENVIRONMENT

What Is the Right Price for Carbon Emissions?

The unknown potential for devastating effects from climate change complicates pricing.

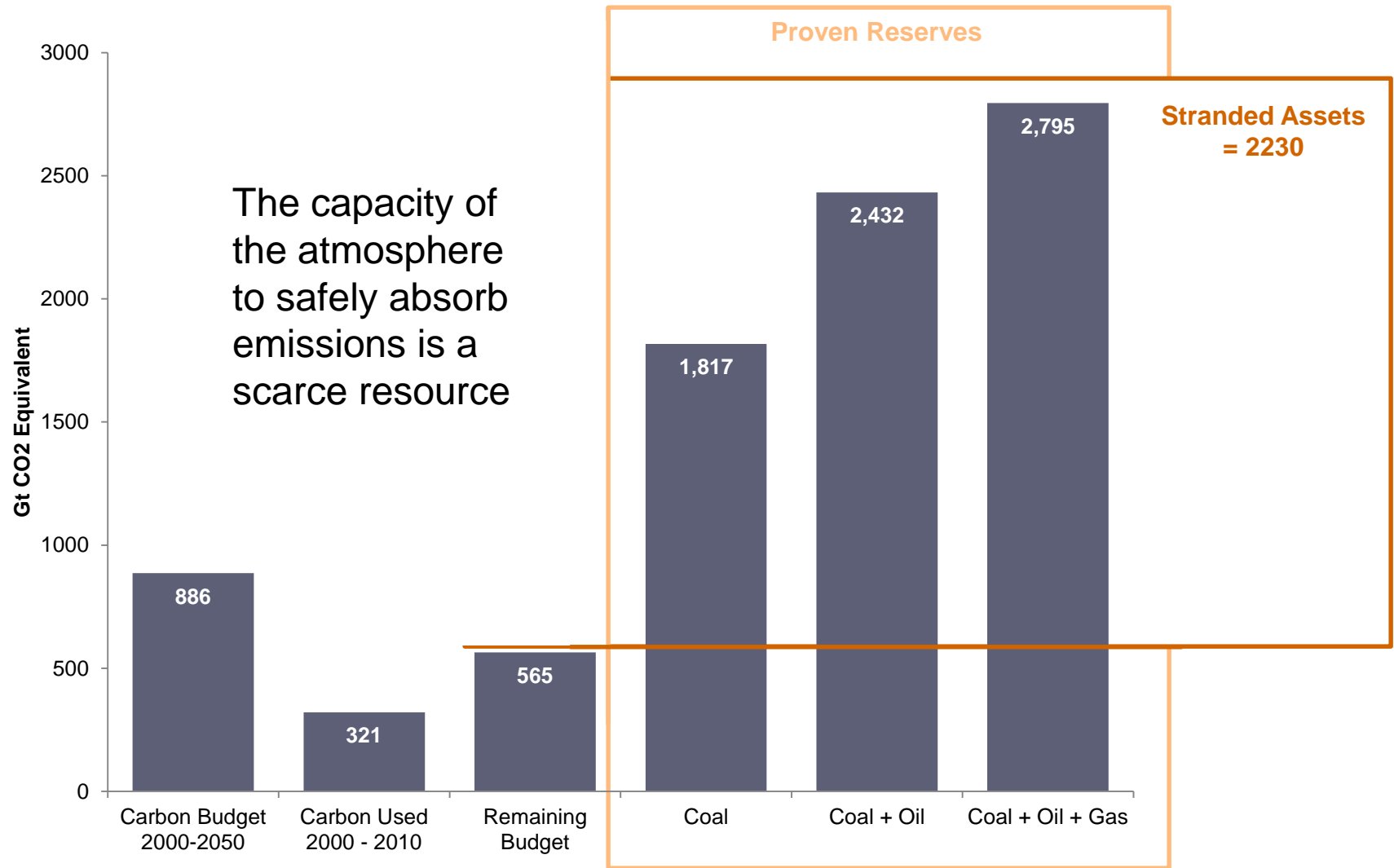
BY BOB LITTMAN

- Pricing emissions is the only effective brake society has which can prevent a future catastrophe
- It is extremely urgent that we construct and deploy such a mechanism
- We don't know how much time we have



