Fat-tails and decision making

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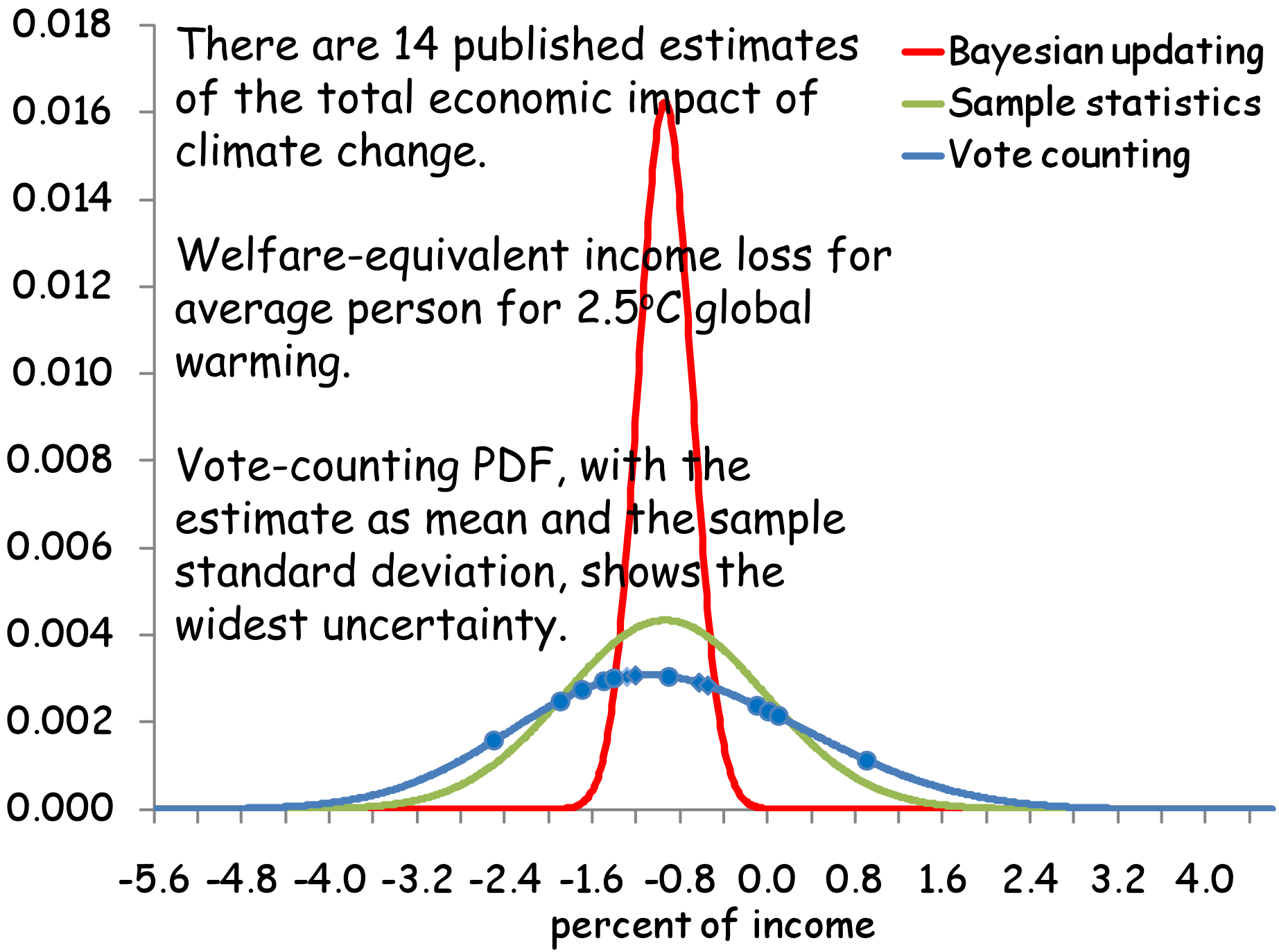
