How Should Climate Change Uncertainty Impact Social Valuation and Policy?

Lars Peter Hansen
UChicago China Forum
Collaborators: Barnett (ASU) and Brock (Wisconsin)
April 23, 2021

What is the challenge?

- human impact on the environment is NOT internalized by markets - social cost $\neq$ private costs
- two sources of uncertainty:
  - geosciences: CO_2 emissions today impact the future climate
  - economics: climate change in the future alters economic opportunities and social well-being

Economists refer to this wedge between social and market valuation as an externality.

Research ambition

A computationally tractable laboratory to explore subjective uncertainty including potential model misspecification and ambiguity across models. Goals:

- ▷ assess the impact of uncertainty on climate policy outcomes
- ▷ isolate the forms of uncertainty that are most consequential for these outcomes
- ▷ explore policy-relevant consequences of models in an open and honest way

Confronting policy uncertainty

Tension:

- ▷ limited understanding of the mechanism by which policy influences economic outcomes
- ▷ demand for precise answers by the public and/or government policy-makers

Haunted by Hayek's forewarning

"Even if true scientists should recognize the limits of studying human behaviour, as long as the public has expectations, there will be people who *pretend* or *believe* that they can do more to meet popular demand than what is really in their power."
(From Hayek's Nobel address, 1974)

For quantitative policy analysis, how should we acknowledge the limits to our understanding?

Social Cost of Carbon (SCC)

Commonly referred to in policy discussions

While meanings and measurements *differ* across applications, we use a well-posed version as an analytical tool to assess the impact of uncertainty.

- externality - carbon emissions alter the climate, which in turn impacts economic opportunities and social well-being in the future
- social cost of carbon includes an adjustment missed by market prices that "corrects" this "externality"

SCC includes a wedge between market prices and their social counterpart.

Where does uncertainty emerge?

Quantitative storytelling with multiple stories

- ▷ risk: (uncertainty within models) each model has explicit random impulses
- ▷ ambiguity: (uncertainty across models) multiple models give rise to multiple "stories" with different implications
- ▷ misspecification: (uncertainty about models) each model is an abstraction and not intended to be a complete description of reality

Dangers of Being Naive

The Cheat, Georges de La Tour

Navigating uncertainty

Probability models we use in practice are simplifications that provide a lens for observing a complex reality. Moreover, there is ambiguity as to which among multiple models is the best one.

- aims:
  - use models in sensible ways rather than discard them
  - use tools from probability and statistics to limit the type and amount of uncertainty that is entertained
- aversion - dislike of uncertainty about probabilities over future events