Stranded Assets

The carbon budget consistent with an 80% probability of DC < 2°

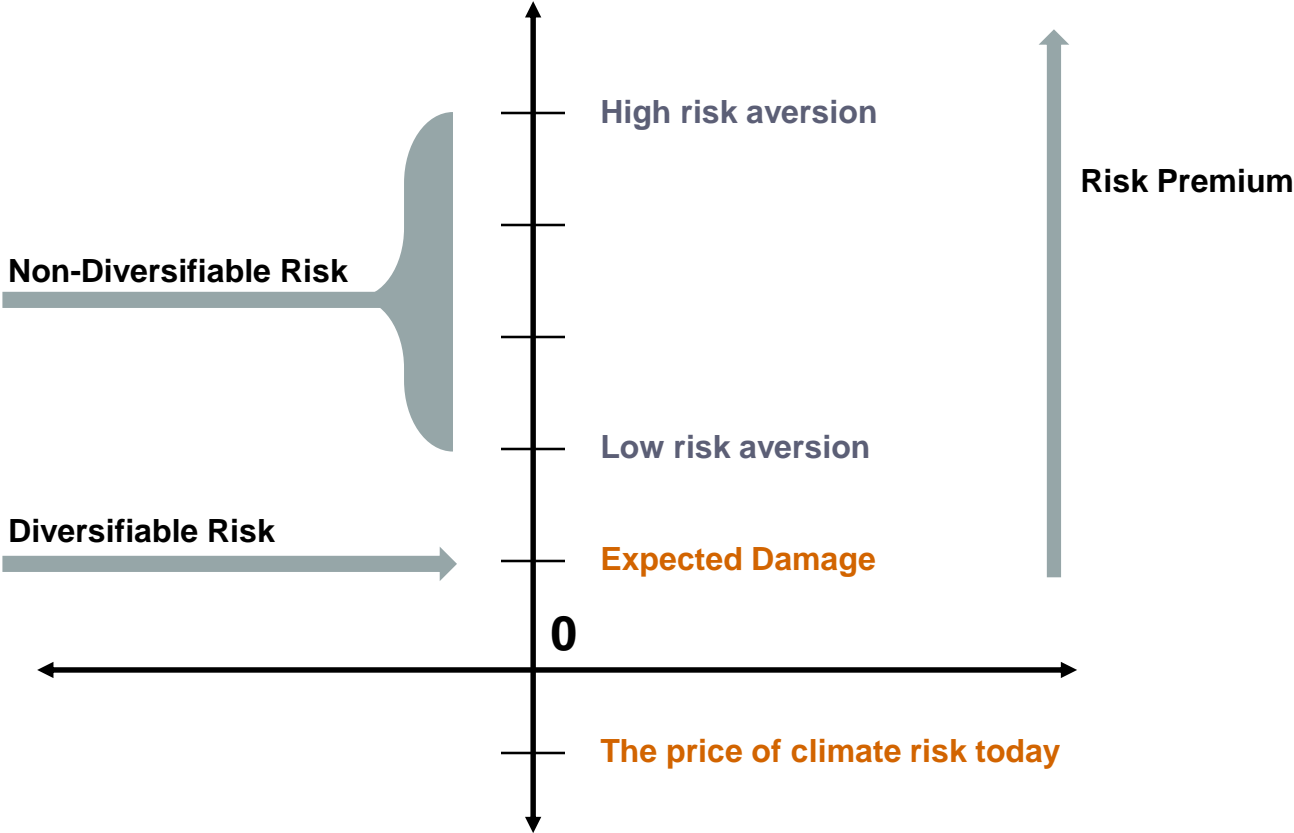


Source: Carbon Tracker Initiative

- Through lack of pricing, society is currently wasting this scarce resource

Where Should Climate Risk Be Priced?

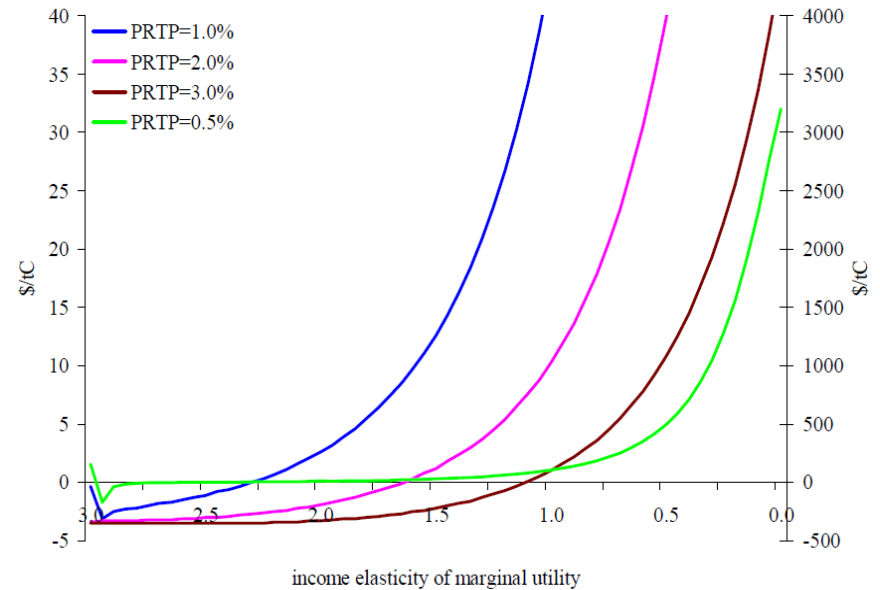
Economists call this “The Social Cost of Carbon”



The Importance of Risk

Fundamental disconnect between how we think about risk in finance and in climate change

- With a few notable exceptions, preferences used in climate studies have been standard isoelastic or power utility functions, with low levels of implied risk-aversion

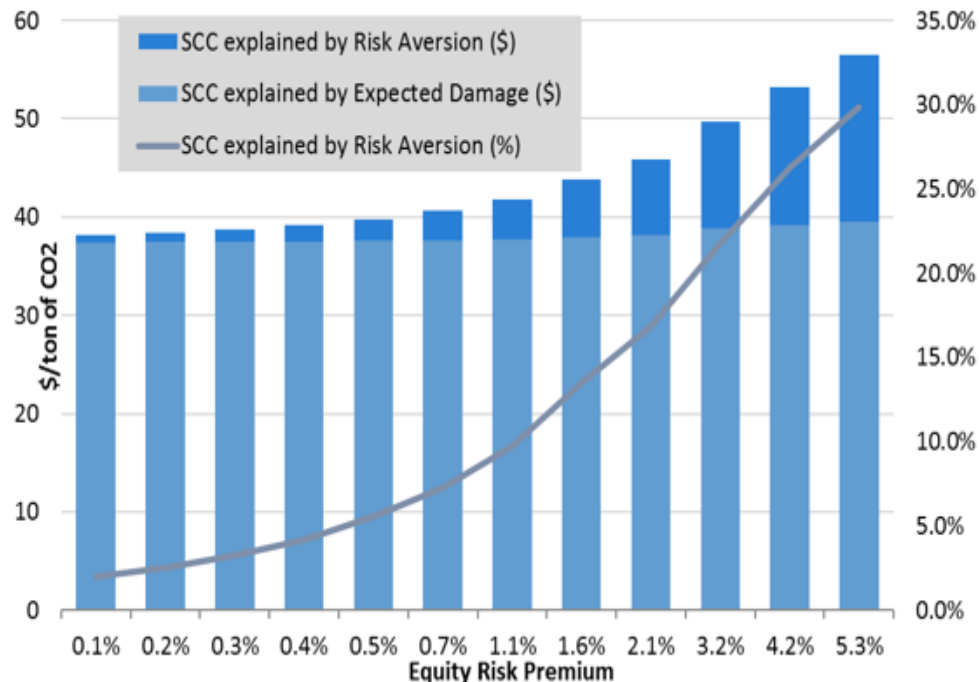


- As is well known in the macroeconomics and finance literature, these utility functions have difficulty reconciling the behavior of consumption and asset prices