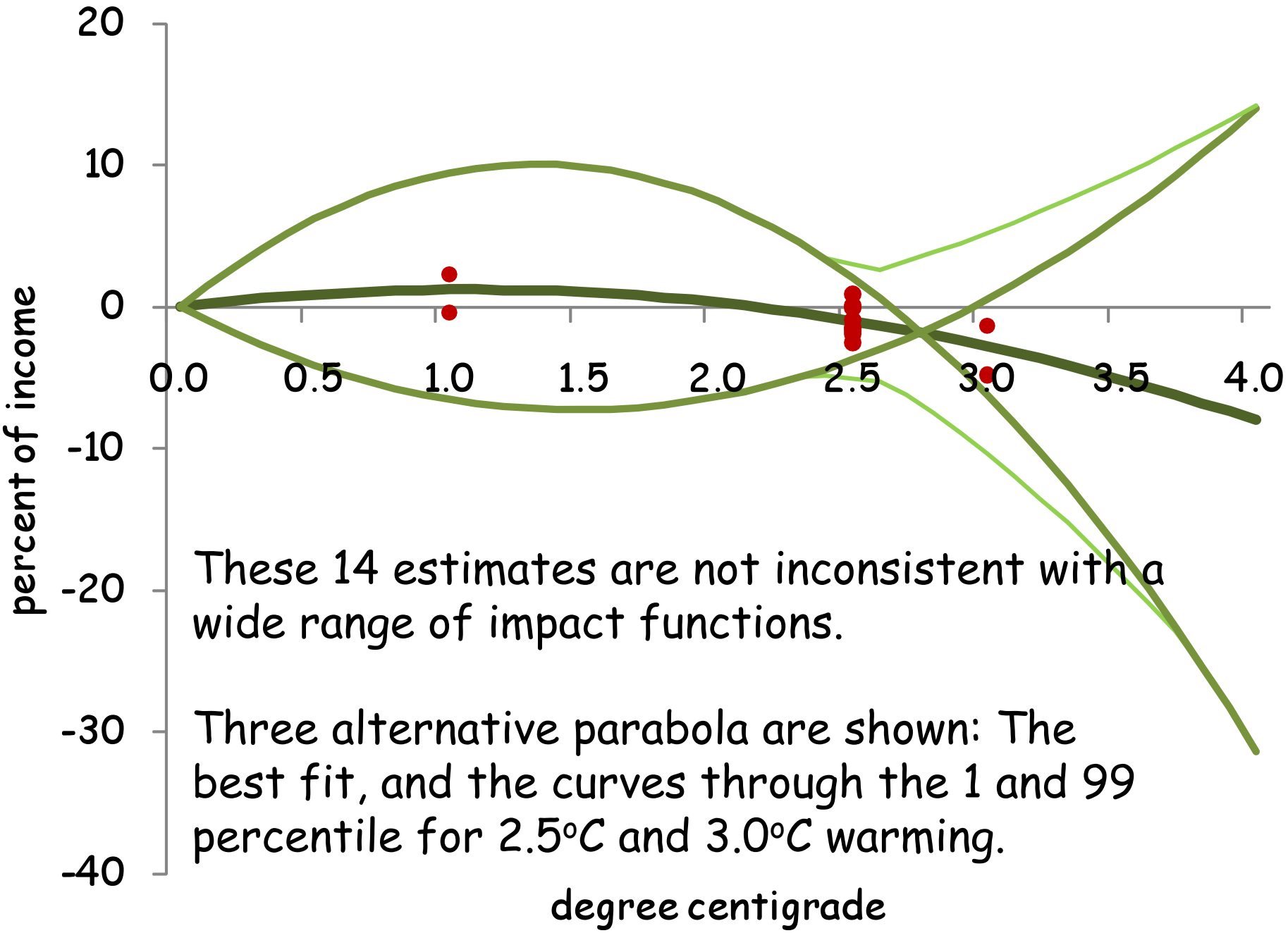
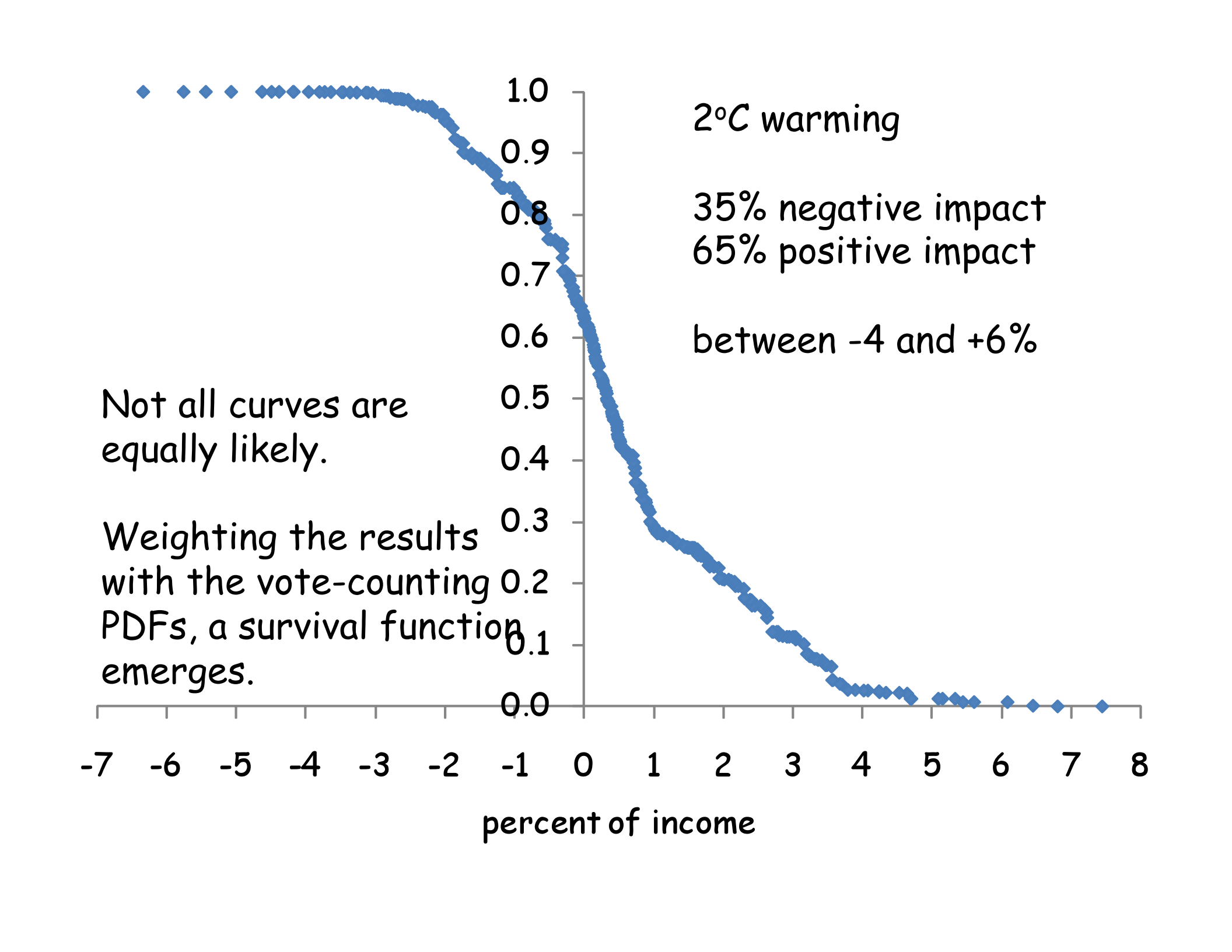
