Pricing Climate Risk In Markets

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Climate Change

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Bob Litterman

Senior Partner, Kepos Capital

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Financial Risk Management

Provides four lessons for addressing climate change

- Risk management requires consideration of worst case scenarios
- A growing risk is an urgent priority; time is of the essence
- The purpose of risk management is not to minimize risk, it is to price risk appropriately
- Risk is what we measure; uncertainty is what we manage

Consider the Johnstown flood of 1889

The earth's atmosphere is a reservoir

We are filling it with greenhouse gases

No one knows what level is safe, or what the consequences will be if we cross a tipping point

The lesson is this:

Certain actions are inherently dangerous, such as filling a reservoir

If a catastrophe occurs it does not matter if the particular scenario was anticipated

Those who fill a reservoir are strictly liable for the consequences of their actions

Economists Use Models To Estimate The Damage Created by Carbon Emissions

Applying Asset Pricing Theory to Calibrate the Price of Climate Risk

Kent Daniel*, Robert Litterman† & Gernot Wagner‡

(NBER 2016; Published in PNAS, 0ctober 2019)

* † Kepos Capital ‡ HARVARD JOHN A. PAULSON SCHOOL OF ENGINEERING AND APPLIED SCIENCES

Two Questions Motivate This Research

- How serious is the risk from climate change?
  - We find the risk is very serious
  - In our base case CO_2 emissions should be priced today at $126. per ton, reducing current consumption by approximately 4.3%
  - Global emissions would be dramatically reduced (70% over 15 years)

- How costly is a delay in implementing appropriate policy?
  - Delay wastes the unknown remaining carbon budget, and is incredibly costly
  - For example, 5-year delay in pricing climate risk creates a deadweight loss of utility equivalent to 11% of global consumption during that period of delay
  - Moreover, the deadweight loss created by delay grows with the square of time

Source: Daniel, Litterman & Wagner (NBER 2016; latest version: October 2017)

Why Are Our Answers Dramatically Different Than Other Economic Models?

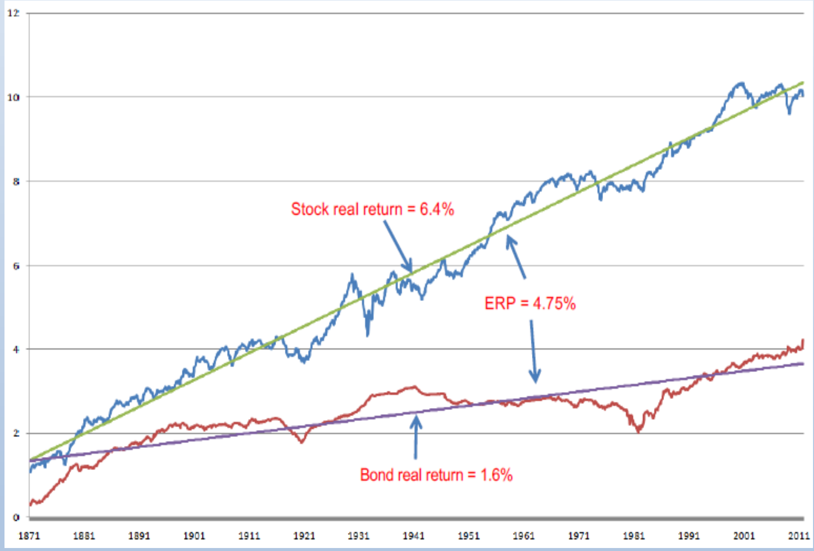
- Standard models are inconsistent with asset pricing theory
  - they don't adequately take risk into account
  - they use arbitrary discount rates to present-value expected damages
  - their policies do not respond to revelation of new information
  - they don't search for an optimal policy
- In contrast, we search for an optimal emissions pricing policy in the context of an uncertain future that includes potential tipping points with catastrophic outcomes, and which is consistent with the pricing of both risk free and risky cash flows in financial markets

Source: Daniel, Litterman & Wagner (NBER 2016; latest version: October 2017)