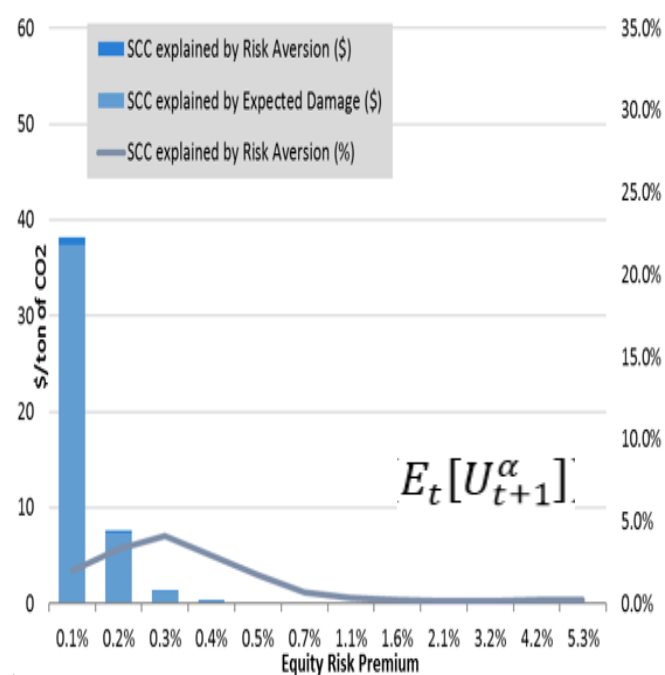
Pricing Climate Risk

Epstein-Zin utility was developed to fit the equity risk premium

Epstein-Zin utility



CRRRA utility

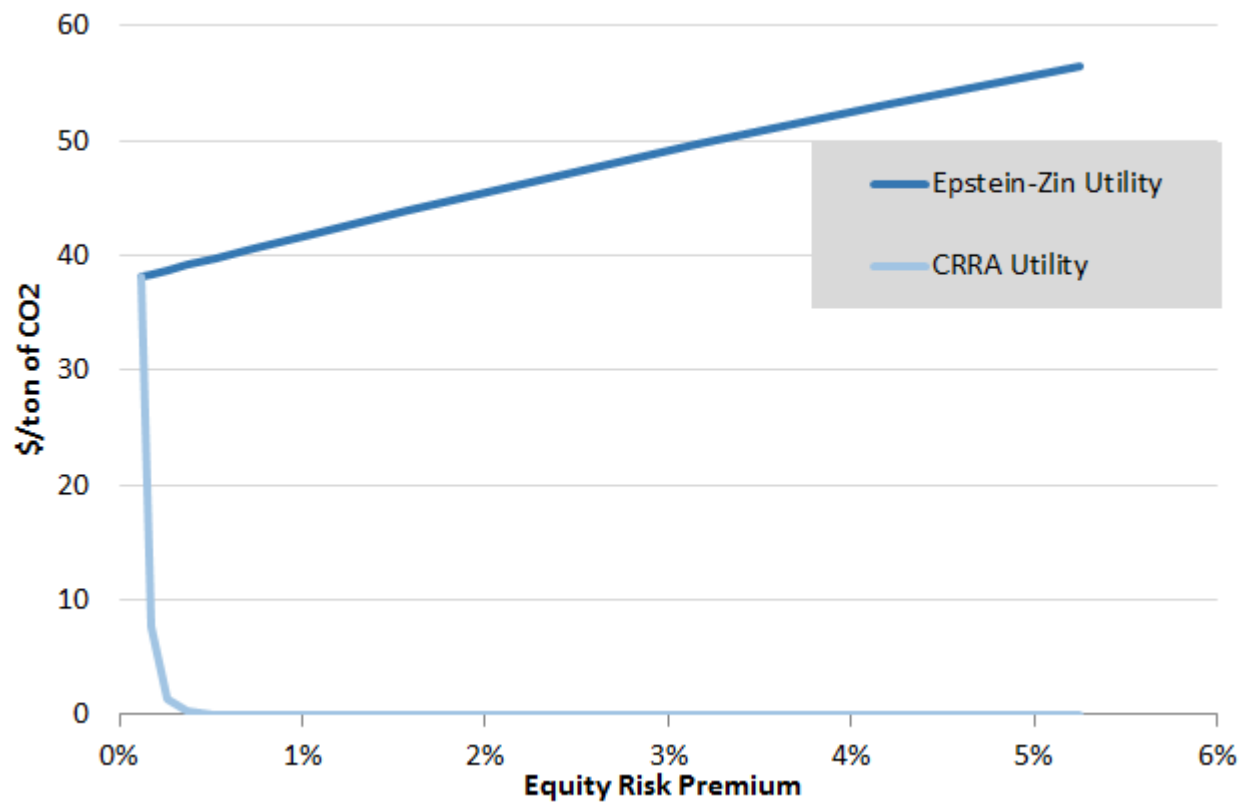


$$U_t = [(1 - \beta)c_t^\rho + \beta[(E_t[U_{t+1}^\alpha])^{1/\alpha}]^\rho]^{1/\rho} \quad ; \quad U_t = [(1 - \beta)c_t^\rho + \beta E_t[U_{t+1}^\rho]]^{1/\rho}$$

- Given the uncertainty of future climate impacts, intuition suggests that risk should play a significant role in the pricing of emissions. Given the time horizons involved, this requires a more flexible utility function that can separate risk aversion from intertemporal substitution.