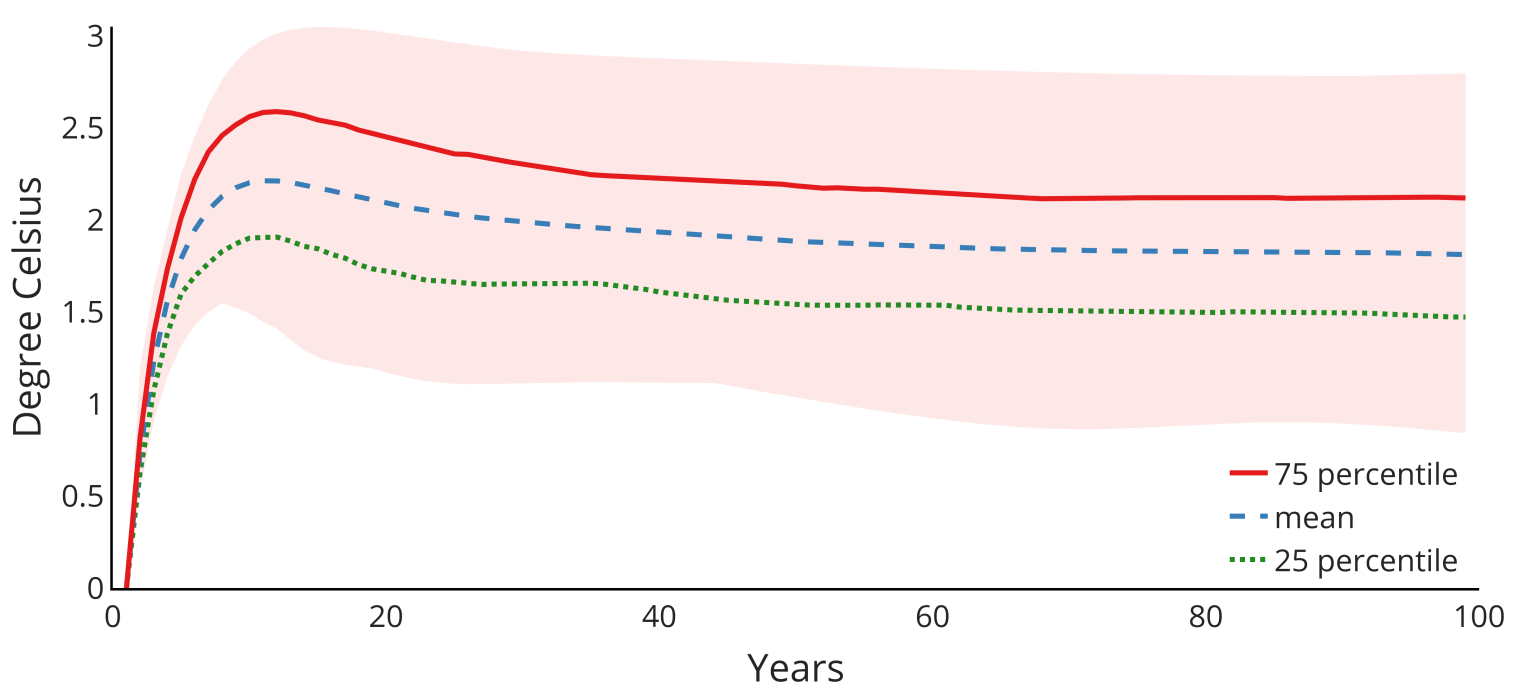
Uncertainty tradeoff

Use mathematical models informed by expert judgement and empirical evidence to:

- ▷ make best guesses
- ▷ determine potentially bad outcomes

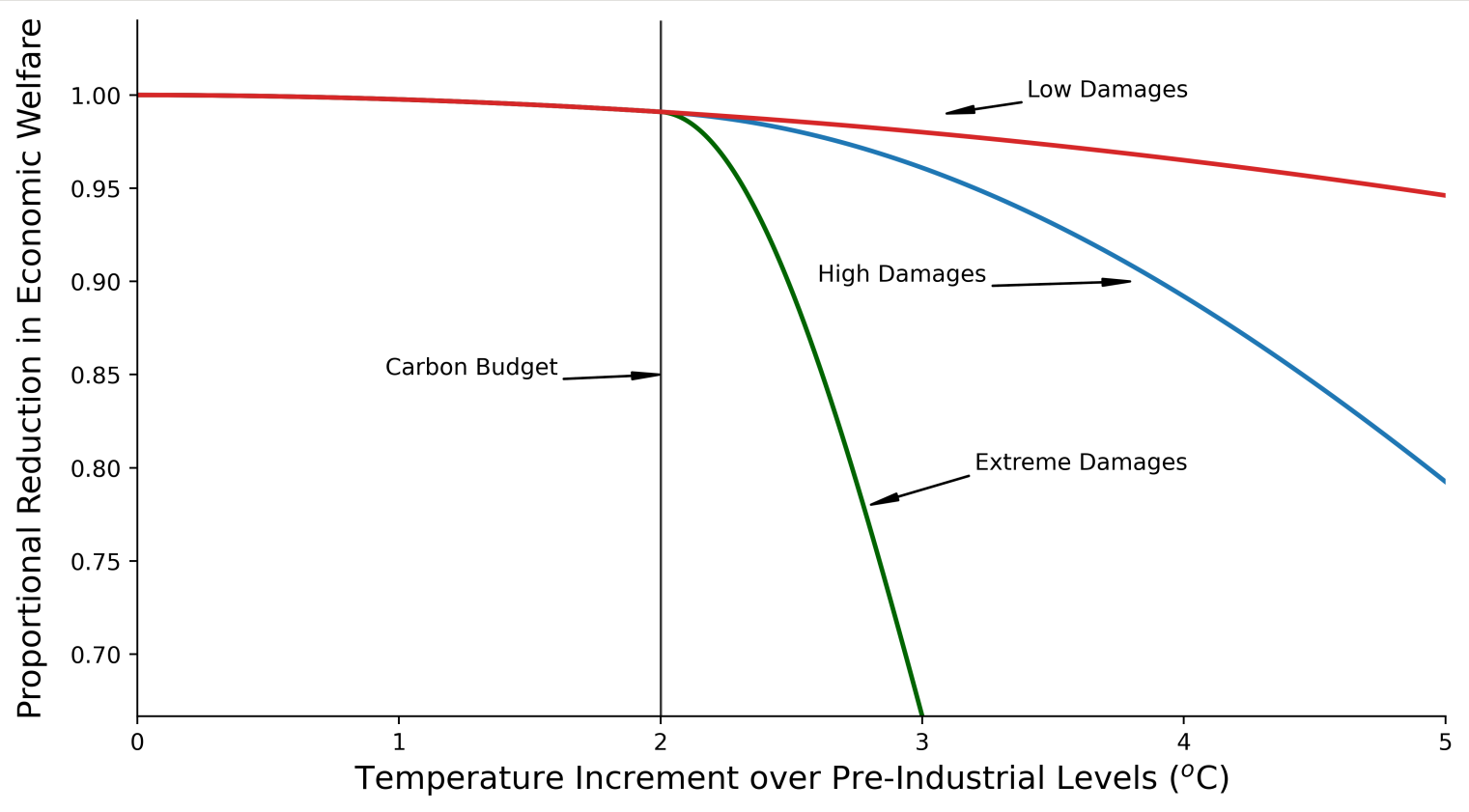
How much attention do we pay to best guesses versus possible bad outcomes when making decisions including constructing investment strategies and designing policy?