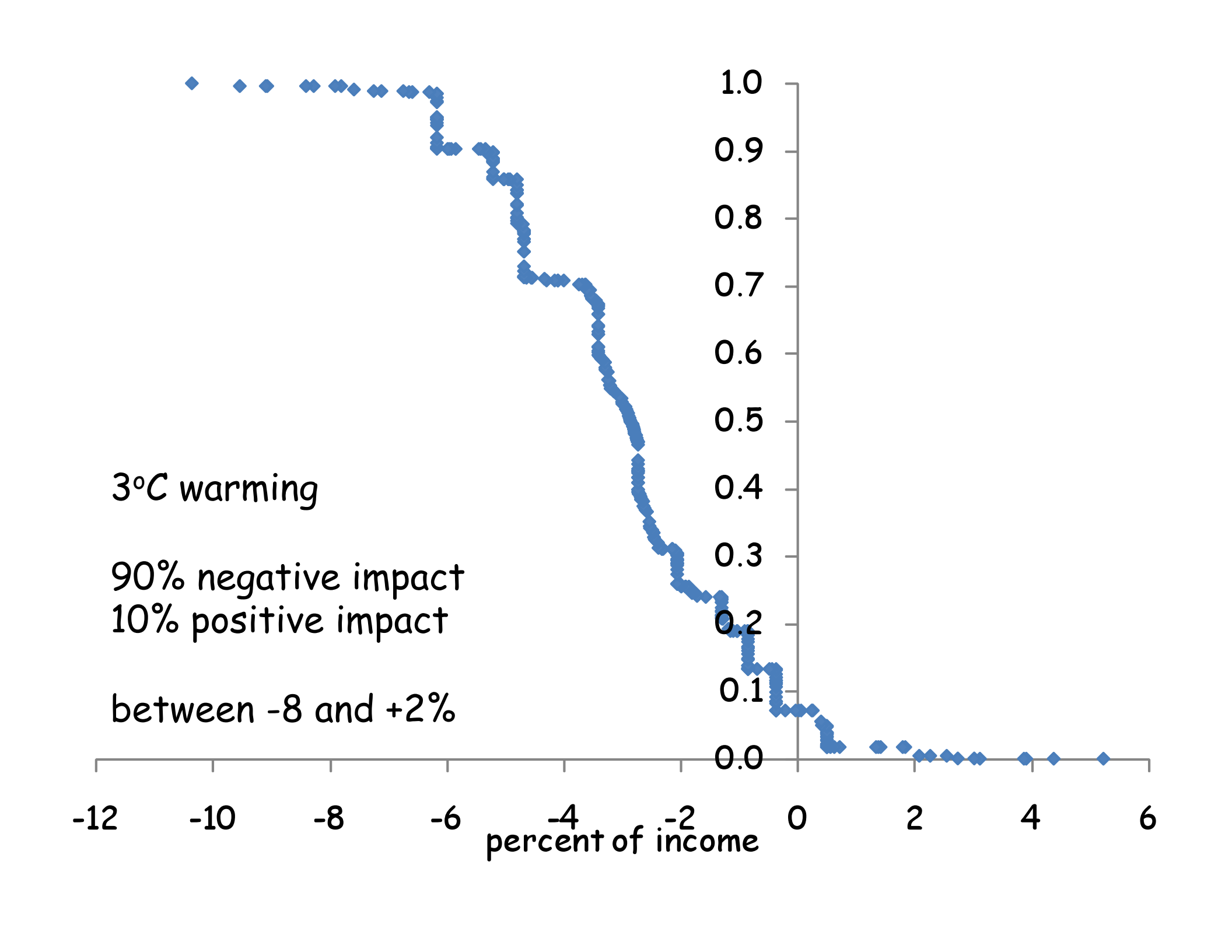
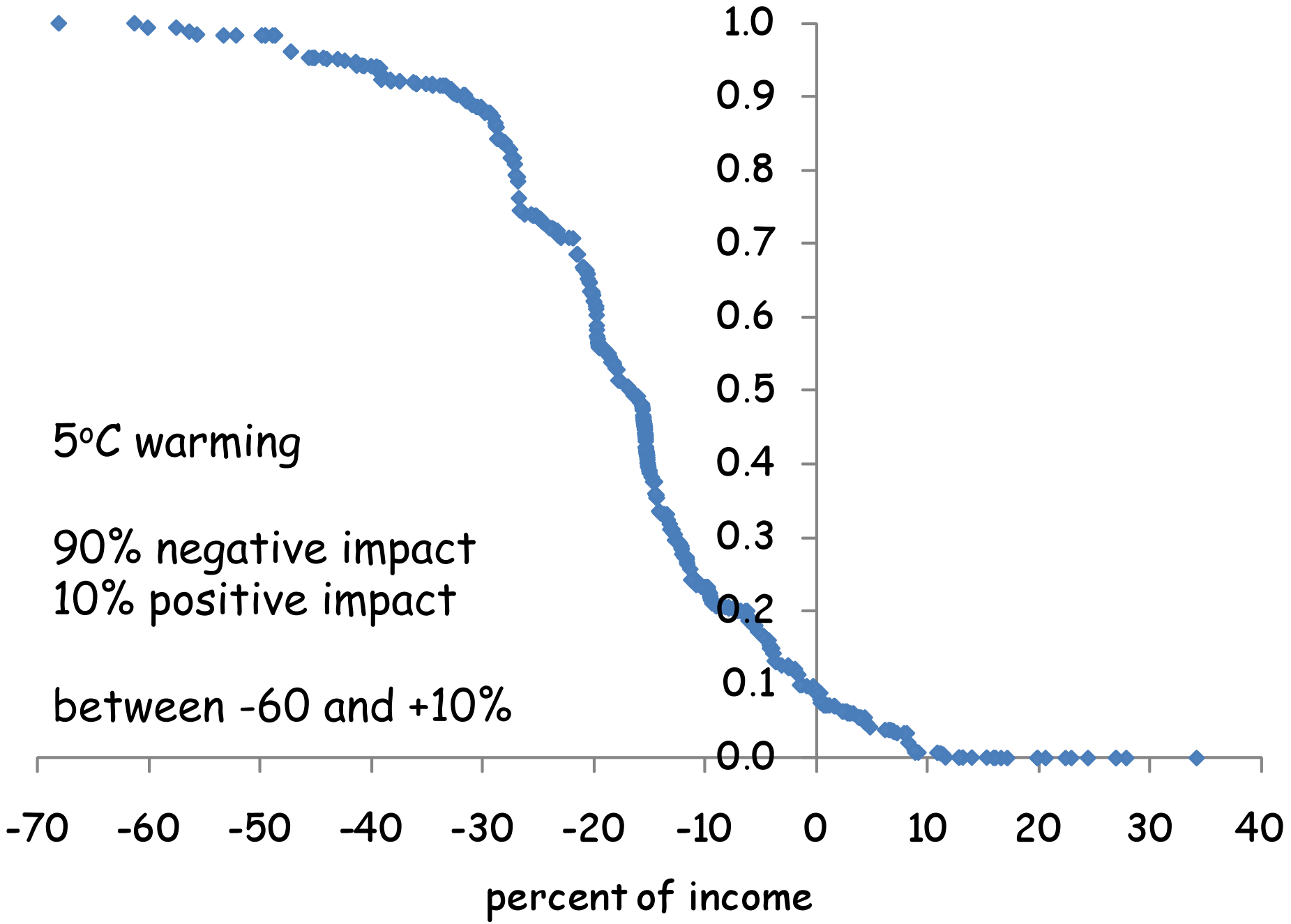
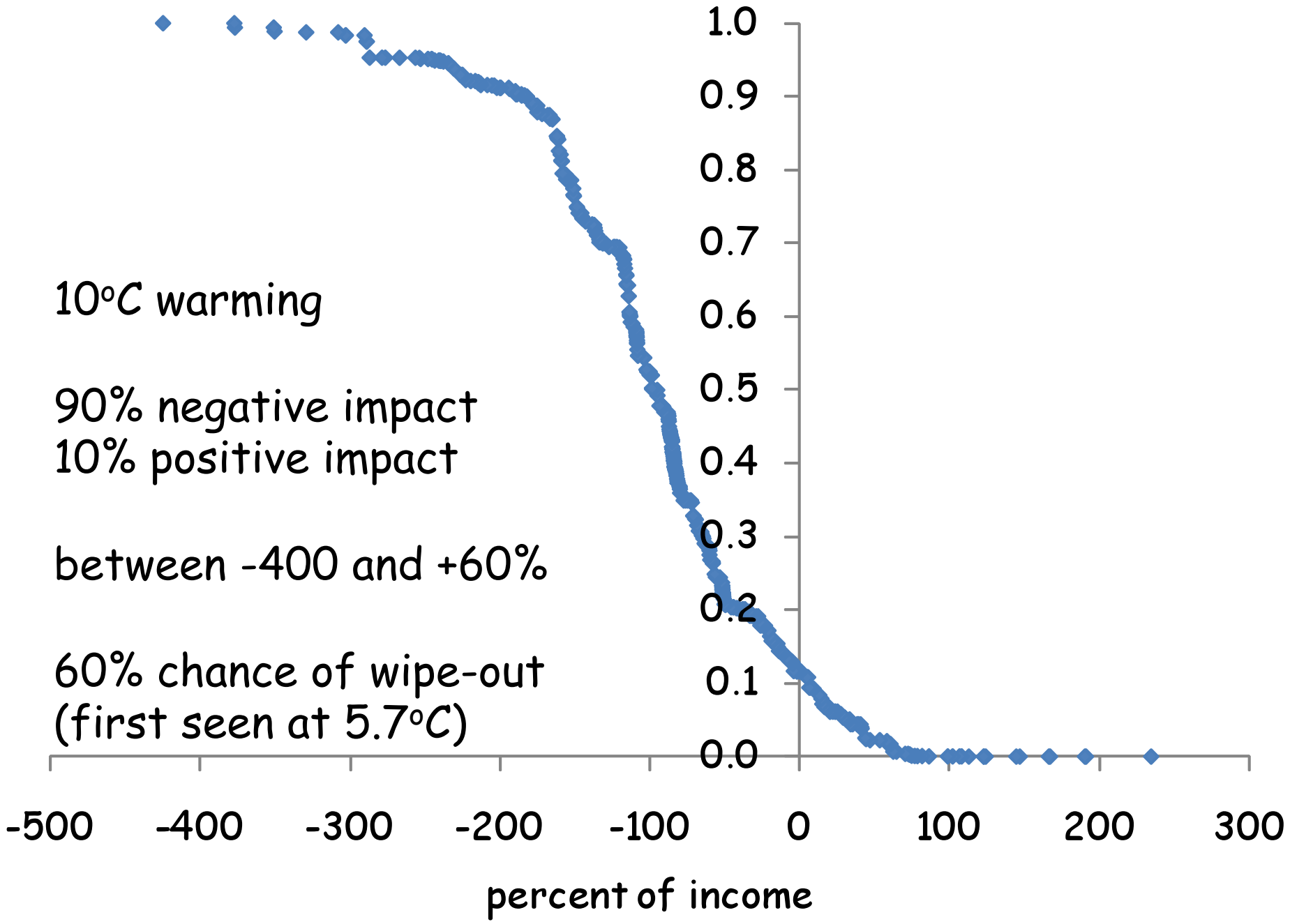