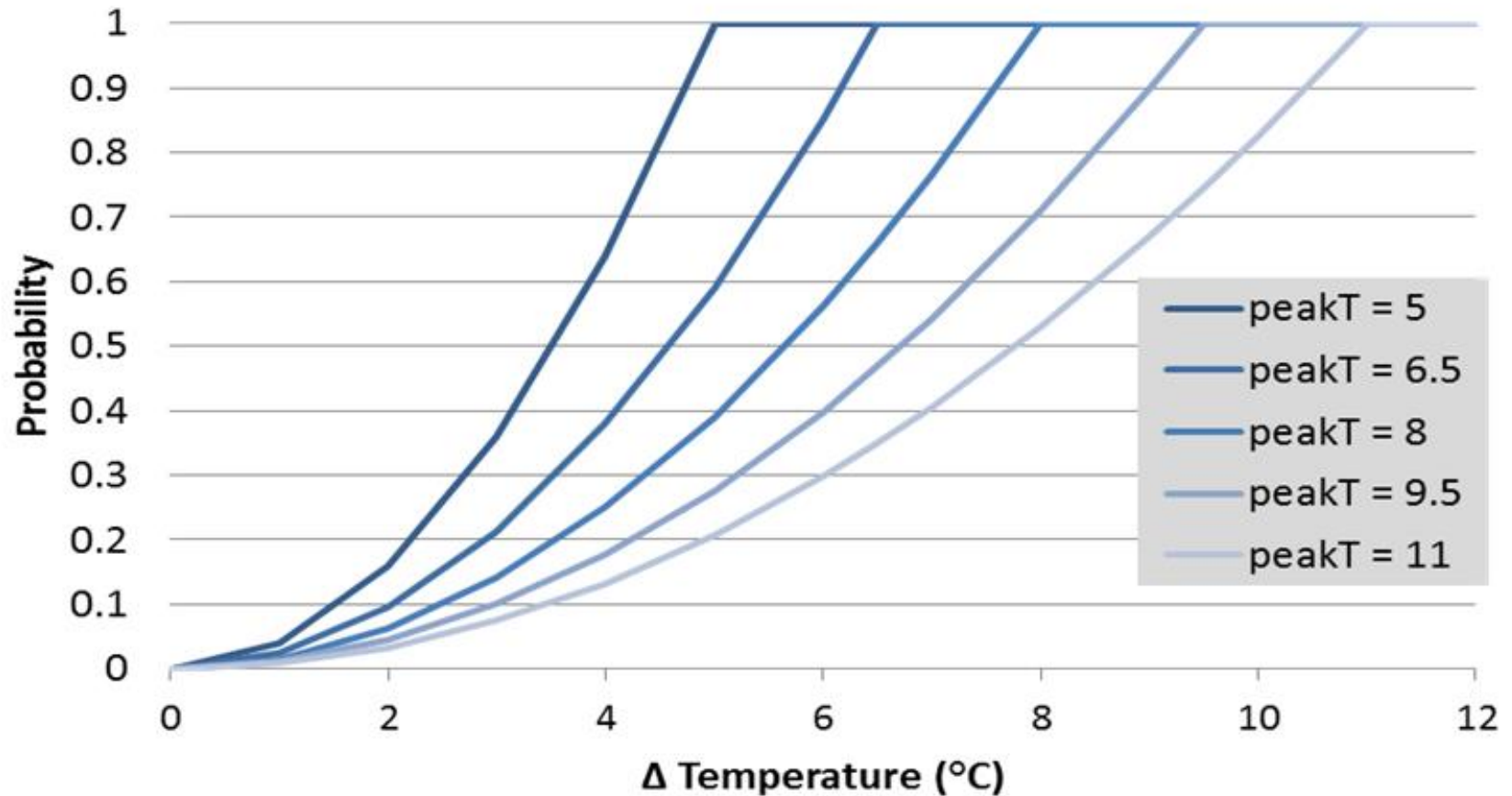
Solving the Model

Maximize representative agent's utility, using Epstein-Zin preferences

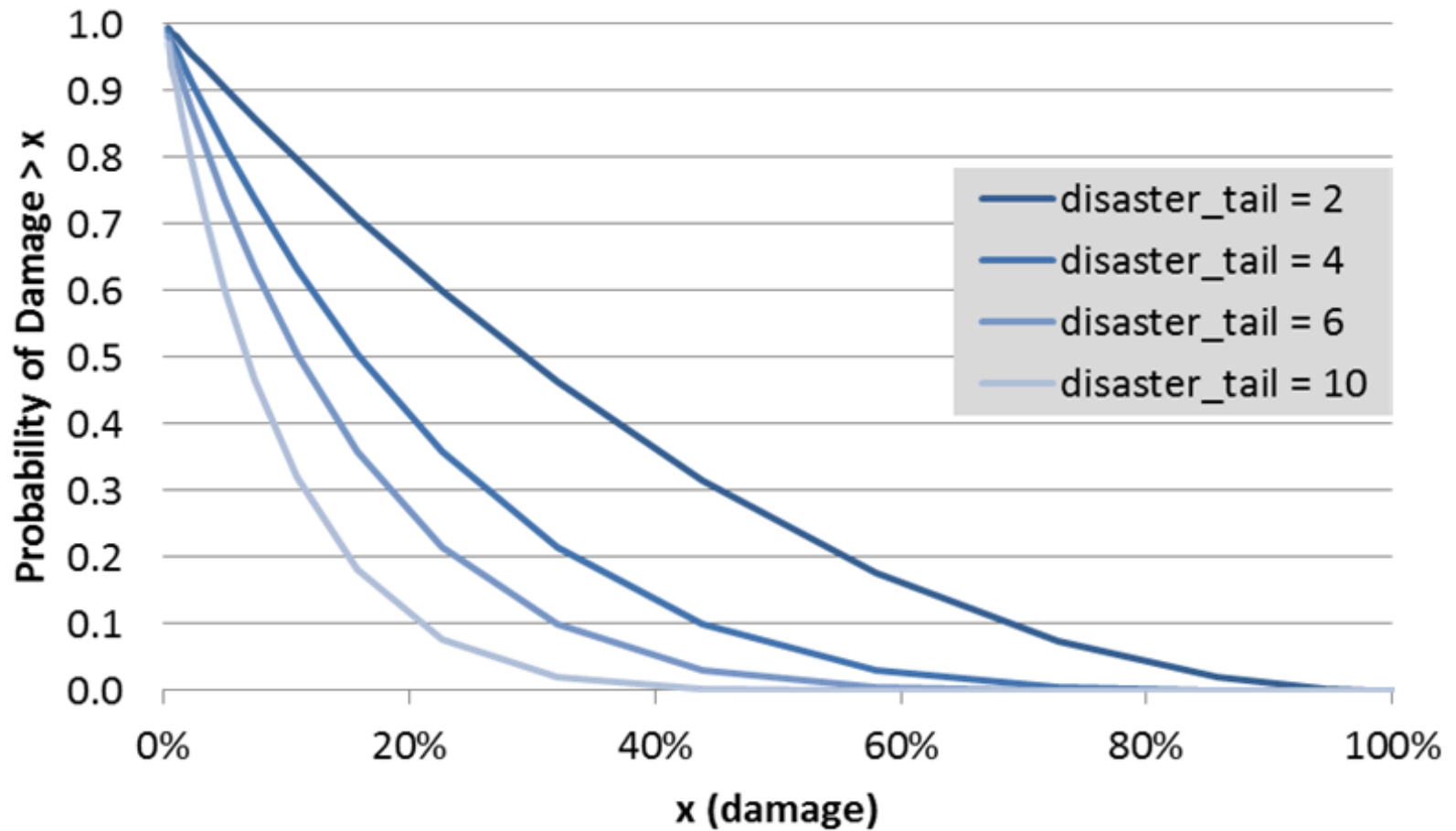


Tipping Point Probabilities

We allow for catastrophic outcomes with probabilities that rise with temperature

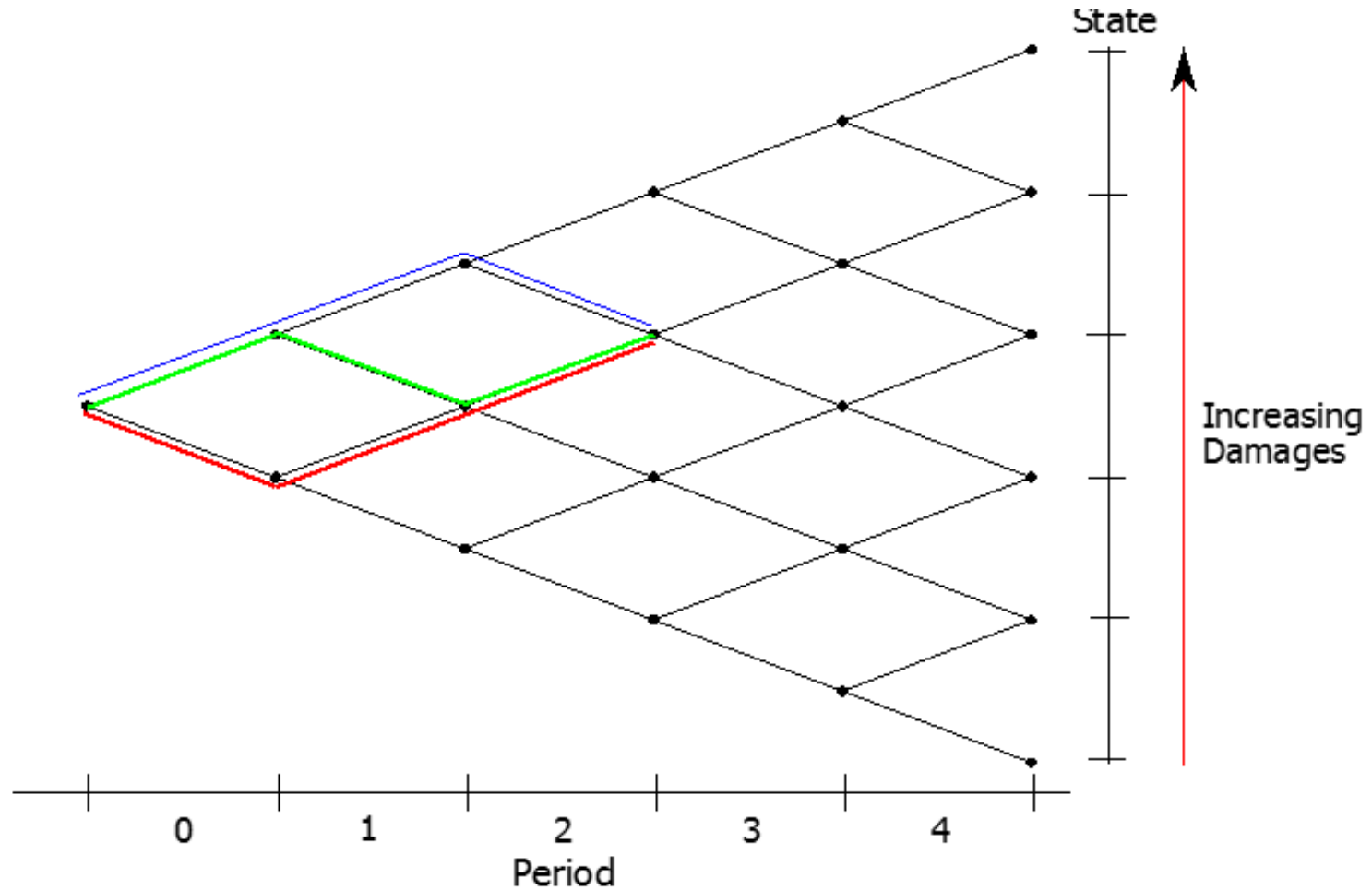


