

Research and Policy: A Golden Minnesota Partnership  
Celebrating 50 years of economic revolution

## Climate Change Panel

*Bob Litterman*

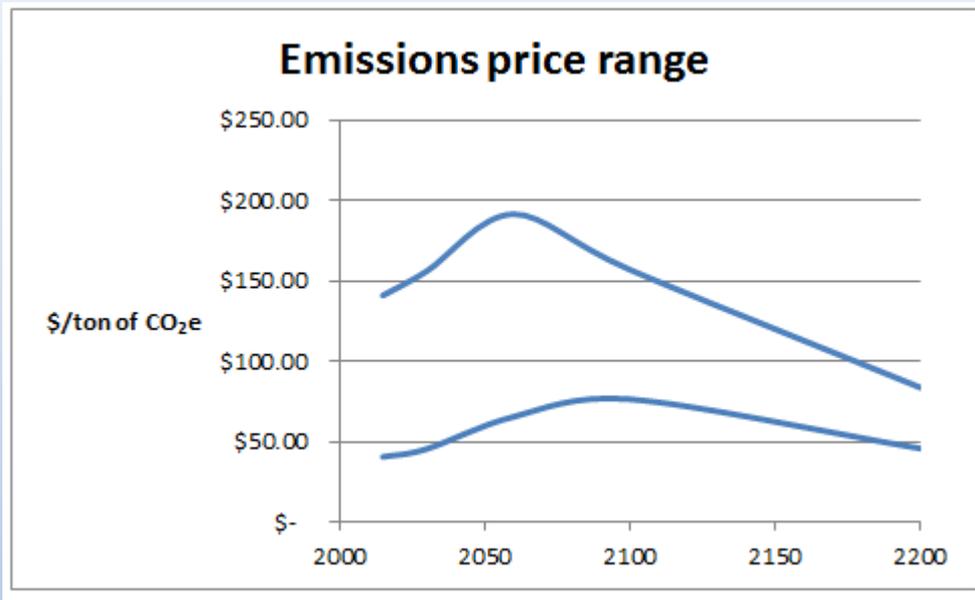
*FRB Minneapolis*

*August 23, 2019*

# Research:

- Emissions create risk of negative impacts on future well-being
- The solution is to price this risk -- that is, to create appropriate incentives to reduce emissions
- Carbon pricing is an asset pricing problem
  - emissions create random negative cash flows in the future
  - the marginal utilities in different states of nature impact the discount rate
  - worst case outcomes get more weight
- Carbon pricing is also a dynamic optimal control problem
  - emissions prices should evolve to reflect all information at each point in time
- Uncertainties abound

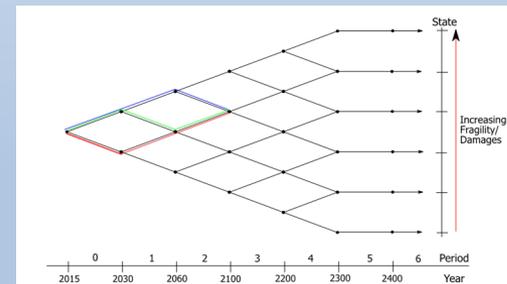
# What is the right price path for emissions?



Over time prices will be driven primarily by the revealed fragility of the environment and the rate of technological change, particularly with respect to the cost of direct air capture of carbon dioxide at scale (which more or less creates an upper bound)

Increased uncertainty and higher risk aversion both increase the appropriate emissions price