There are 14 published estimates of the total economic impact of climate change.
Welfare-equivalent income loss for average person for 2.5°C global warming.
Vote-counting PDF, with the estimate as mean and the sample standard deviation, shows the widest uncertainty.
Bayesian updating
Sample statistics
Vote counting
0.018
0.016
0.014
0.012
0.010
0.008
0.006
0.004
0.002
0.000
-5.6 -4.8 -4.0 -3.2 -2.4 -1.6 -0.8 0.0 0.8 1.6 2.4 3.2 4.0
percent of income


20
10
0
-10
-20
-30
-40
percent of income
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
degree centigrade
These 14 estimates are not inconsistent with a wide range of impact functions.
Three alternative parabola are shown: The best fit, and the curves through the 1 and 99 percentile for 2.5°C and 3.0°C warming.


2°C warming
35% negative impact
65% positive impact
between -4 and +6%
Not all curves are equally likely.
Weighting the results with the vote-counting PDFs, a survival function emerges.
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-7 -6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6 7 8
percent of income

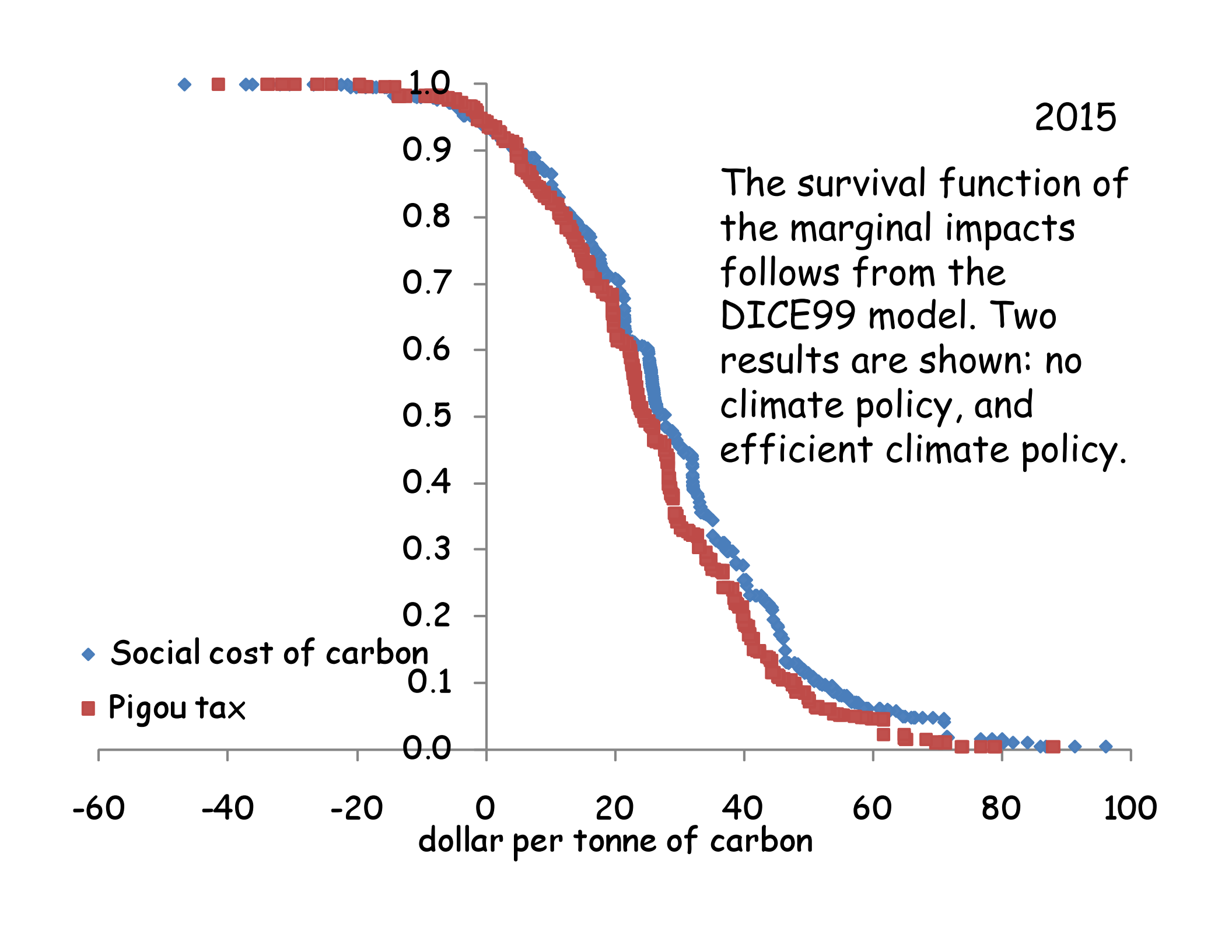

3°C warming
90% negative impact
10% positive impact
between -8 and +2%
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-12
-10
-8
-6
-4
-2
0
2
4
6
percent of income