Increased Risk Aversion Increases the Optimal CO_2 Price

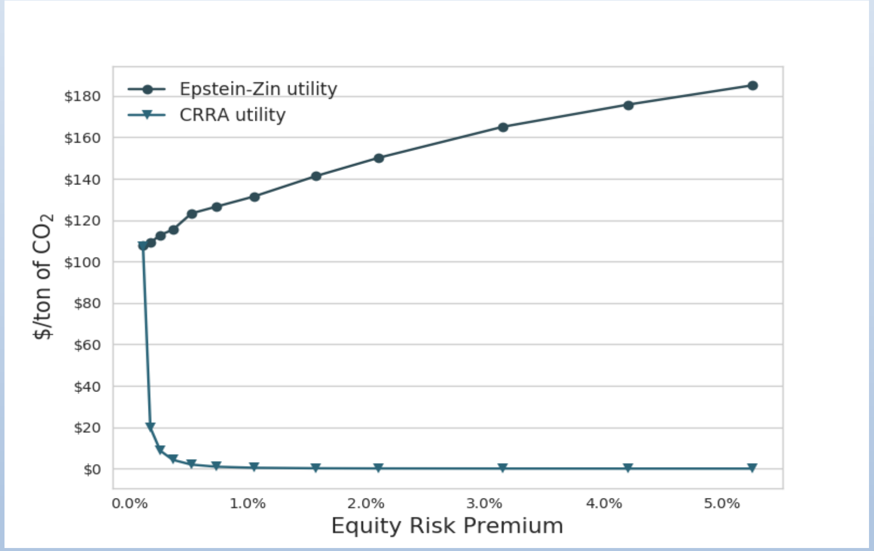
With CRRA utility, high risk aversion implies a high discount rate which implies lower optimal CO_2 price

Log real return for stocks and bonds with fitted trend lines



Source: Return data from Shiller (2000) and since continuously updated: http://www.econ.yale.edu/~shiller/data.htm

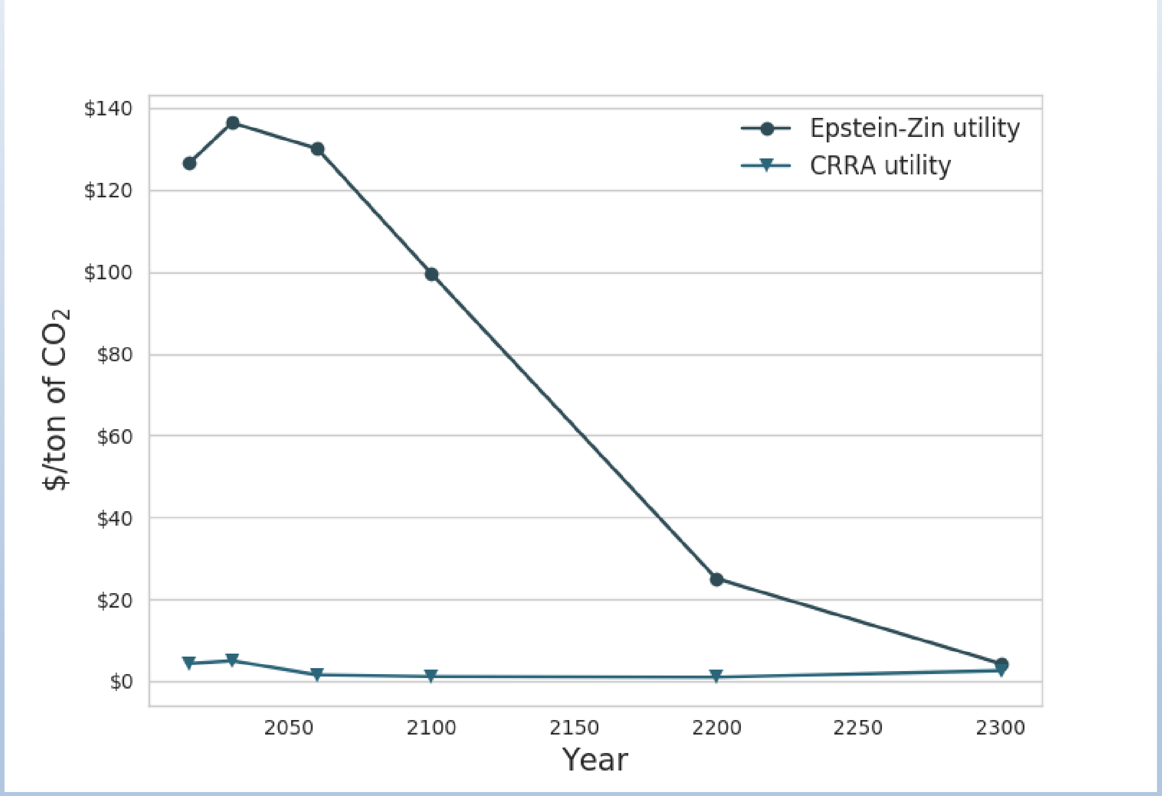
Epstein-Zin utility separates risk across time and states of nature