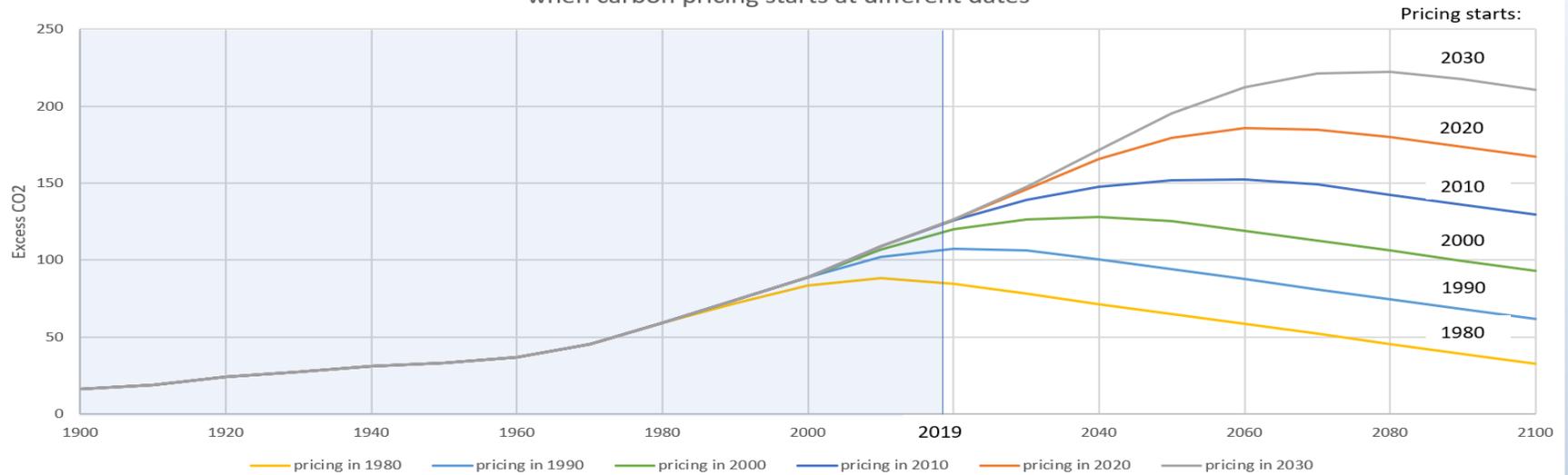
This graph illustrates an expected range, but the actual path should respond to new information



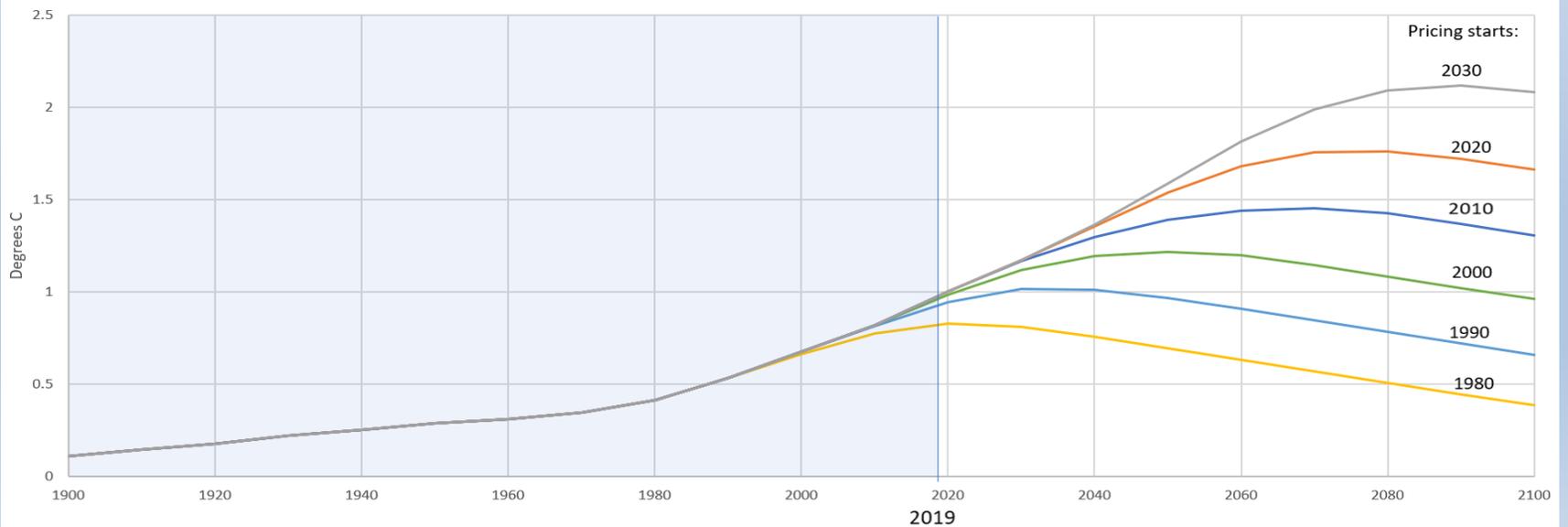
We use a tree structure similar to those used to price options