Damage Distribution Conditional on a Tipping Point



Climate Mitigation is a Problem of Optimal Control

Information about the fragility of the environment is revealed, and reacted to, over time



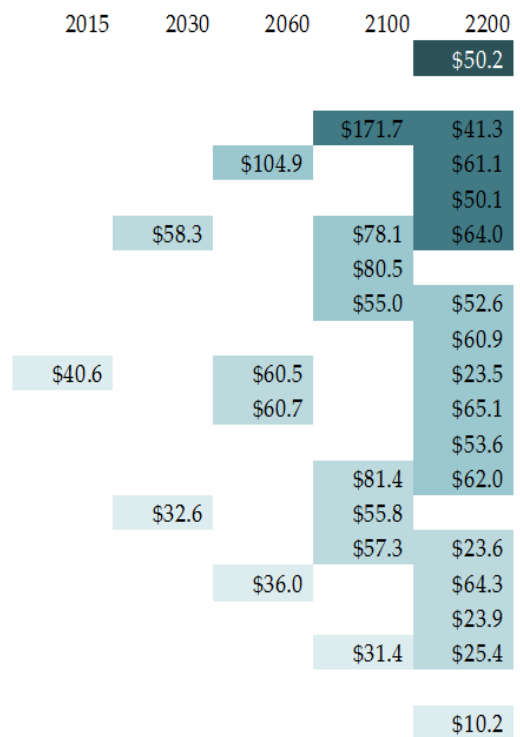
Optimization Results in the Base Case

Strong mitigation starts immediately with a price near \$40 (the USG estimate of the SCC)

