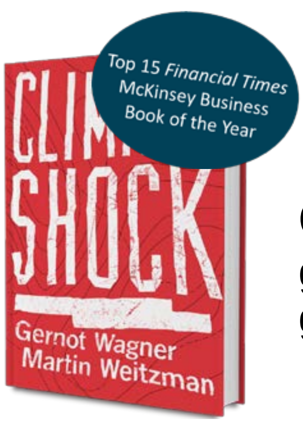
Confronting Deep and Persistent Climate Uncertainty



Gernot Wagner
gwagner@fas.harvard.edu
gwagner.com

Richard J. Zeckhauser
richard_zeckhauser@harvard.edu
hks.harvard.edu/fs/rzeckhau

1.5 – 4.5°C

3°C

1.5 – 4.5°C

3°C

* Charney *et al* (1979)

1.5 – 4.5°C

3°C

* IPCC (1990)

1.5 – 4.5°C

3°C

* IPCC (1990, 1992)

1.5 – 4.5°C

3°C

* IPCC (1990, 1992, 1995)

1.5 – 4.5°C

3°C

* IPCC (1990, 1992, 1995, 2001)

2.0 – 4.5°C

3°C

* IPCC (2007)

1.5 – 4.5°C

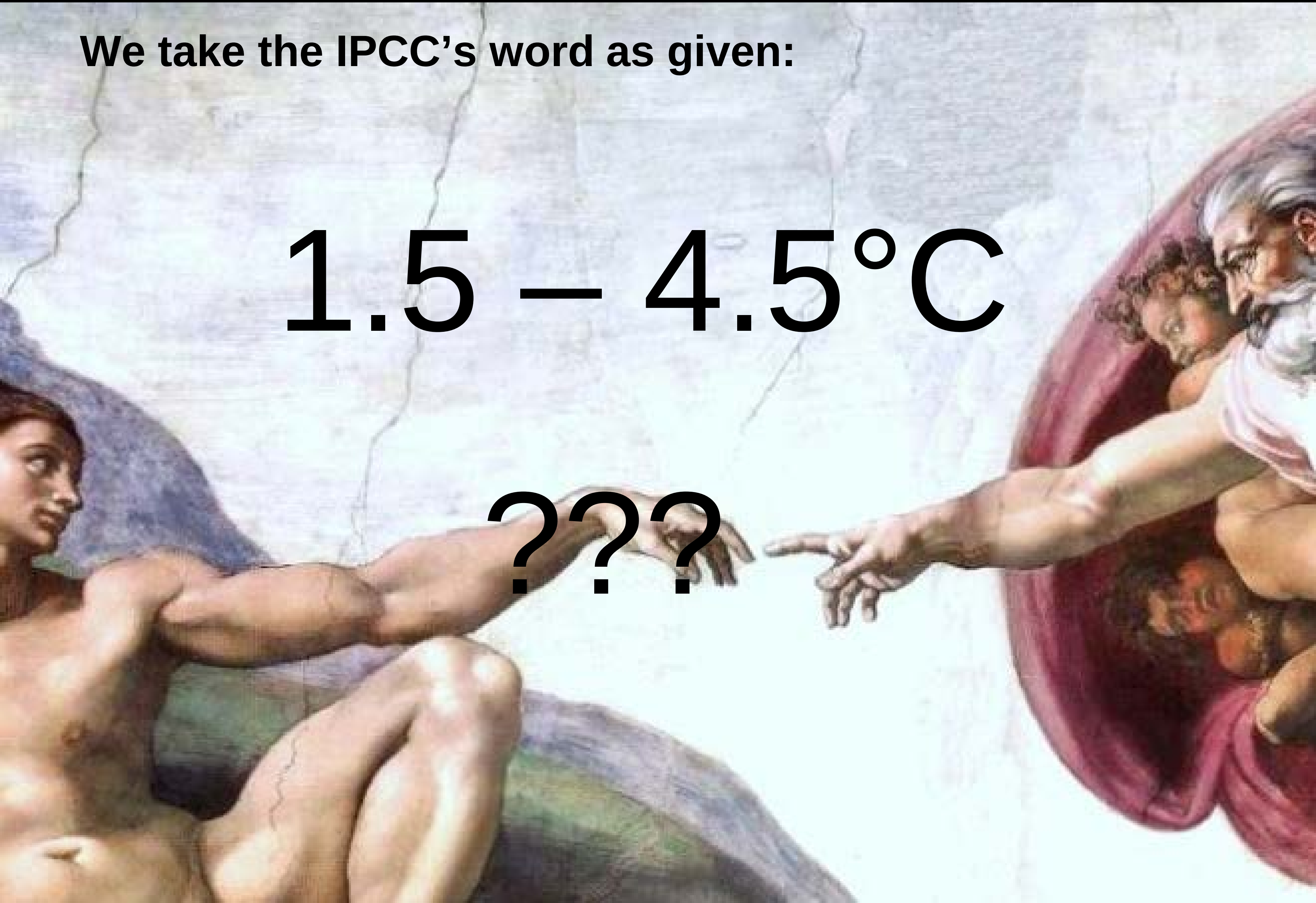
???