# Understanding the cost of delay

Carbon dioxide impulses  
when carbon pricing starts at different dates



Cumulative warming over time



# Pricing Carbon is an Urgent Priority

In a model we can translate the deadweight loss created by a delay in pricing into the dollar equivalent impact on utility

**Delay in Pricing | Required compensation**

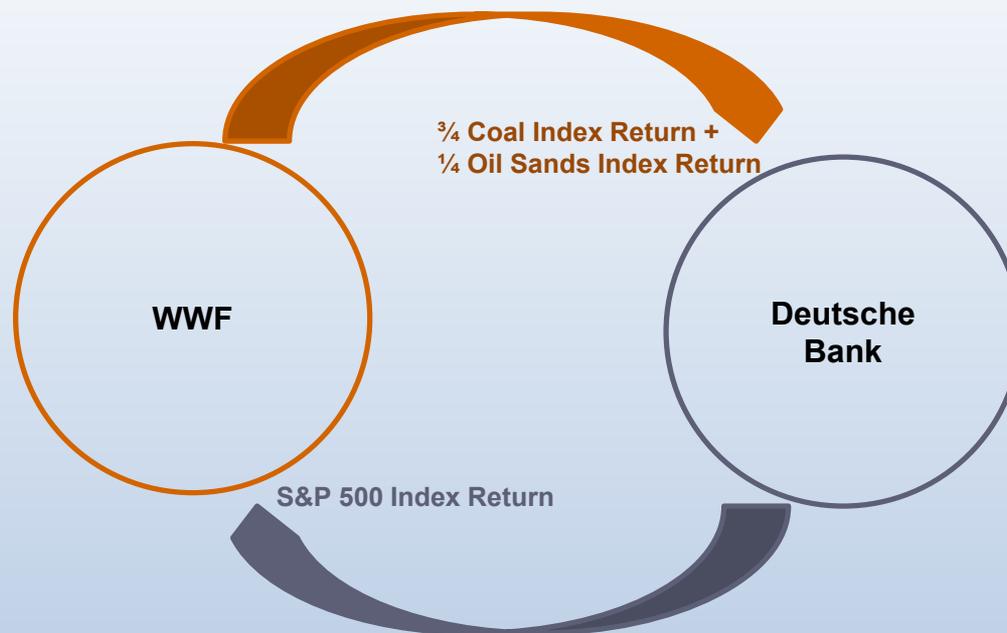
**1-year delay -> \$700 billion (2% of annual consumption)**

**5-year delay -> \$17 trillion (half of annual consumption)**

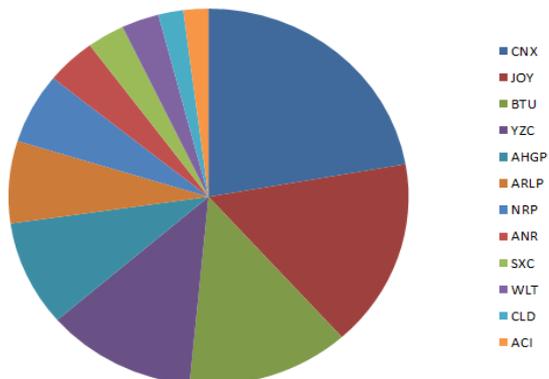
**10-year delay -> \$70 trillion (twice annual consumption)**

The consumption required to compensate for delay in pricing carbon is surprisingly large and grows with roughly the square of time