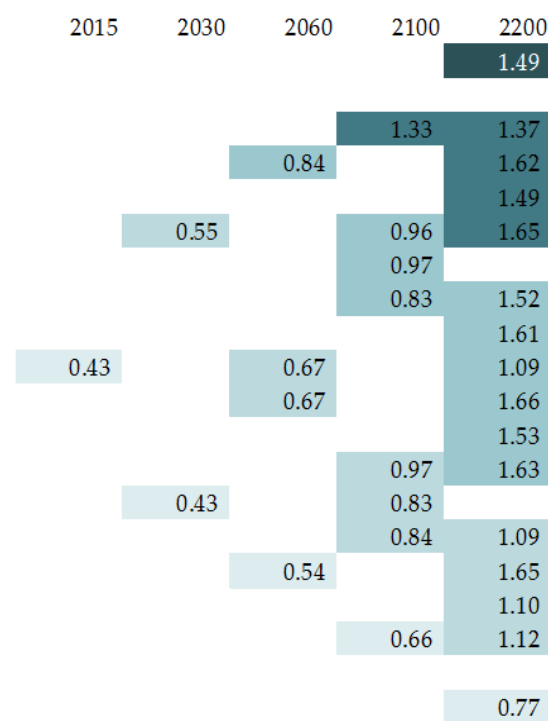
Probabilities



Emissions Price



Mitigation

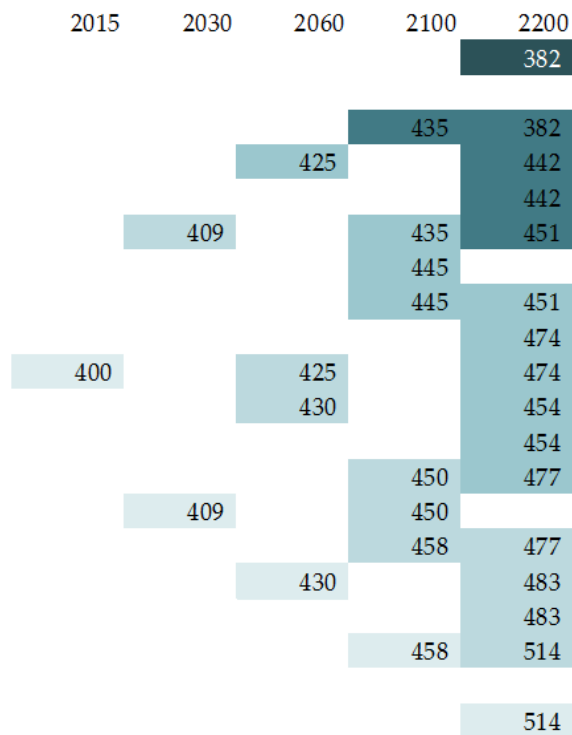


- Direct capture of carbon dioxide from the atmosphere is eventually part of the solution in almost all scenarios.

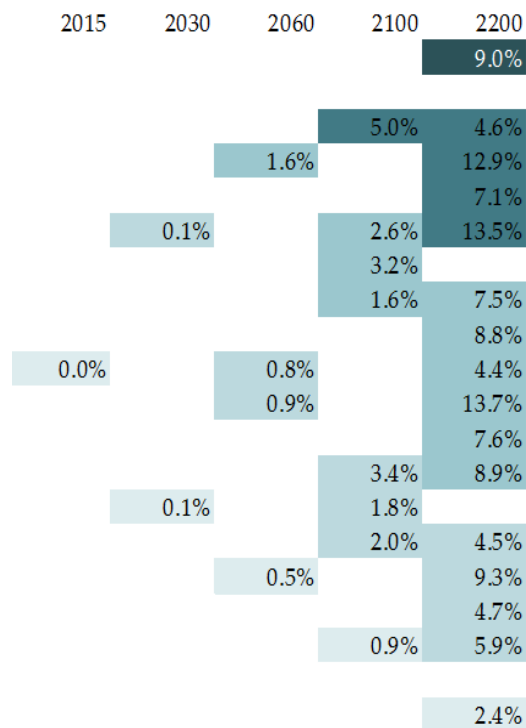
Damages Are Significant

But catastrophes are averted

Greenhouse gases (in ppm)