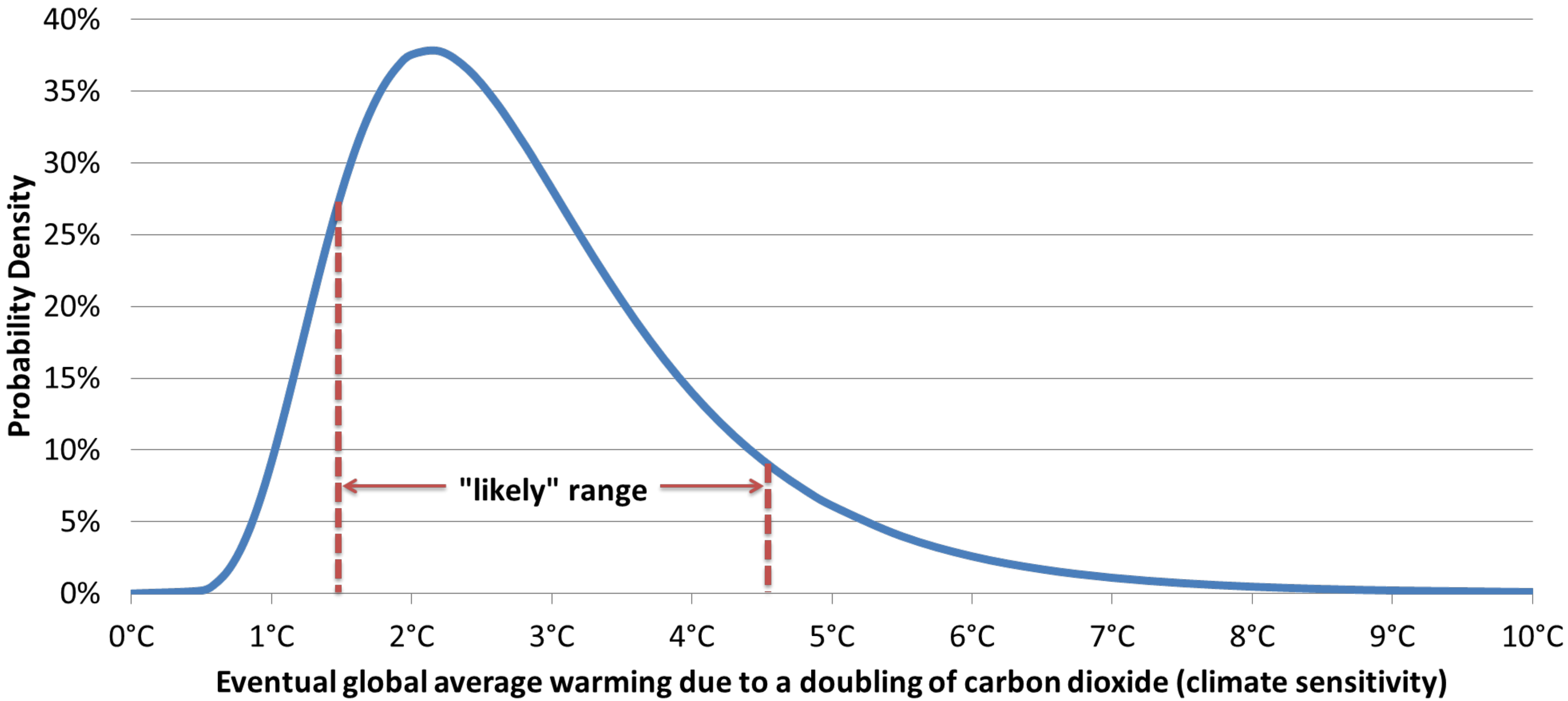
* IPCC (2013)

We take the IPCC's word as given:

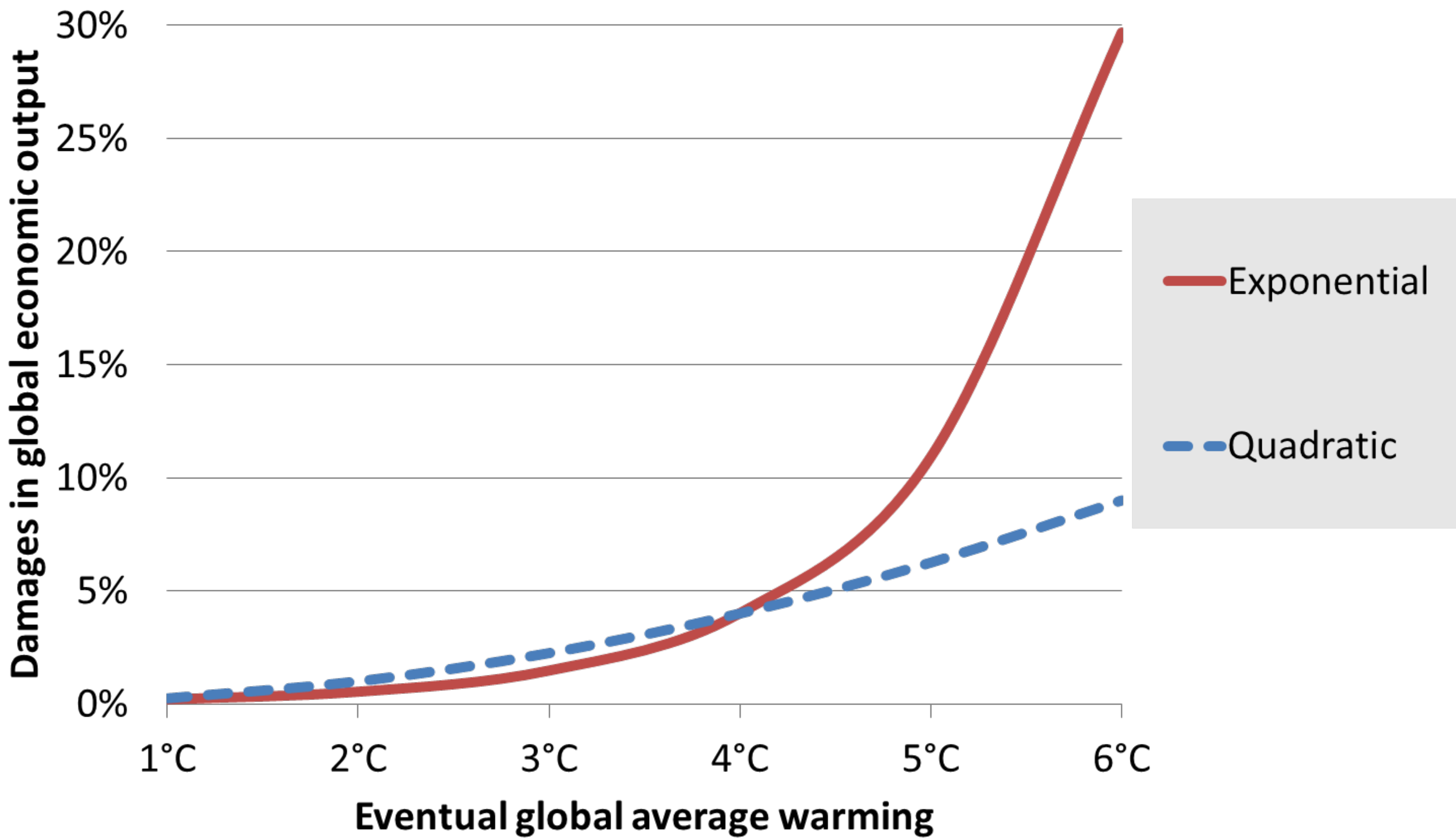
1.5 – 4.5°C

???