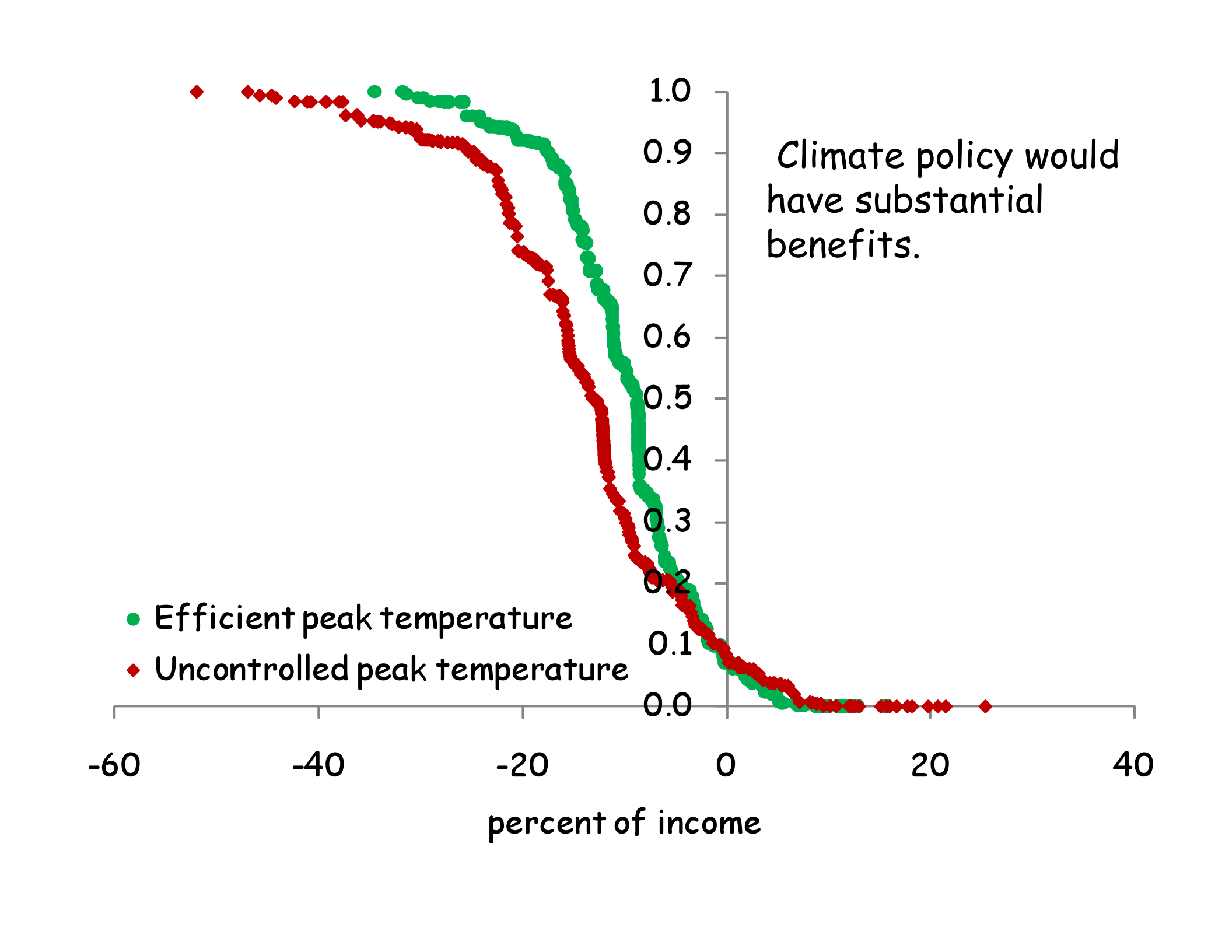

1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5°C warming
90% negative impact
10% positive impact
between -60 and +10%
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
40
percent of income


10°C warming
90% negative impact
10% positive impact
between -400 and +60%
60% chance of wipe-out
(first seen at 5.7°C)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-500
-400
-300
-200
-100
0
100
200
300
percent of income

Stock take

- We have three handfuls of estimates of the economic impact of a global warming of 1°C to 3°C
- The empirical basis is weak, even if we disregard group think and overconfidence
- Climate change may well go beyond 3°C,
- Impact estimates rapidly become speculative
- Cannot exclude the possibility of a total loss of welfare


2015
The survival function of the marginal impacts follows from the DICE99 model. Two results are shown: no climate policy, and efficient climate policy.
Social cost of carbon
Pigou tax
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-60
-40
-20
0
20
40
60
80
100
dollar per tonne of carbon


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
-60
-40
-20
0
20
40
percent of income
Efficient peak temperature
Uncontrolled peak temperature
Climate policy would have substantial benefits.