Damages

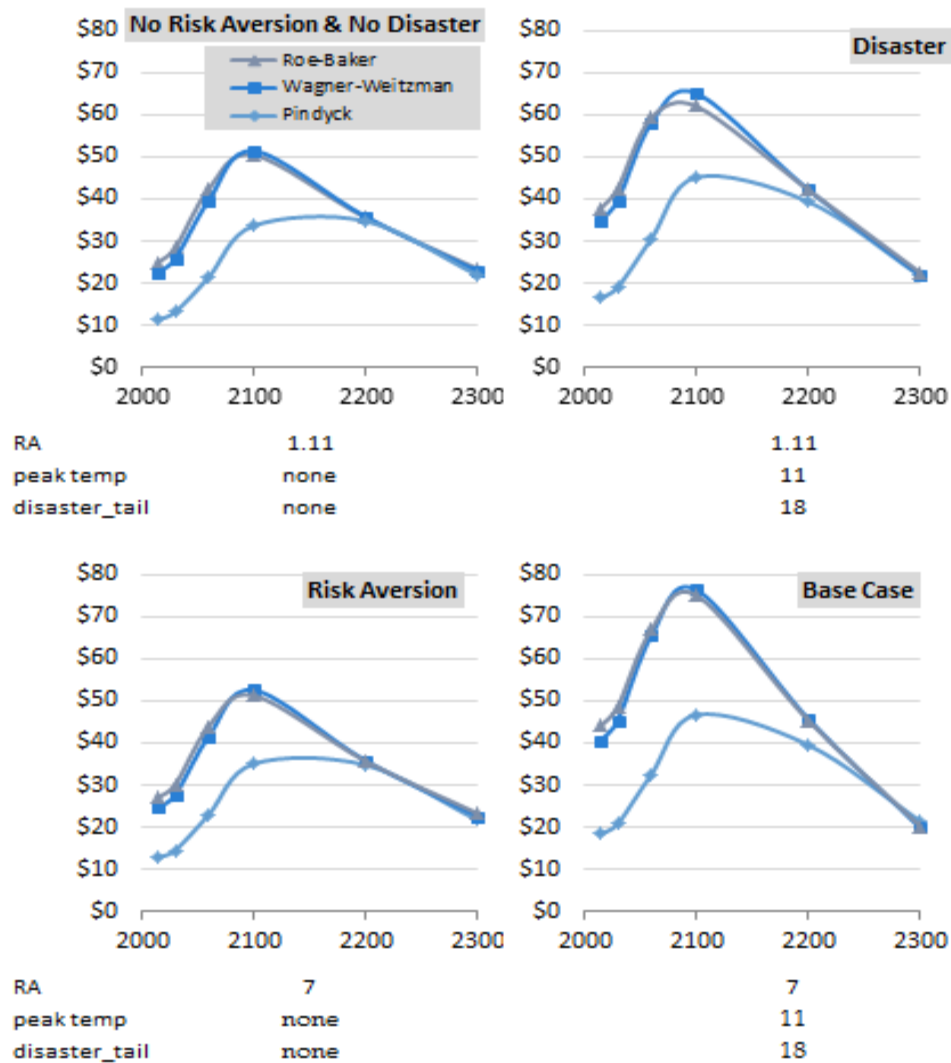


Consumption



Results – Risk Aversion & Disaster

Social cost increases with risk aversion and disaster



Exxon Lied to its Shareholders!

Think asbestos, tobacco...

Really? ExxonMobil left the risk out of its climate risk report

Natasha Lamb and Bob Litterman

Wednesday, May 28, 2014 - 4:30am

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Director of Equity
Research and
Shareholder Engage
Arjuna Capital



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ExxonMobil sign image by Taina Sahlman via Shutterstock.

Imagine cycling down a sweeping mountain road when you hit a dense patch of fog. You know there's a hairpin turn ahead that runs across the lip of a dangerous cliff, but you don't know exactly how far ahead it is. When do you start braking? And how hard do you brake over time?

The answers seem so intuitive that the questions are hardly worth asking — you'd hit the brakes immediately, and hard — but these are the fundamental questions society must ask to address the risks posed by climate change.

Exxon Continues to Exaggerate Costs of the Low-Carbon Future...

...and to underestimate the risks of climate change

Exxon Mobil

Tell the truth, ExxonMobil: a low-carbon future is affordable - and necessary

Exxon's narrative of preferring, and even encouraging, inaction in the face of climate change is the oil giant's well-established modus operandi