Source: Wagner & Weitzman's *Climate Shock* (2015), Wagner & Zeckhauser working paper



Source: Wagner & Weitzman’s *Climate Shock* (2015), Wagner & Zeckhauser working paper

The mean-standard deviation tradeoff (1/2)

Illustrative thought experiment

- If best guess is 3°C, and we draw

  a) 3°C
  b) 3.01°C
  c) 4.5°C

  it's easy to see how it's

  a) Good
  b) Good
  c) Bad

The mean-standard deviation tradeoff (2/2)

Illustrative thought experiment

- If best guess is 3°C, and we draw

  a) 3°C
  b) 2.99°C
  c) 1.5°C

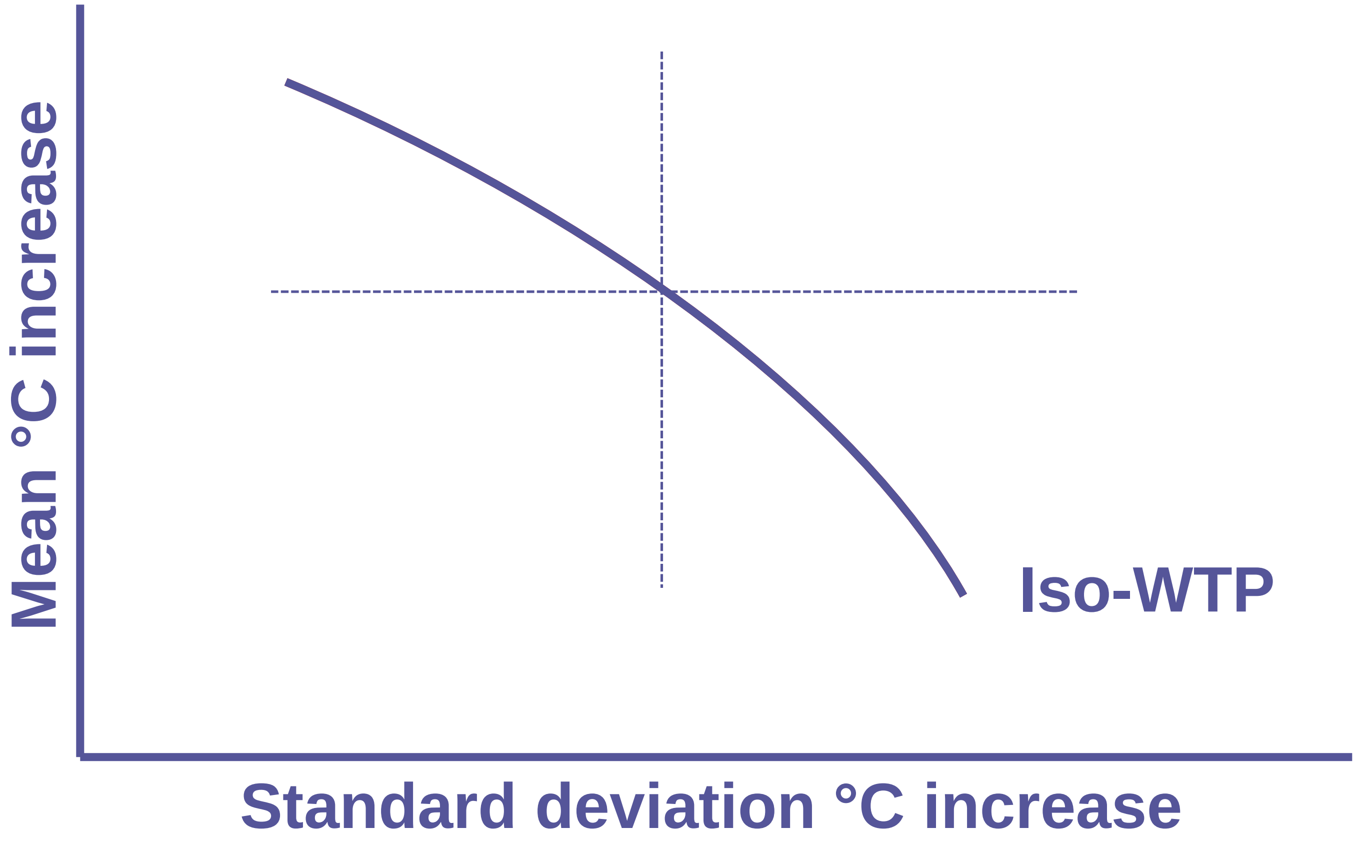
  it may still be

  a) Good
  b) Good
  c) Bad

1.5°C draw is unlikely to tell all, increasing fear of further uncertainties

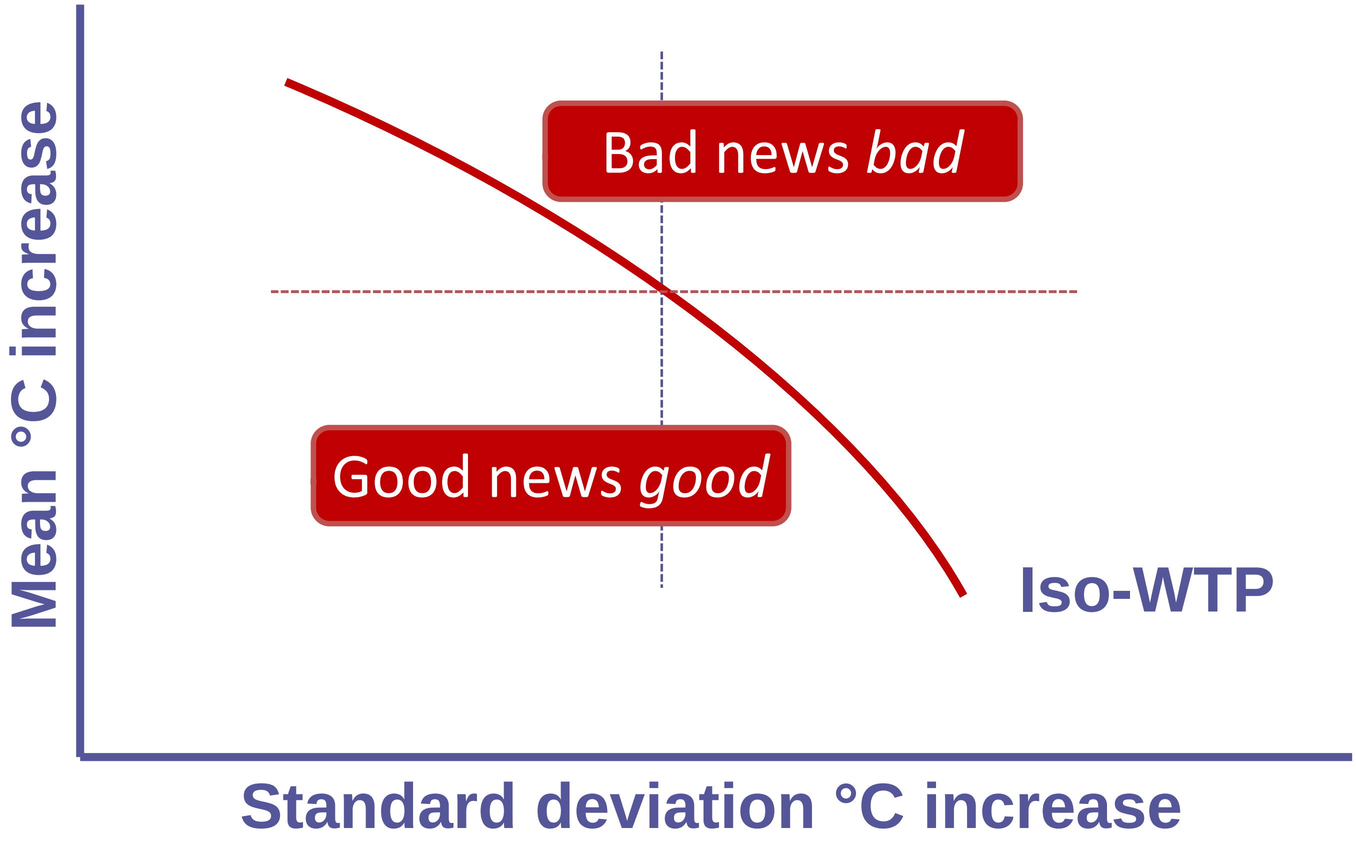
The mean-standard deviation tradeoff illustrated

Schematic, following Pindyck (2012)



The mean-standard deviation tradeoff illustrated

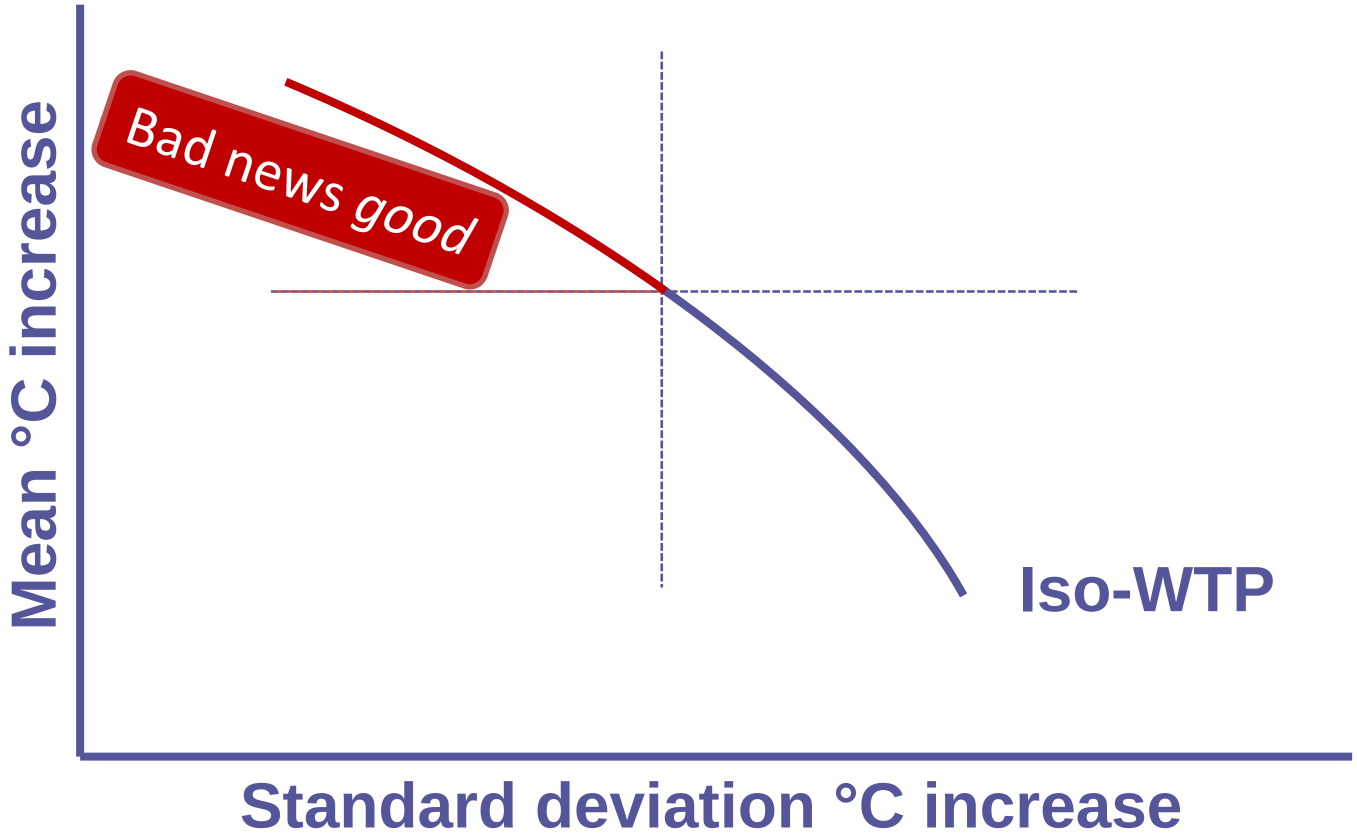
Schematic, following Pindyck (2012)