Caveats

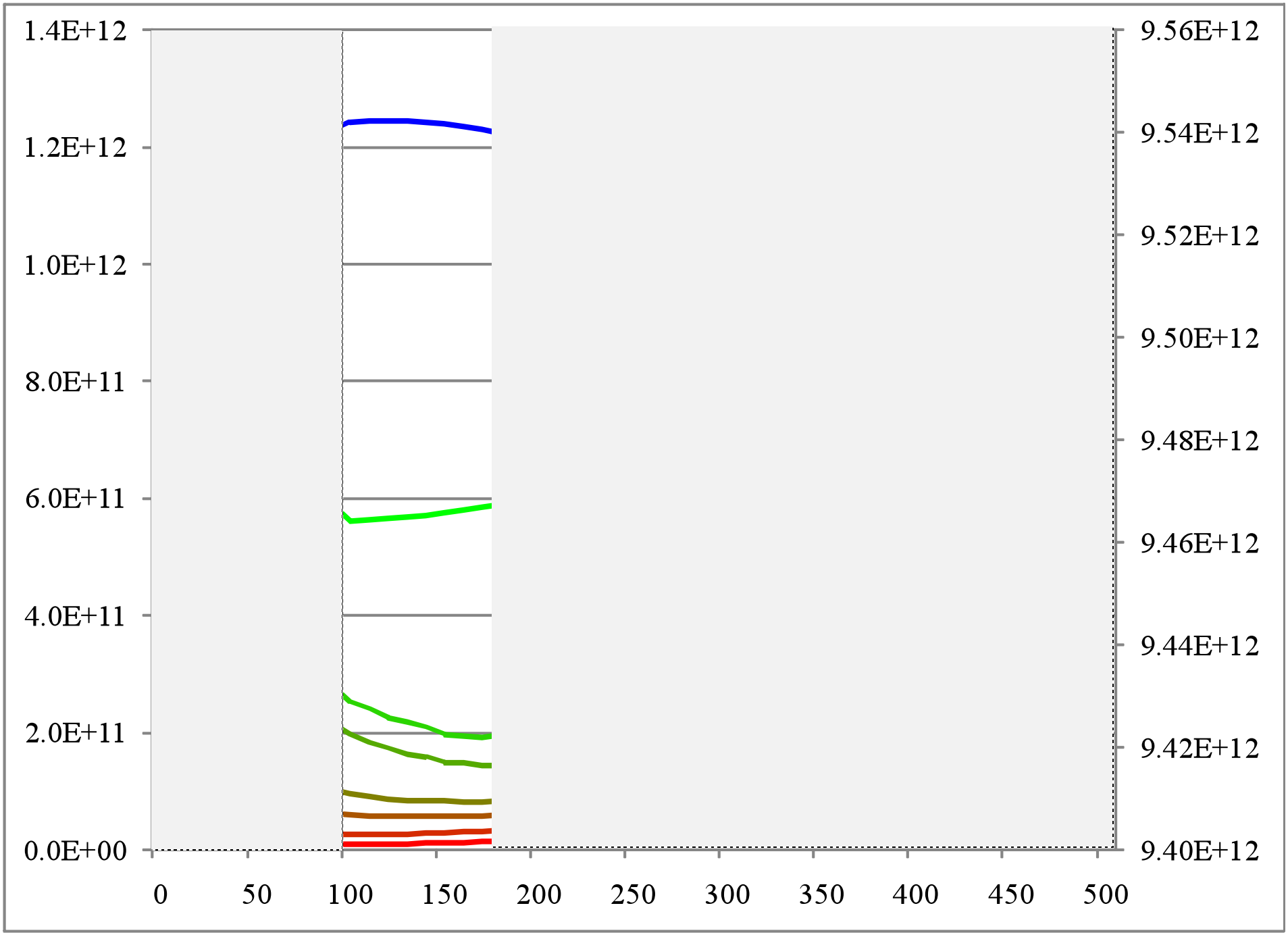
- Uncertainty about climate impact only
- No equity
- No risk premium
- Without climate policy, temperature peaks at 4.6°C (early in 23rd century)
- With climate policy, temperature peaks at 4.1°C
- That is, resource scarcity and technological progress would remove the climate problem before it gets really serious



Fat tails

- Above, fat tails avoided by scenario design
- Not reassuring
- How to detect non-existence of moments in a numerical model?
- How to advice policy under fat-tailed uncertainty?
  - Expected cost-benefit analysis
  - Minipercentile regret
  - Minimize fatness of tail
  - Extrapolate optimal intervention