Source: Daniel, Litterman & Wagner (NBER 2016; latest version: October 2017)

Optimal CO_2 price declines over time

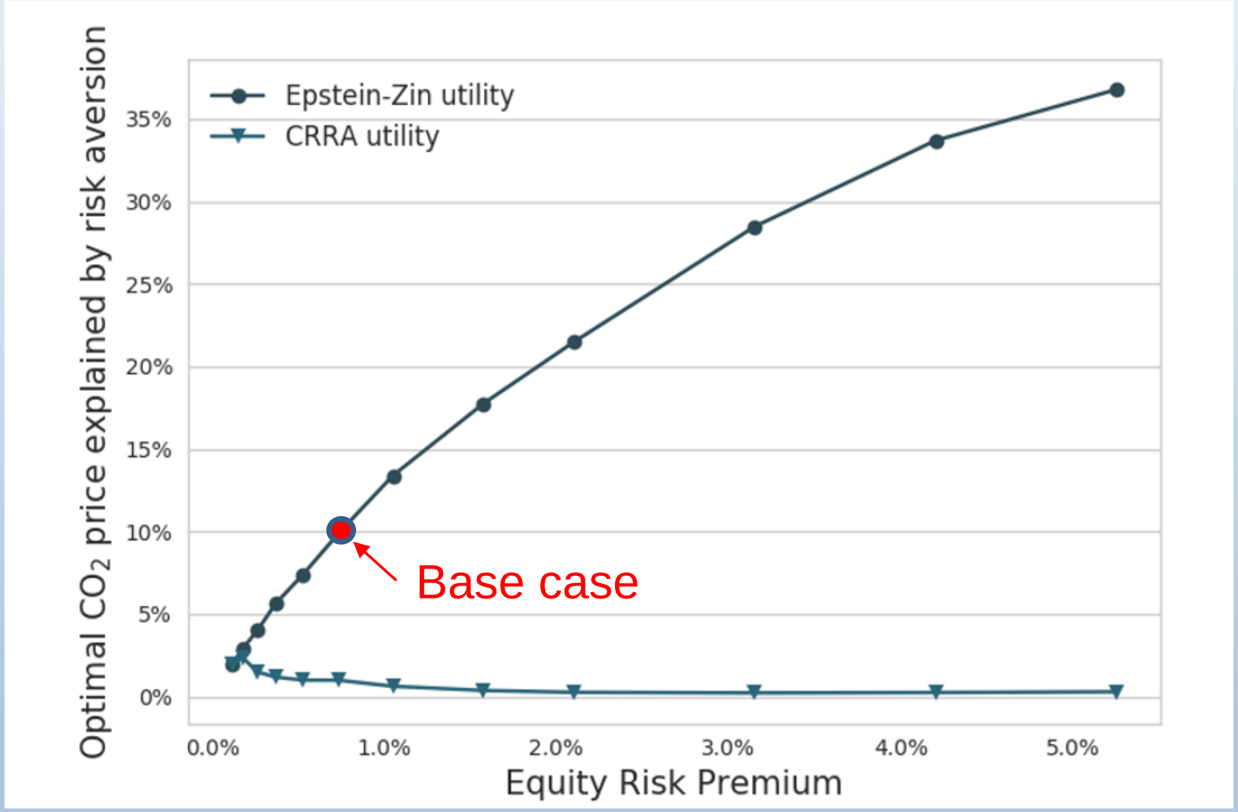
Optimal price starts $>100, declines as uncertainties clear up



Source: Daniel, Litterman & Wagner (NBER 2016; latest version: 2017)

Epstein-Zin utility allows the risk premium to play a significant role

Though in our base case it only contributes 10% to the total price



Source: Daniel, Litterman & Wagner (NBER 2016; latest version: 2017)

Very High Social Cost of Delay

Cost of delay increases with roughly the square of time

First-period length	Annual consumption cost equivalent of the deadweight loss in utility from delay in pricing emissions
5 years	11%
10 years	23%
15 years	36%

Each year of delay causes the equivalent consumption loss *over the entire first period* to increase by roughly 2.3%

Source: Daniel, Litterman & Wagner (NBER 2016; latest version: 2017)

The Revaluation of Fossil Fuel Assets is in Progress

Seven years ago WWF executed a stranded asset total return swap

The stranded assets: coal, tar sands, and expensive sources of oil, have underperformed the market by over 15% per year