Natasha Lamb and Dr Bob Litterman

Sunday 31 January 2016 07.00 EST



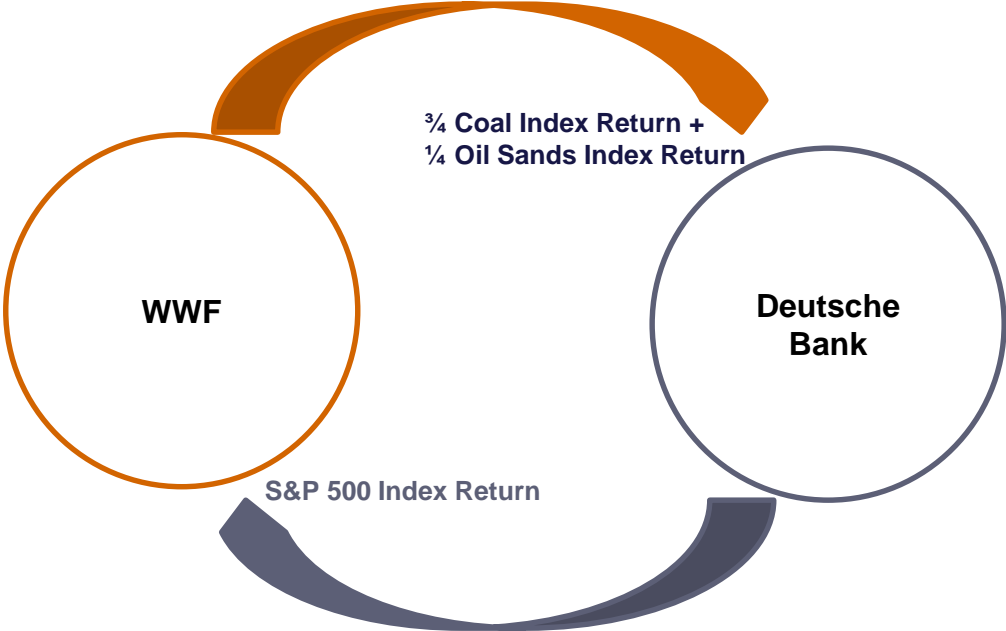
Shares Comments

2,220

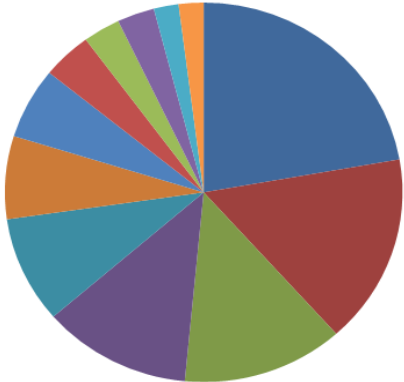
85



Stranded Assets Total Return Swap

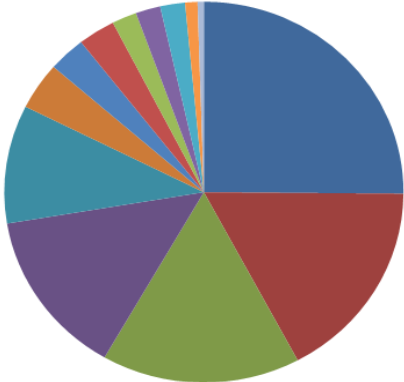


Coal index -- 12 stocks
market cap weights



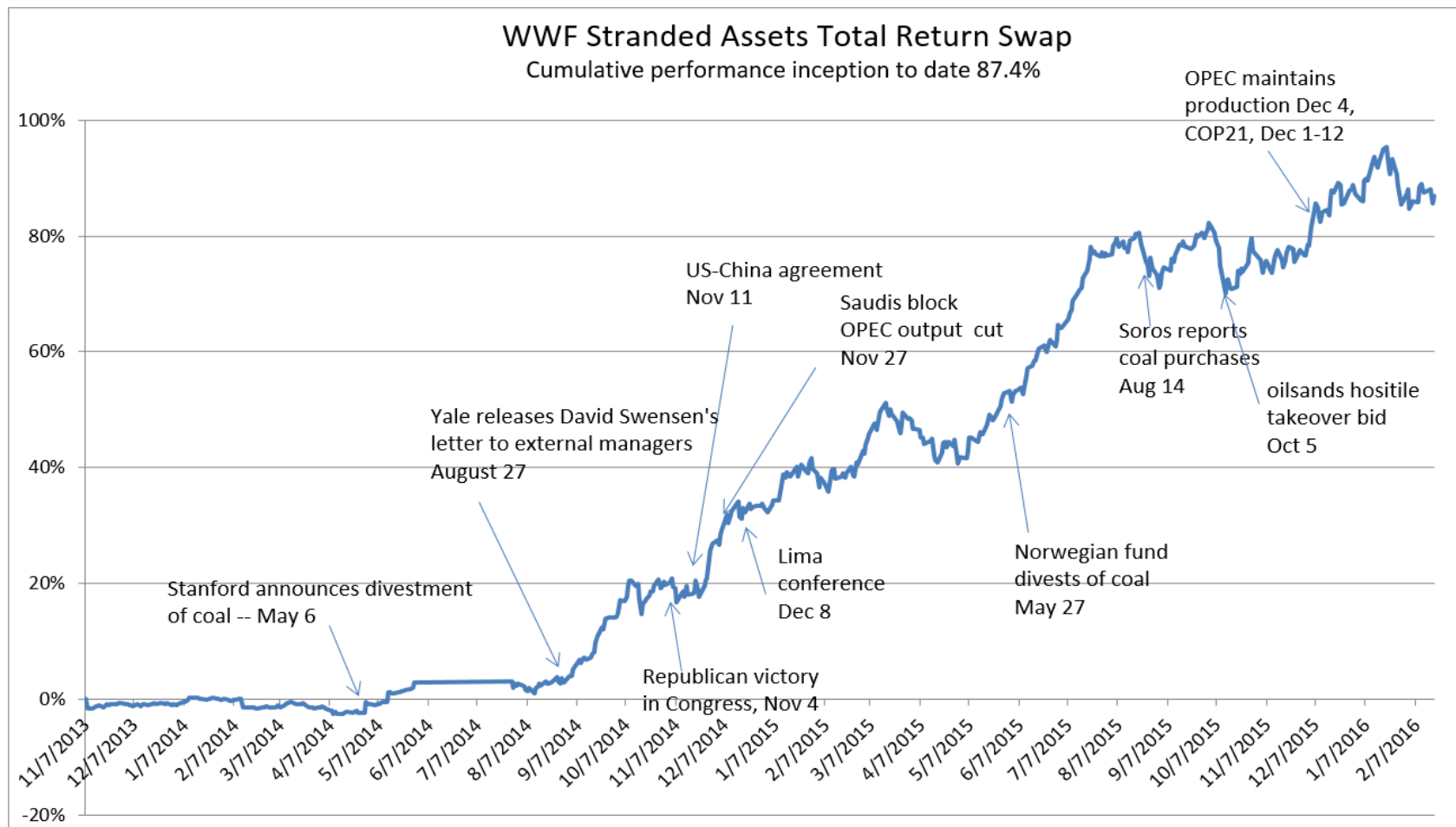
- CNX
- JOY
- BTU
- YZC
- AHGP
- ARLP
- NRP
- ANR
- SXC
- WLT
- CLD
- ACI

Oil sands index -- 13 stocks
market cap weights



- SU
- IMO
- CNQ
- HSE.TO
- CVE
- COSWF
- MEG.TO
- PWE
- BTE
- POU.TO
- PGH
- ATH.TO
- PXX.TO

Increasing Expectations of Emissions Pricing?



- Stranded Assets underperformed the S&P 500 by 33% last year
- In the previous 3 years, the annualized underperformance was 18%

Aviation – An Opportunity to Create a Global Price for Emissions?

- **Aviation has promised:**

- A “market-based measure” (MBM) to reduce emissions
- But seems to have no intention to create appropriate incentives

- **Aviation will need capacity to create emissions**

- Requires high energy content of liquid fuel for takeoff and ascent
- Atmosphere’s capacity to safely absorb emissions is limited
- Thus aviation has a special incentive to lead on this issue

- **Owners of aviation shares have an important role to play**

- Management often focuses too much on short term profits
- Long-term owners have longer term priorities, such as creating appropriate global incentives to reduce emissions

- **Asset owners and MIT are leading an Engagement with the Aviation Sector**
 - The International Civil Aviation Organization has agreed to create a “Market Based Measure” (MBM) to reduce emissions

- **Today the aviation industry has no intention of pricing emissions appropriately in its “market-based measure”**

- **The current aviation plan is inadequate and is a wasted opportunity**
 - The Aviation MBM will be the world’s first globally harmonized emissions price
 - It is critically important that this benchmark appropriately reflect the economic externality

- **Global asset owners are asking that “science, economics and investors” have a seat at the table in the design of the first globally harmonized emissions price**