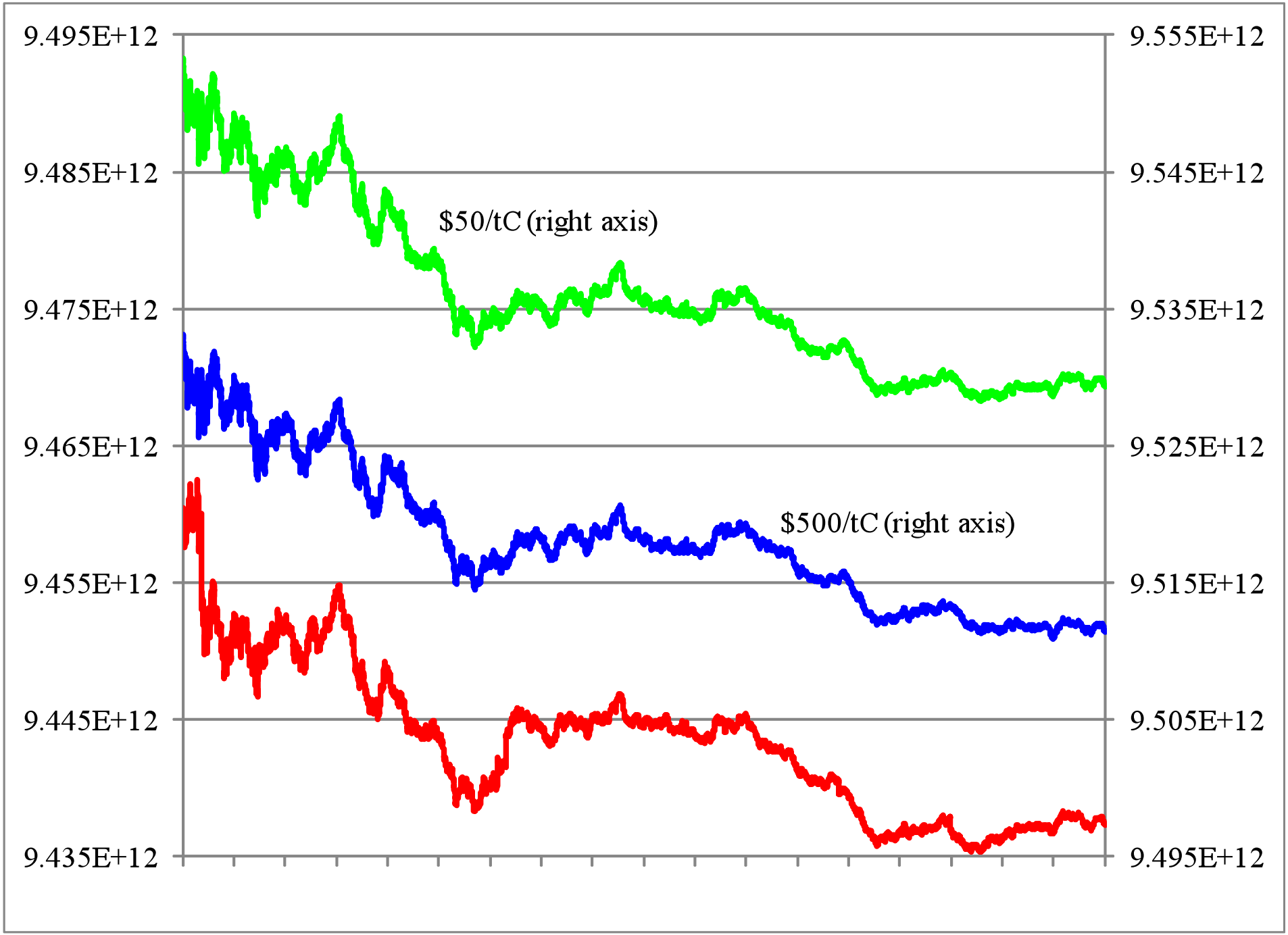


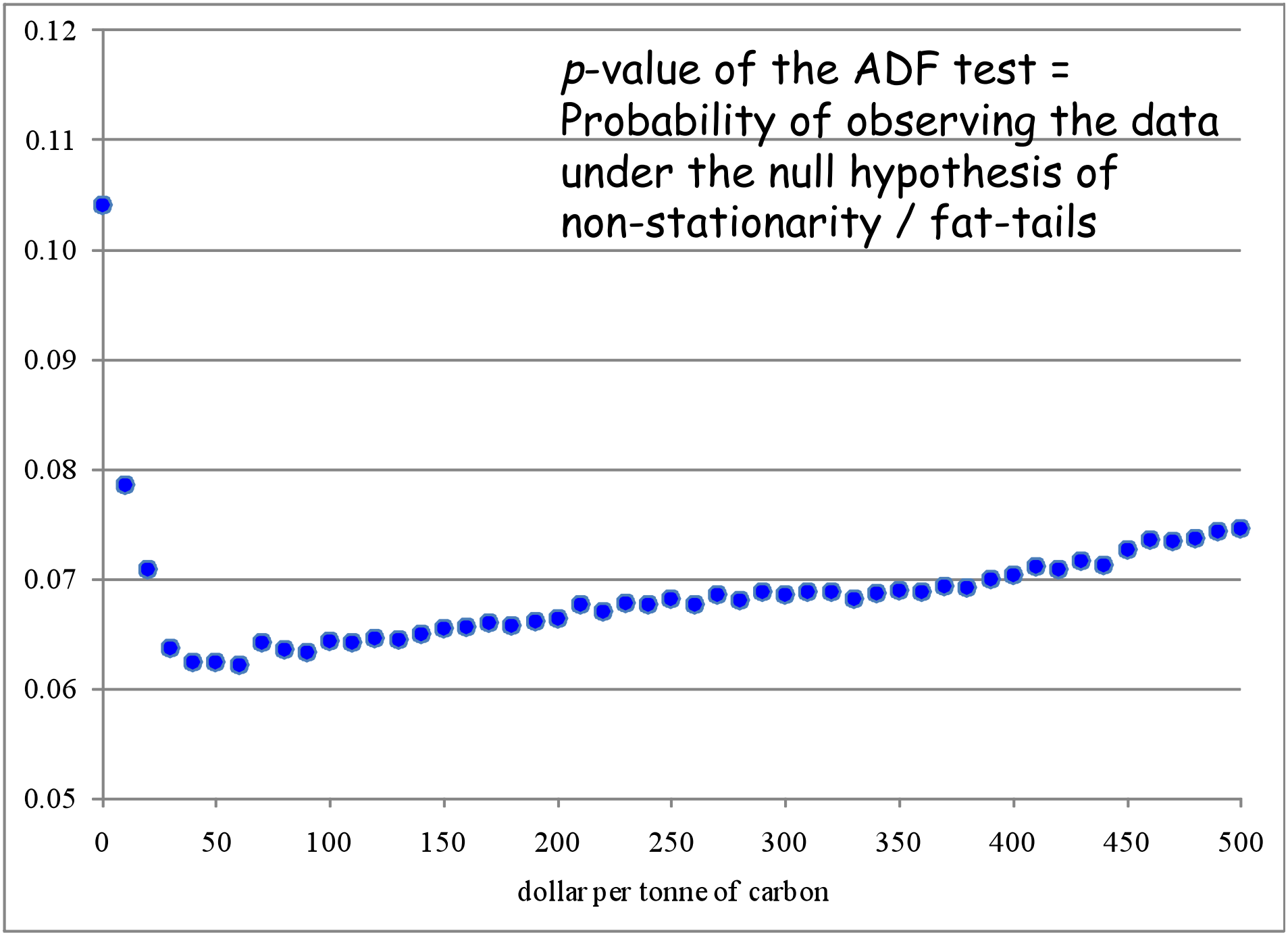

1.4E+12
1.2E+12
1.0E+12
8.0E+11
6.0E+11
4.0E+11
2.0E+11
0.0E+00
9.56E+12
9.54E+12
9.52E+12
9.50E+12
9.48E+12
9.46E+12
9.44E+12
9.42E+12
9.40E+12
0
50
100
150
200
250
300
350
400
450
500