Mean and WTP move in the same direction

The mean-standard deviation tradeoff illustrated

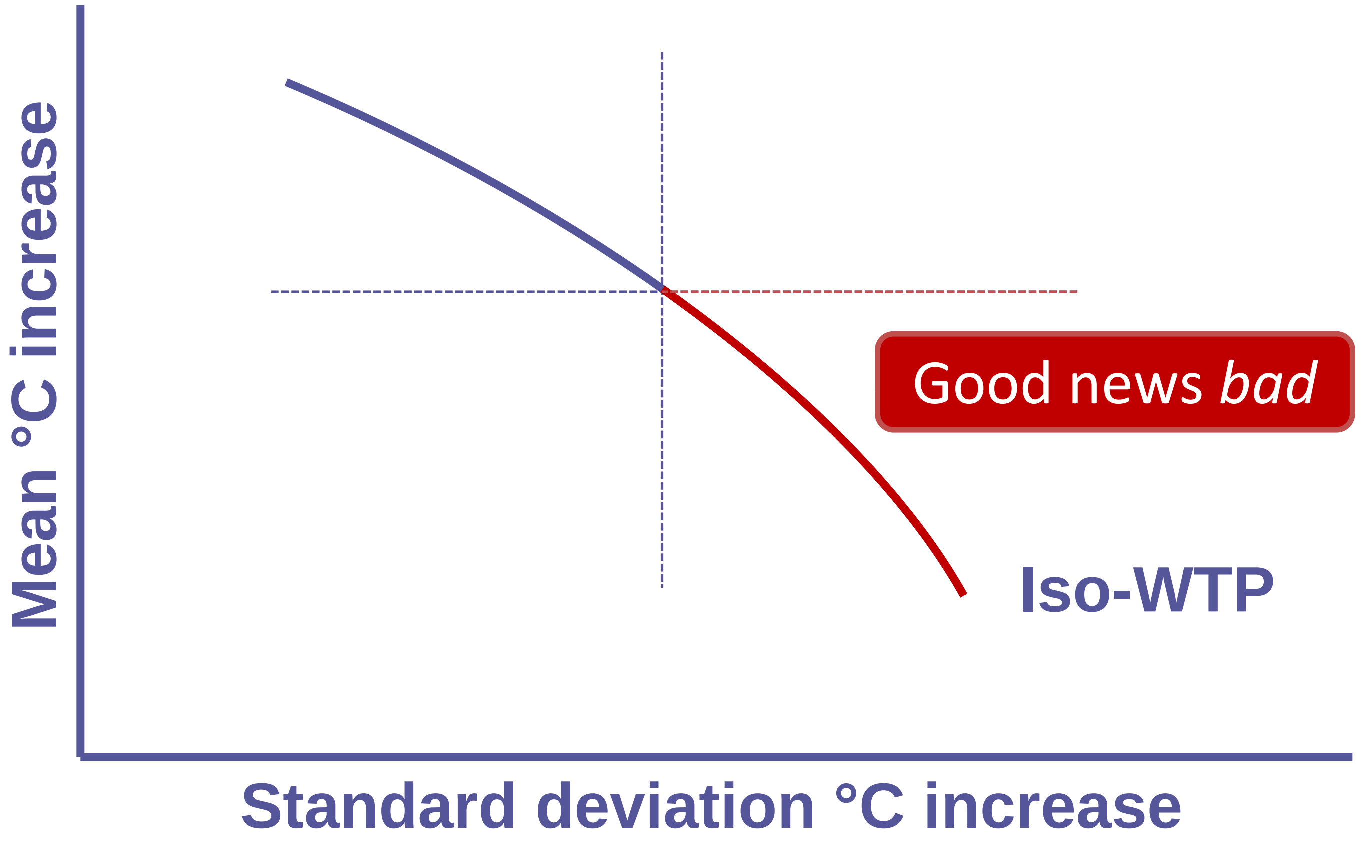
Schematic, following Pindyck (2012)



Mean goes up, yet WTP goes down

The mean-standard deviation tradeoff illustrated

Schematic, following Pindyck (2012)



Mean goes down, yet WTP goes up

Willingness-to-pay (WTP) as simple (simplistic?) measure

How much to avoid climate damages?

Modeling approach:

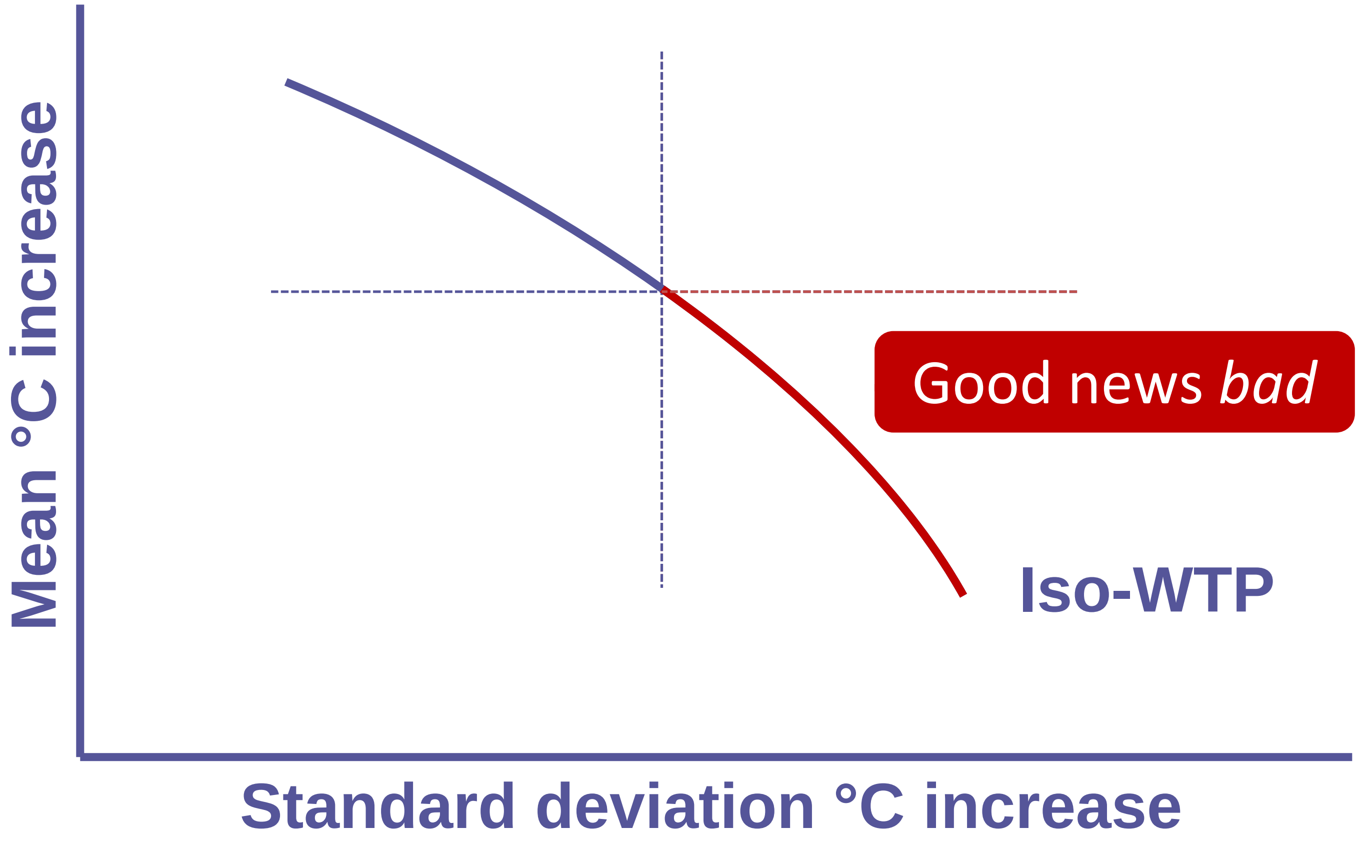
- Pindyck's (2012) WTP,
  - with a Weitzman (2009) lognormal calibration,
  - and certain γ (damages for each °C realization),
- calibrated to avoid > +2°C by 2100,
- comparing 2-4.5°C to 1.5-4.5°C with IPCC's 66% "likely" probability.

Is *good* news, in fact, *good*?

Source: Wagner & Zeckhauser working paper, and Freeman, Wagner & Zeckhauser (2015)

Higher uncertainty increases WTP

Move from 2-4.5°C to 1.5-4.5°C for IPCC's 66% "likely" range

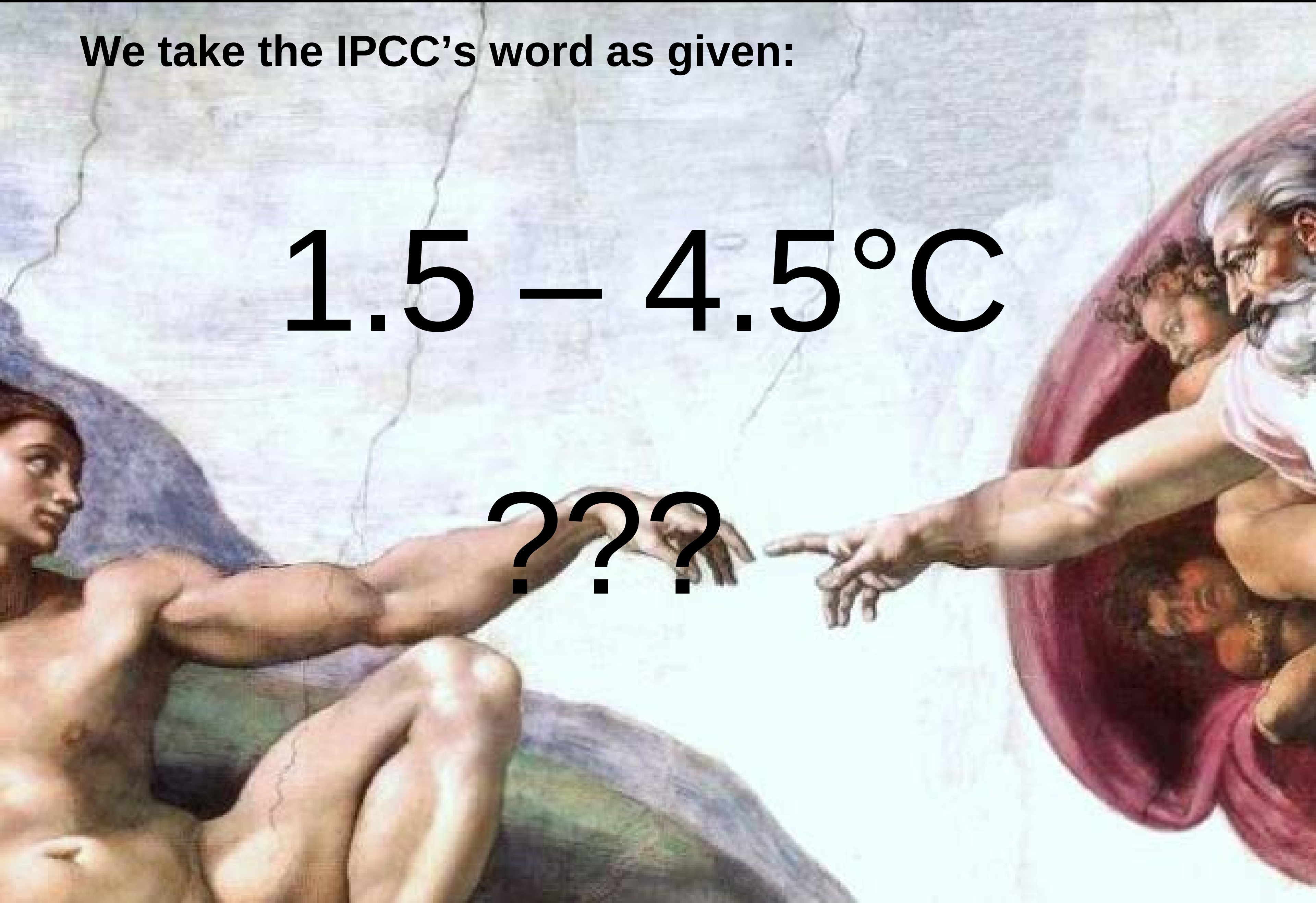


Move from 2-4.5°C to 1.5-4.5°C:
WTP goes up by >1/3

We take the IPCC’s word as given:

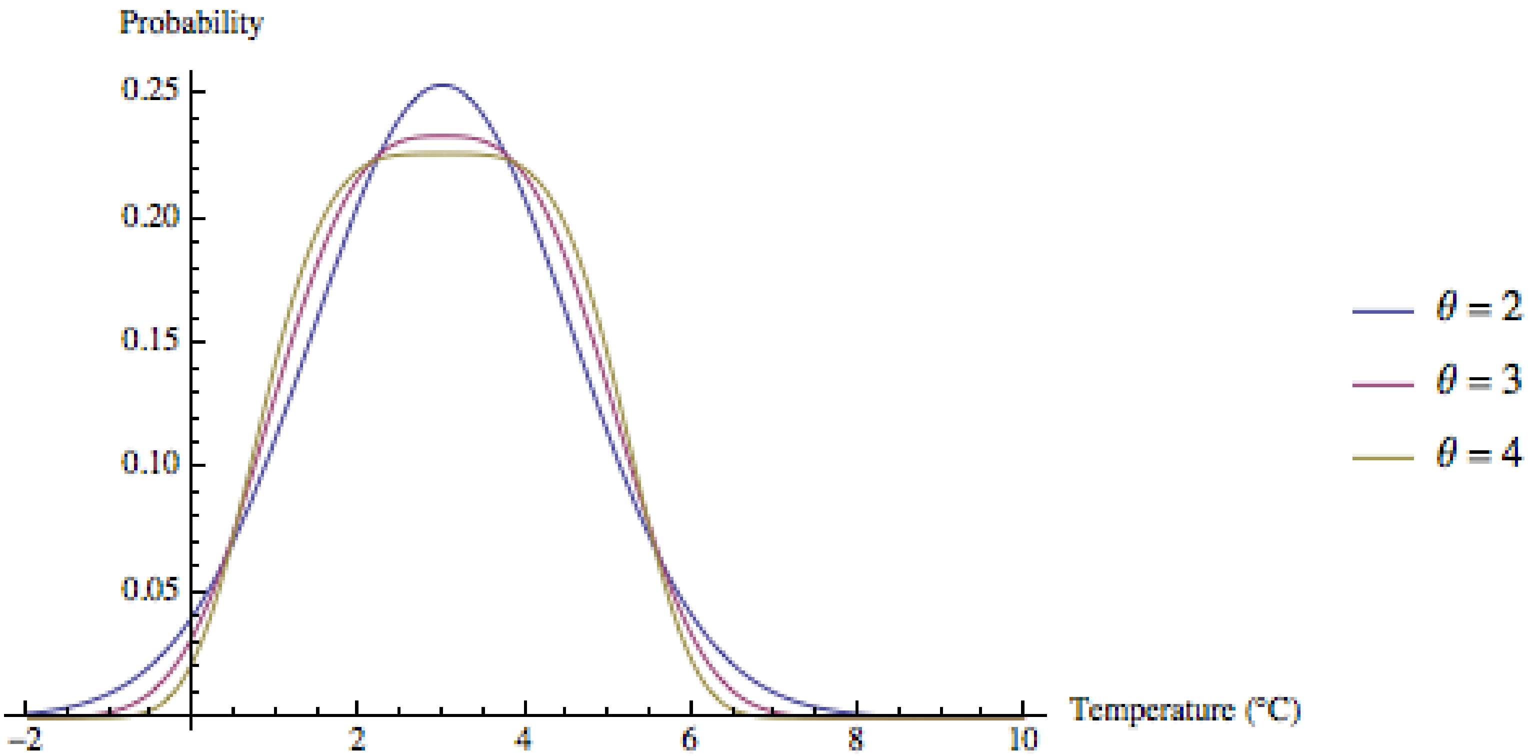
1.5 – 4.5°C

???