Climate model predictions

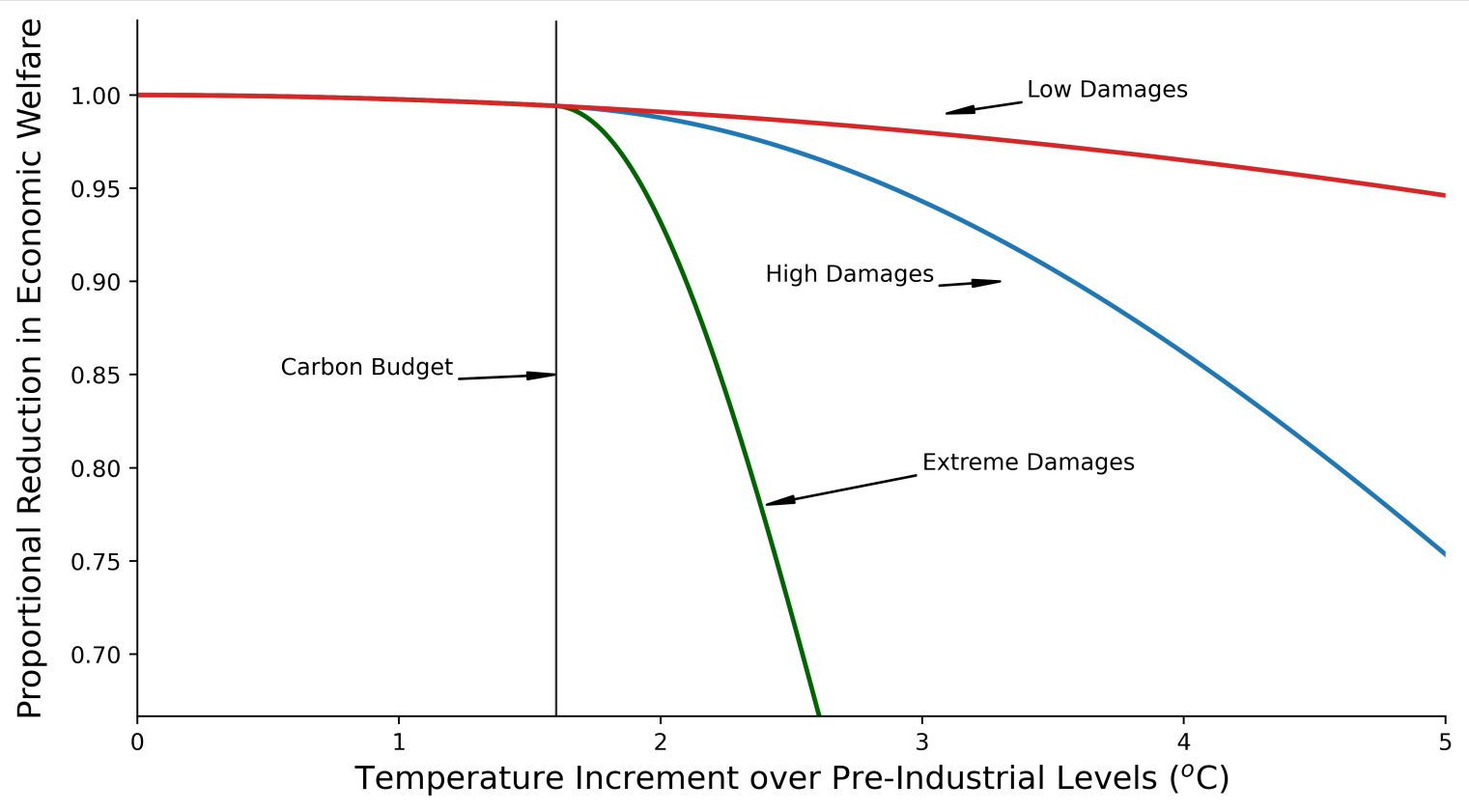


Percentiles for temperature responses to emission impulses. The emission pulse was 100 gigatons of carbon (GtC) spread over the first year. The temperature units for the vertical axis have been multiplied by ten. The boundaries of the shaded regions are the upper and lower envelopes based on 144 models.