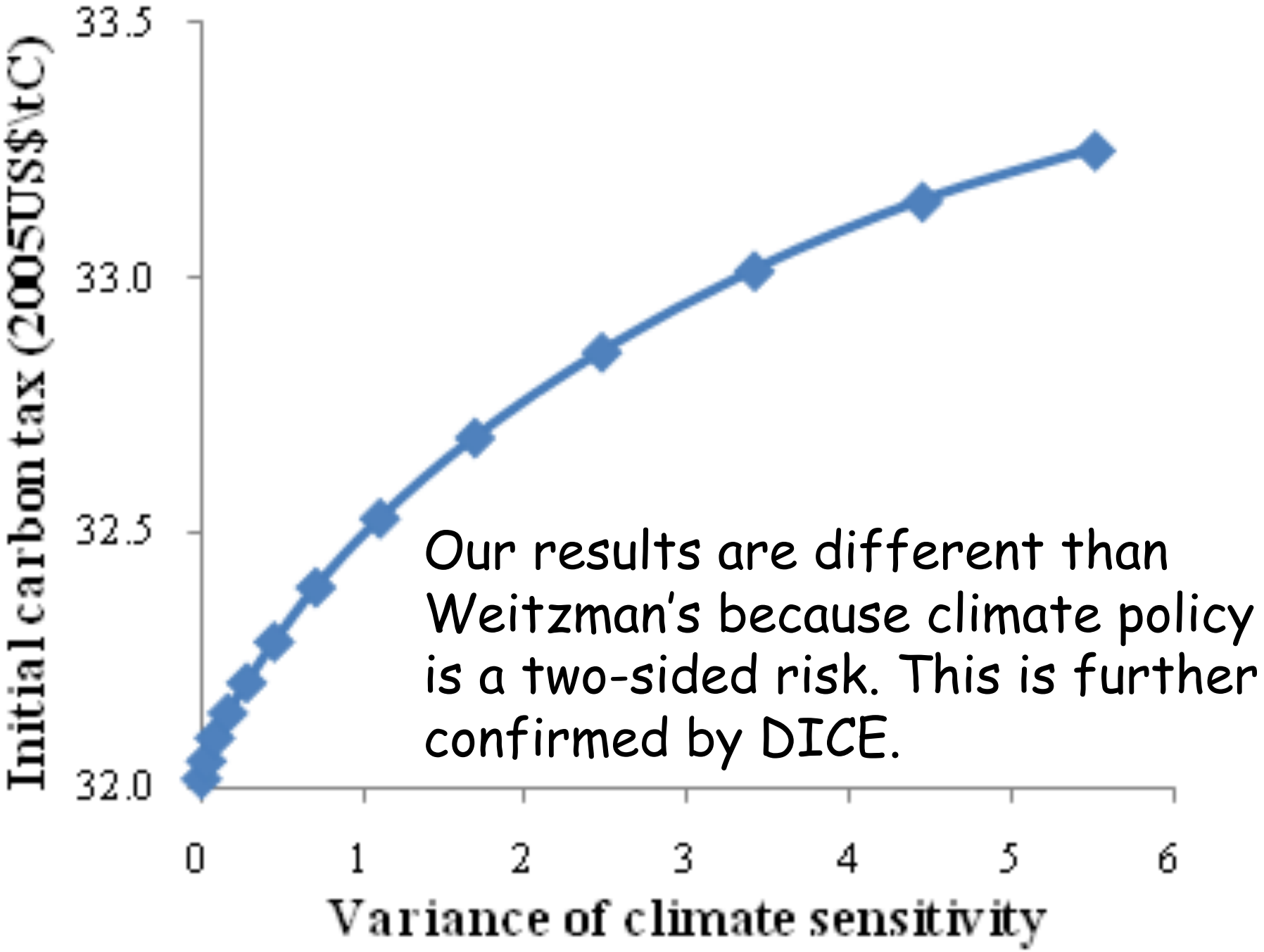
Alternatives

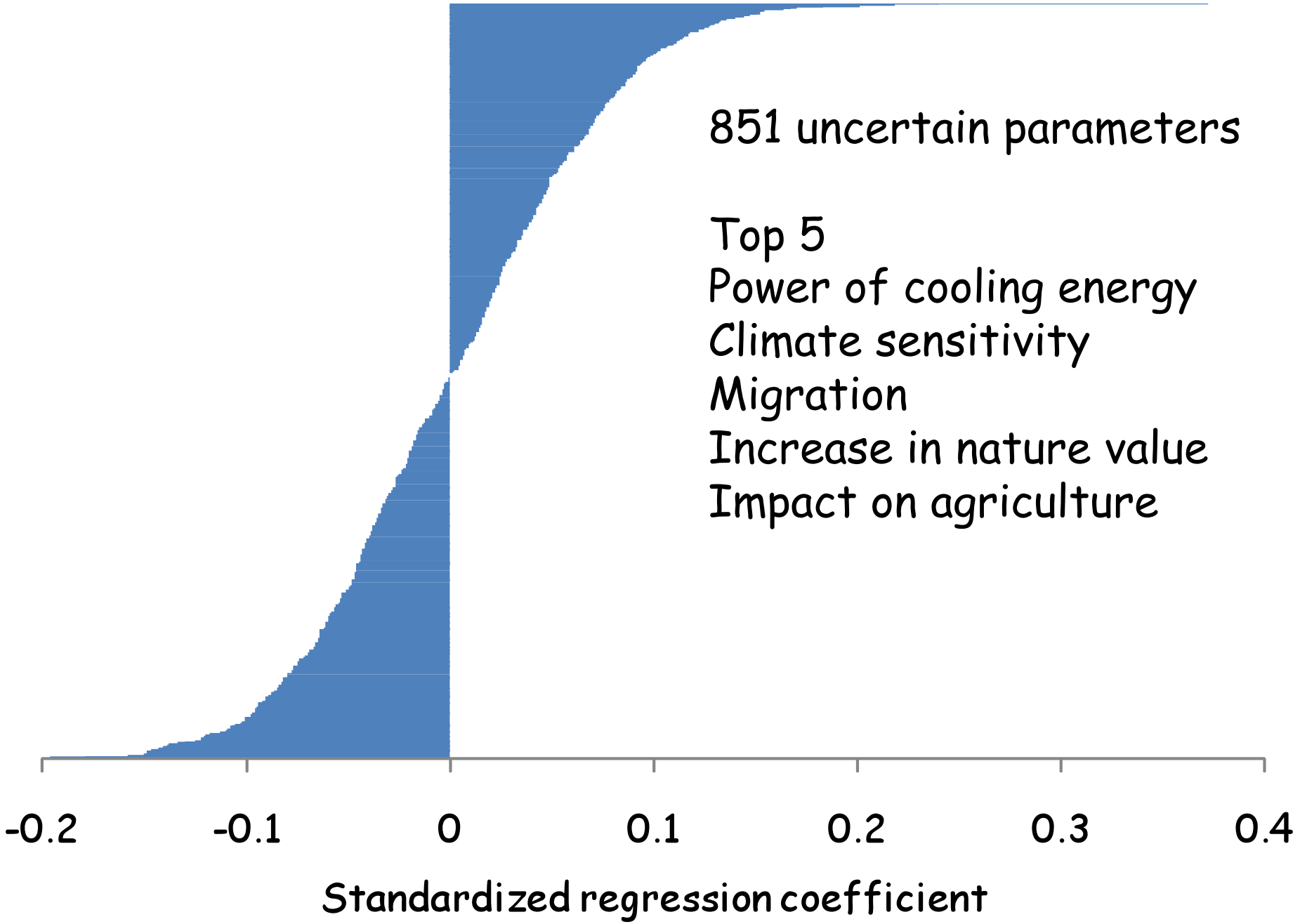
- In minimax regret, you do the best you can in each state of the world, and make sure you are robust to uncertainty
- There is no guarantee, however, that the outcome will be acceptable: Regret may be a small difference between very low levels of welfare
- Regret is a measure of the slope of the welfare function, rather than its level
- Therefore, minimize the fatness of the tail




9.495E+12
9.485E+12
9.475E+12
9.465E+12
9.455E+12
9.445E+12
9.435E+12
9.555E+12
9.545E+12
9.535E+12
9.525E+12
9.515E+12
9.505E+12
9.495E+12
$50/tC (right axis)
$500/tC (right axis)


p-value of the ADF test =
Probability of observing the data
under the null hypothesis of
non-stationarity / fat-tails
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0
50
100
150
200
250
300
350
400
450
500
dollar per tonne of carbon


Initial carbon tax (2005US$\tC)
33.5
33.0
32.5
32.0
0
1
2
3
4
5
6
Variance of climate sensitivity
Our results are different than Weitzman's because climate policy is a two-sided risk. This is further confirmed by DICE.


851 uncertain parameters
Top 5
Power of cooling energy
Climate sensitivity
Migration
Increase in nature value
Impact on agriculture
-0.2
-0.1
0
0.1
0.2
0.3
0.4
Standardized regression coefficient

This project

- Where do the PDFs come from? How do we choose one over the other?
- Beware overconfidence
- How fat are the tails?
- What are the key parameters?
- How do uncertainties change with policy interventions?
- Focus on the uncertainties about variables that are key to decision making