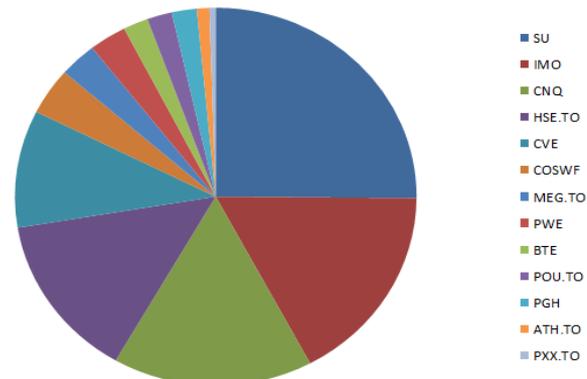
# WWF stranded assets total return swap



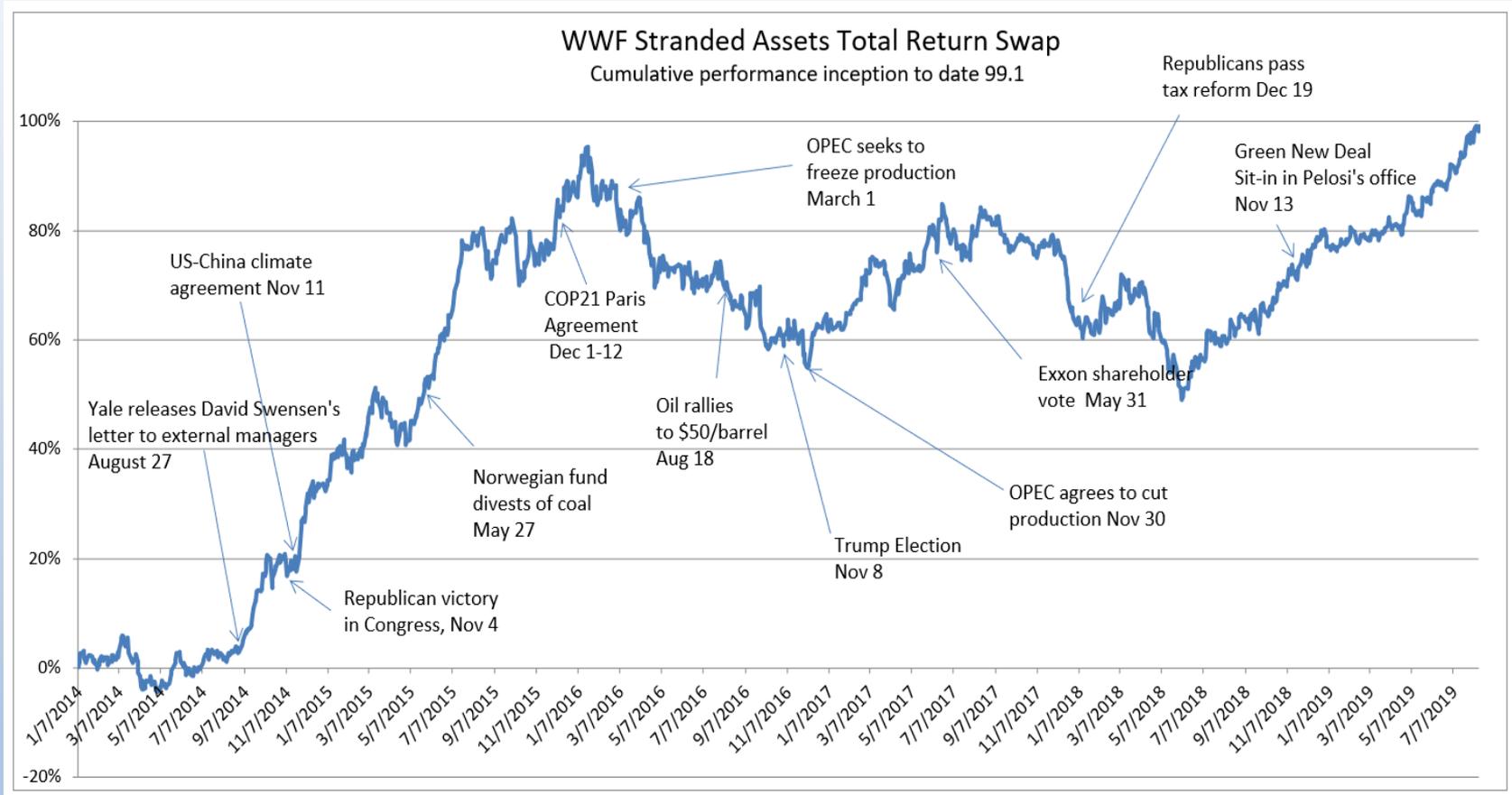
Coal index -- 12 stocks  
market cap weights



Oil sands index -- 13 stocks  
market cap weights



# Increasing expectations of emissions pricing?



- Stranded Assets have underperformed the S&P 500
- At a rate of more than 13% annually since Jan 2014

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# Policy:

U.S. Federal carbon pricing legislation

Climate Leadership Council carbon dividend plan

- 1.) a gradually increasing price
- 2.) revenues returns via a per-capita carbon dividend
- 3.) border carbon adjustments
- 4.) regulatory simplification

International Coordination and Governance

Enhanced Corporate Disclosure