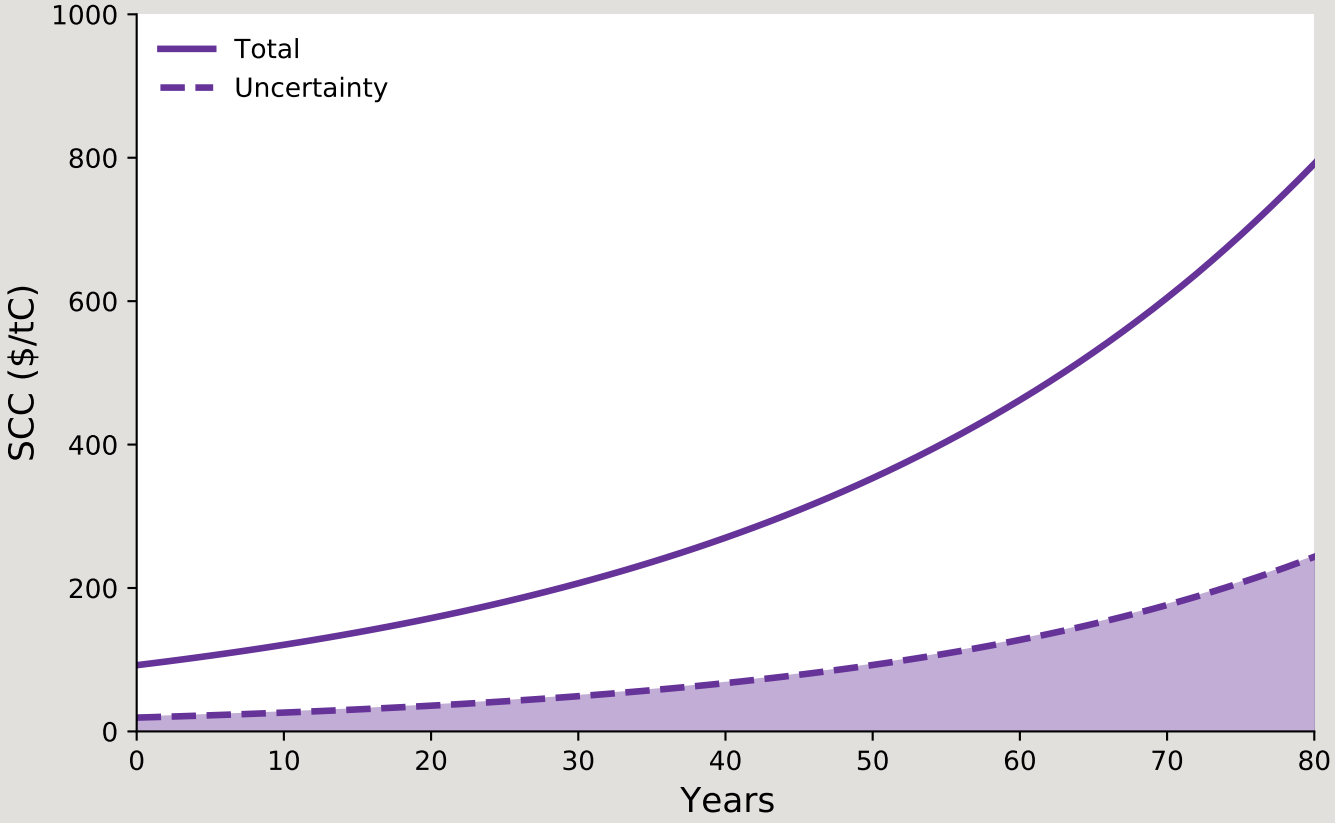
Economic damage uncertainty



Economic damage uncertainty



Uncertainty and the SCC



Alternative policy levers

- taxing carbon emissions
- subsidizing transition to renewable sources of energy
- subsidizing research and development of new, clean technology
- incentivizing the reforestation and preserving existing natural carbon sinks

How does uncertainty impact the costs and benefits of these policy alternatives?