“Peakedness” of the distribution

Low peakedness = low kurtosis = high θ

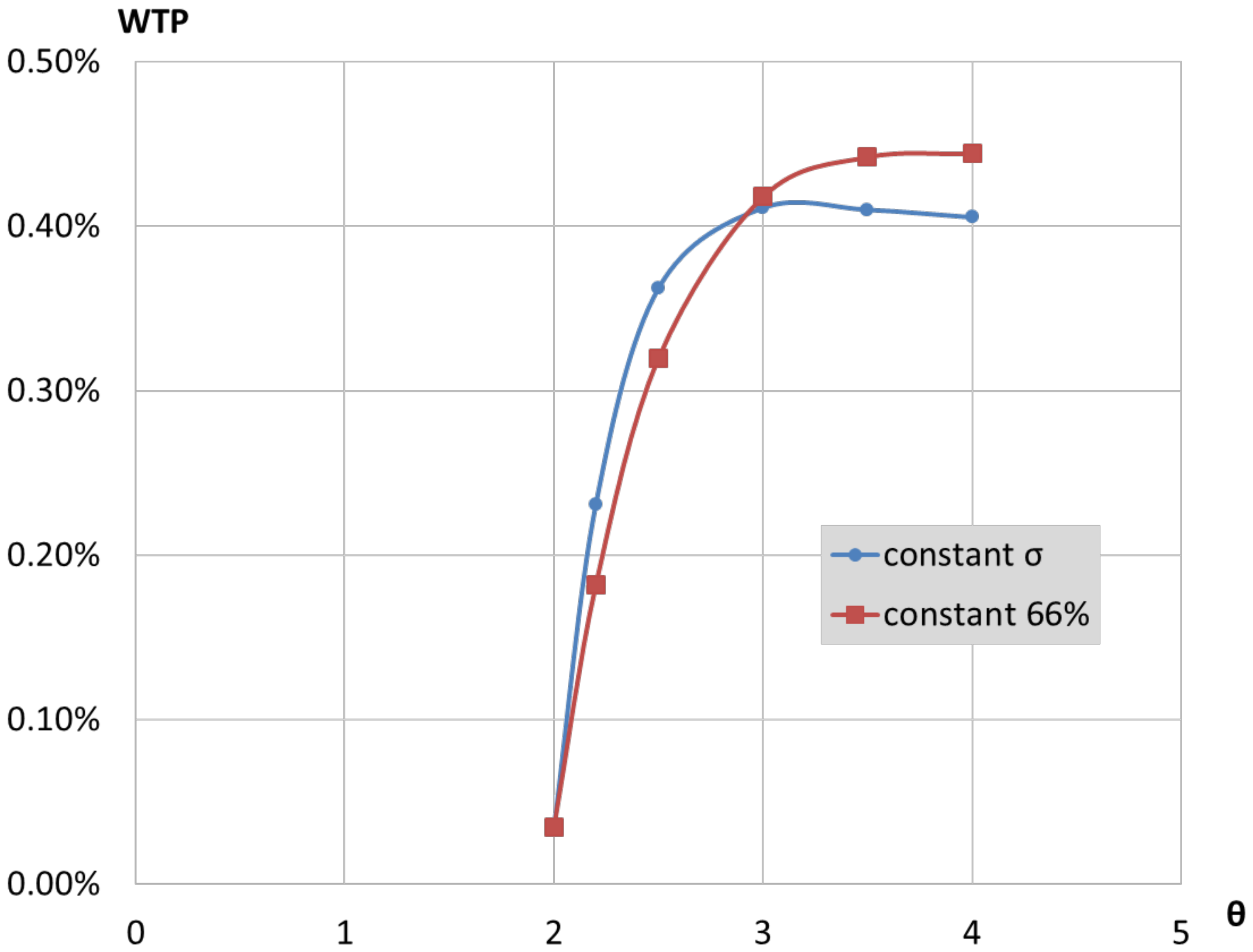


Knowing less about the mean within 66% likely range decreases peakedness

Source: Wagner & Zeckhauser working paper, and Freeman, Wagner & Zeckhauser (2015)

WTP increases with decreasing peakedness

Holding IPCC's "likely" range constant, WTP goes up with *θ*



Source: Wagner & Zeckhauser working paper, and Freeman, Wagner & Zeckhauser (2015)

Uncertainty up, WTP up

Peakedness alone not most important factor but necessary for proper understanding

- When is good news *good*?

  When it does not increase variance or decrease peakedness by enough to increase WTP

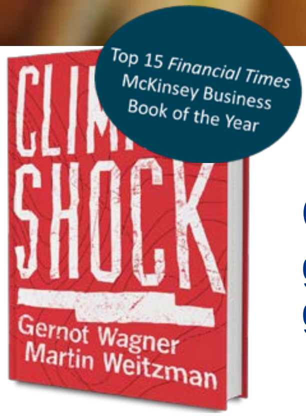
  Sadly not the case here:

- IPCC (2013), “acknowledging” “decade without warming” and black carbon’s newfound effects, and removing “most likely” climate sensitivity estimate increases WTP

- Skewedness (fat tails) may yet dwarf peakedness in importance

Deep climate (sensitivity) uncertainty comes at a potentially high cost

Source: Wagner & Zeckhauser working paper



Gernot Wagner
gwagner@fas.harvard.edu
gwagner.com

Richard J. Zeckhauser
richard_zeckhauser@harvard.edu
hks.harvard.edu/fs/rzeckhau

What do climate models get right?

30 years of climate science have given us…seemingly all but insights on climate sensitivity

- Long-term global average surface temperature trends
- Seasonal regional surface temperatures
- Frequency of extreme warm and cold days and nights
- Polar sea ice extent
- Ocean heat content and transport
- Carbon dioxide fluxes from atmosphere to oceans and land
- Cloud radiative effects today
- Wind stress over oceans

Climate sensitivity seems to be elusive, and perhaps deeply uncertain

Source: IPCC (2013). Thanks to Ilissa Ocko for compiling this list.

Climate sensitivity by far from only uncertainty

Potentially deep uncertainties every step along the way from emissions to impacts

- Emissions (IPAT equation!)
- Link between emissions and atmospheric concentrations
- Link between concentrations and temperatures
- Link between temperatures and physical climate damages
- Link between physical damages and their consequences
- and, at least as important, how society will respond

Compounding uncertainties makes (early) uncertainties worse

Source: Wagner & Weitzman (2015), Wagner & Zeckhauser working paper

God Plays DICE* With The Universe

* pun fully intended

- Heisenberg and quantum theories reveal that even the most informative possible science will never be able to accurately predict the future.

- We are far from the most informative possible science about climate futures:

    1. How the climate will develop.
    2. How society (human and non-human) will respond to climate developments.

- Uncertainties are reflected in the dot product of these two types of uncertainty.

True realization of climate sensitivity is hundreds of years out

Deep uncertainty analogy

“Only time can tell…”

- Think of analogy to string theory. We are no closer today than we were three decades ago in knowing whether it helps explain the universe. It represents a deep uncertainty.
- We are confronted with a dice-playing God, and alas we do not know how many sides are on the dice, nor what many of the symbols on the sides mean.
- Over past few decades, we have made no progress in learning about the dice.

Climate sensitivity range no narrower today than 35 years ago

Benefits of further knowledge (1/2)

Knowledge beneficial if we will change our actions

- Optimal actions and expected utility:
  A. Current scientific status – current actions, A1
  B. Current scientific status – optimal actions, A2
  C. Knowledge of the dice – God's optimal actions, A3
  D. Prophesying God, can foresee outcome of dice, y, – optimal actions A4(y)
- A1 not equal to A2, clearly not equal to A3.
- A4 is a function, not a single action. The value from prophesy is that actions respond to situation.

Benefits of further knowledge (2/2)

Knowledge beneficial if we will change our actions

- We are now choosing A1.
- What will be the gain if we gain scientific understanding?

A. Our actions, A1', will be able to respond to better information.

B. With tighter priors, we may be able to close the disparity between the actual action and the optimal action given current understanding.
That is $|A1'-A2'| < |A1 - A2|$

C. Alas, we have not been tightening priors significantly in recent decades.

D. That represents Deep Uncertainty