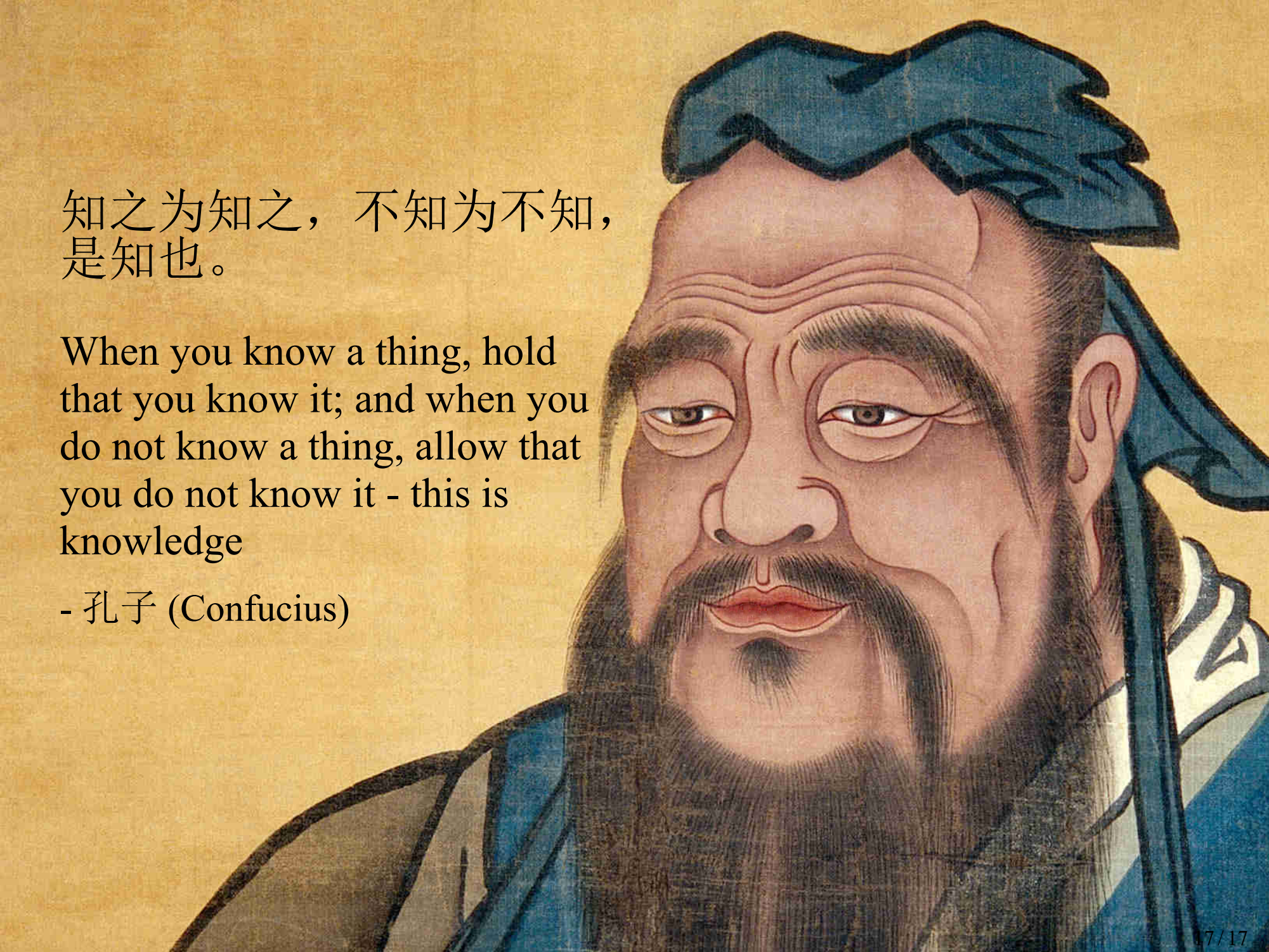
Policy agendas in China and US

Plans:

- China
  - short-term plan - reduce emissions relative to output by eighteen percent in five years
  - long-term plan - carbon neutrality by 2060
- United States
  - short-term plan - reduce emissions by fifty percent by 2030
  - long-term plan - carbon neutrality by 2050

Questions:

- How will the ambitious plans be realized?
- What are the most promising policy approaches?
- How do we restructure incentives?



知之为知之，不知为不知，
是知也。

When you know a thing, hold that you know it; and when you do not know a thing, allow that you do not know it - this is knowledge

- 孔子 (Confucius)

气候变化的不确定性
如何影响社会价值评估和政策

拉尔斯 • 彼得 • 汉森
芝加哥大学中国论坛
合作者：麦克 • 巴内特（亚利桑那州立大学)
威廉 • 布洛克（威斯康星大学麦迪逊分校）
2021 年 4 月 23 日

挑战何在?

- 人类活动 对环境影响的外部性 没有 市场内部化
  - 社会成本 $\neq$ 私人成本
- 不确定性的两个来源:
  - 地球科学: 当下的 CO_2 排放会影响未来的气候
  - 经济学: 未来的气候变化会影响经济机会和社会福利

经济学家将社会价值和市场价值之间的楔形称作外部性。

研究目标

建立一套 可计算出数值解的方法体系用以研究主观不确定性（包括潜在的模型误设以及多个模型之间的模糊）。目标：

- ▷ 评估 不确定性对气候政策结果的影响
- ▷ 分离 对于结果影响最大的不确定性种类
- ▷ 公开、如实地探索 政策相关的模型结果

面对政策不确定性

现实冲突:

- ▷ 人们对于政策如何影响经济产出的机制理解有限
- ▷ 政府官员、政策制定者对于精确答案的需求迫切

哈耶克的预警

“虽然真正的科学家都会承认，对于人类行为的研究他们的能力有限，但是，大众过多的期待，也总会使某些人不顾自己的能力所限，假装或真诚地相信自己能做得更好，以迎合人们的需求。”
(弗里德里希 • 哈耶克，1974 年诺贝尔奖演讲)

在定量政策分析中，应以何种方式将我们理解的局限性纳入考量？

碳排放社会成本

这一概念在政策讨论中经常被提及。

尽管碳排放社会成本的含义及测量都根据应用场景而有所区别，我们在此使用一个适定版本，以此为分析工具，来评估不确定性造成的影响。

- 外部性 - 碳排放改变了气候，气候变化继而影响未来的经济机会以及社会福利
- 碳排放社会成本引入了一项校准，可以“纠正”被市场所忽视的外部性

碳排放社会成本提供了一个分离市场价格及其对应的社会价值的楔子。

不确定性在何处出现？

基于多个故事的定量故事讲述

- 风险：模型内部的不确定性）每一个模型都显式含有随机的冲激
- 模糊：（跨模型间的不确定性）多个模型导致了多个“故事”，不同故事可能有不同含义
- 误设：（关于模型的不确定性）每个模型都是一种对现实的抽象化表述，而非用于完整地描述现实

无知的危险

《方块 *A* 作弊者》, 乔治 • 德 • 拉图尔

漫步于不确定性

科研实践中使用的概率模型是一种简化，为观测更为复杂的现实提供了视角。此外，关于“多个模型中哪一个最好”也存在模糊。

- 目标：
  - 合理地使用多个模型，而非弃置不用
  - 运用概率与统计工具，将不确定性的种类和程度限定在一定范围内
- 不确定性厌恶 - 不喜欢关于未来事件概率的不确定性

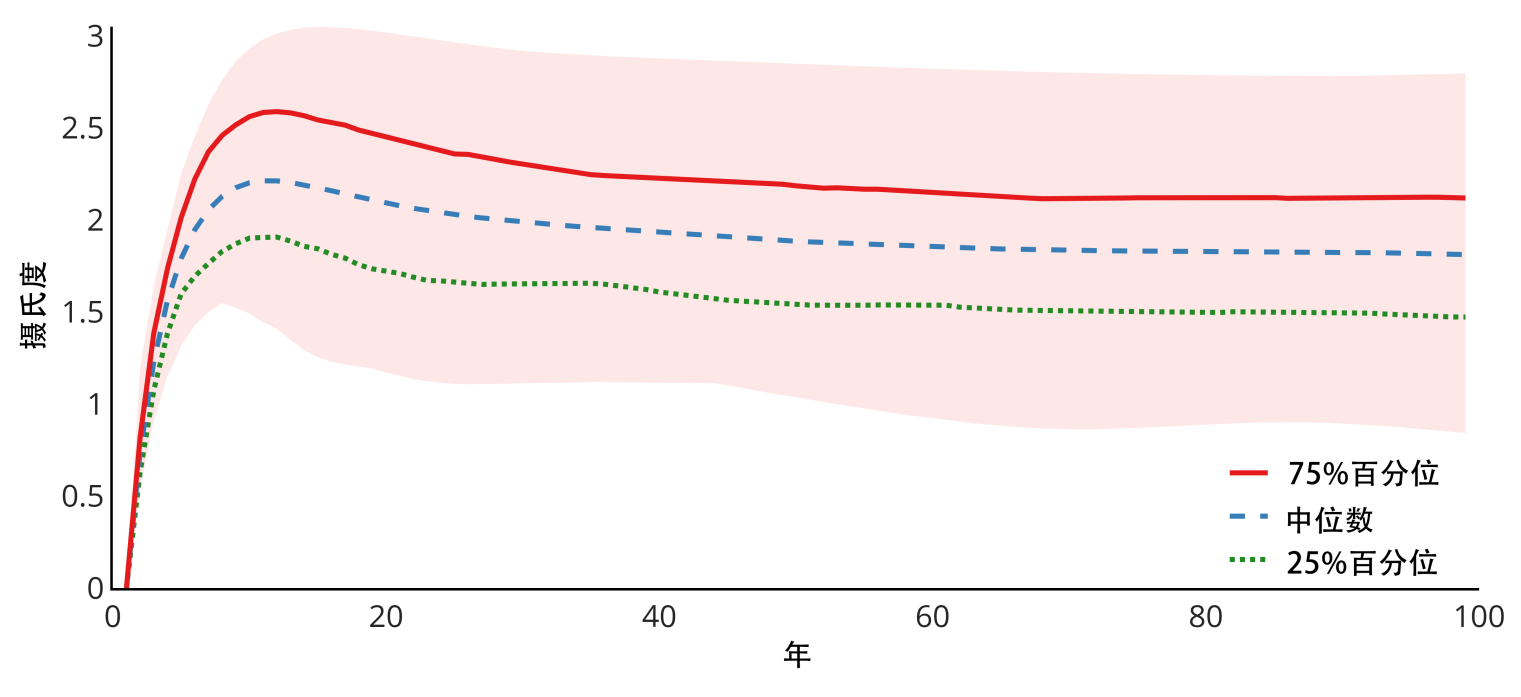
不确定性的权衡

运用基于专业判断和现实证据的数学模型：

- ▷ 做出最佳预测
- ▷ 查明潜在的坏结果

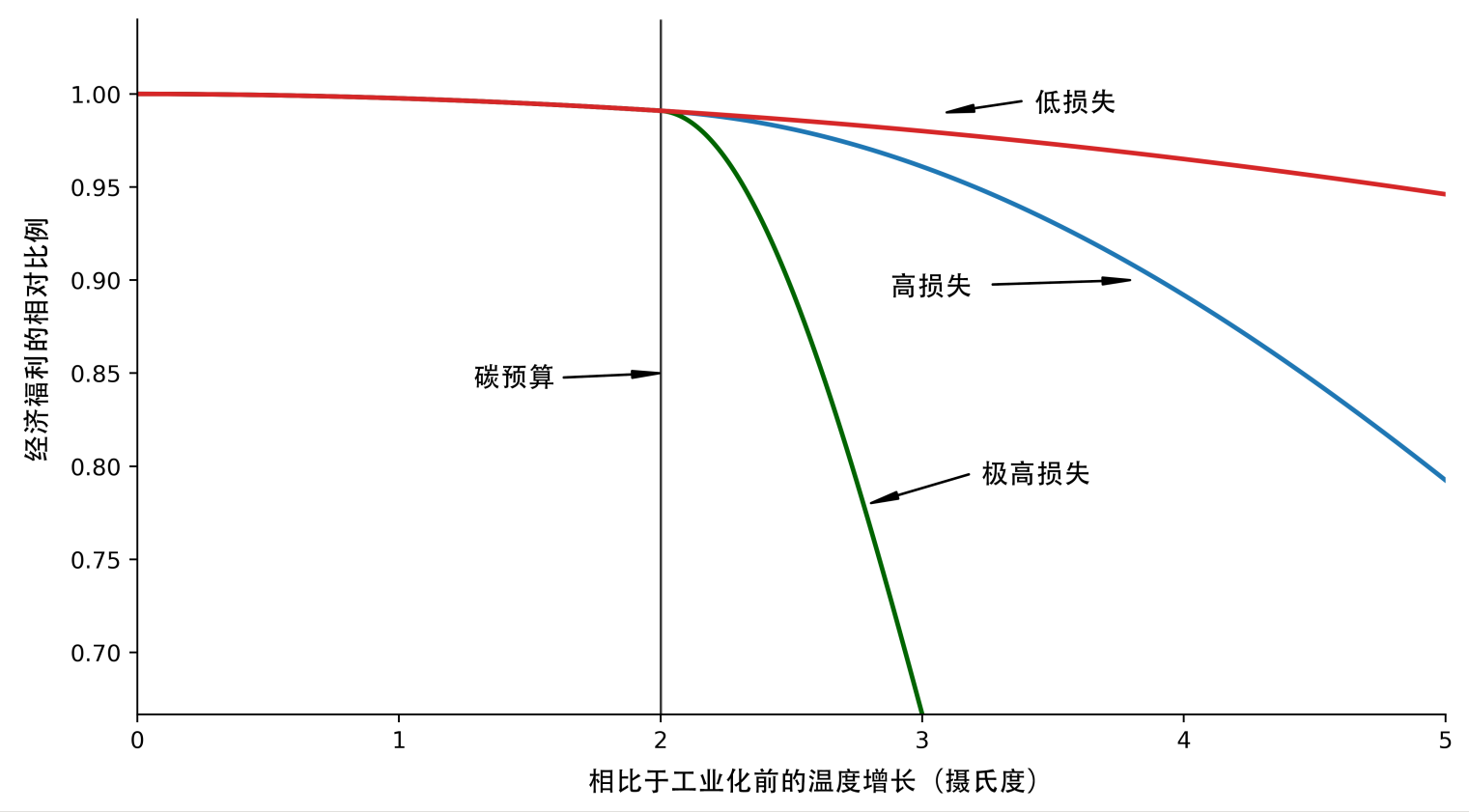
在制定决策（包括投资策略和公共政策）时，对于最佳预测和潜在坏结果分别应该给予多少关注？

气候模型预测

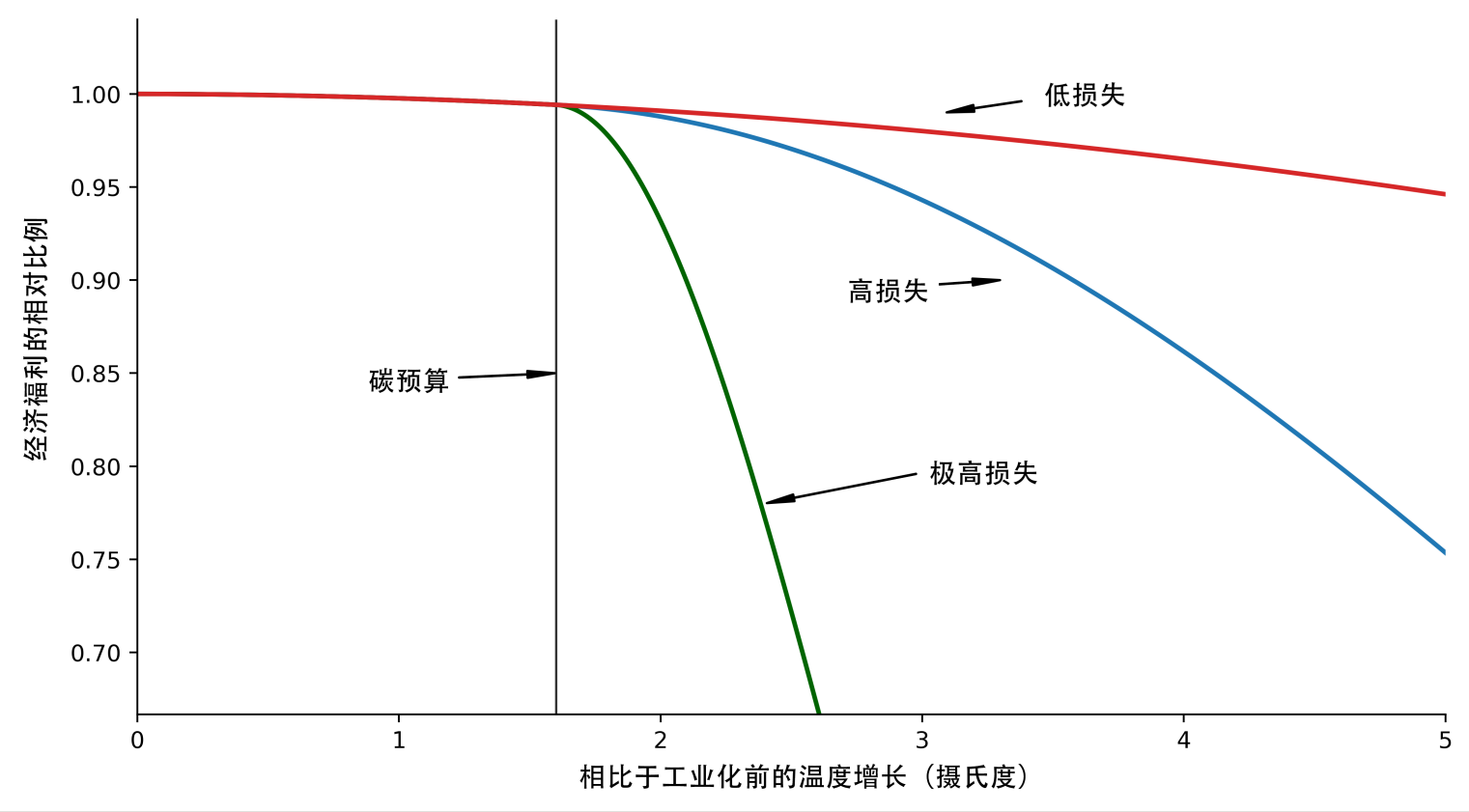


温度对碳排放冲激响应的百分位数。此处使用的碳排放冲激为 1000 亿吨，于第一年排放。纵轴中温度的单位为 ×10 摄氏度。阴影区域的上下边界是使用 144 个模型计算出的最大和最小值。

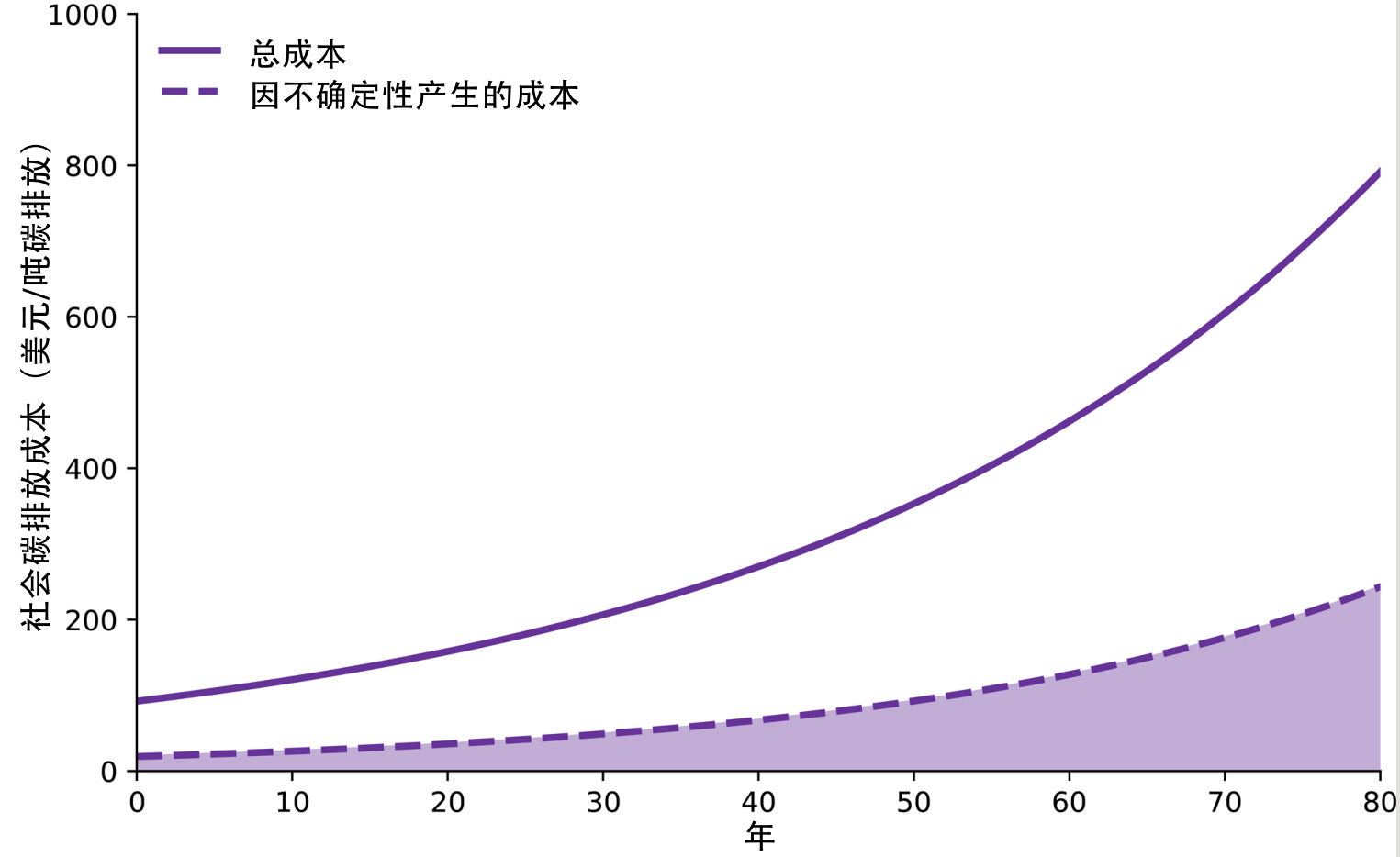
经济损失的不确定性


1.00
0.95
0.90
0.85
0.80
0.75
0.70
经济福利的相对比例
0
1
2
3
4
5
相比于工业化前的温度增长（摄氏度）
低损失
高损失
碳预算
极高损失

经济损失的不确定性


1.00
0.95
0.90
0.85
0.80
0.75
0.70
经济福利的相对比例
0
1
2
3
4
5
相比于工业化前的温度增长（摄氏度）
低损失
高损失
碳预算
极高损失

碳排放社会成本的不确定性



可选的政策杠杆

- 对碳排放征税
- 对转型使用可再生能源给予补贴
- 对新型洁净能源的研发给予补贴
- 鼓励植树造林，保护自然界已有的碳汇

不确定性如何影响这些政策选项的成本和收益？

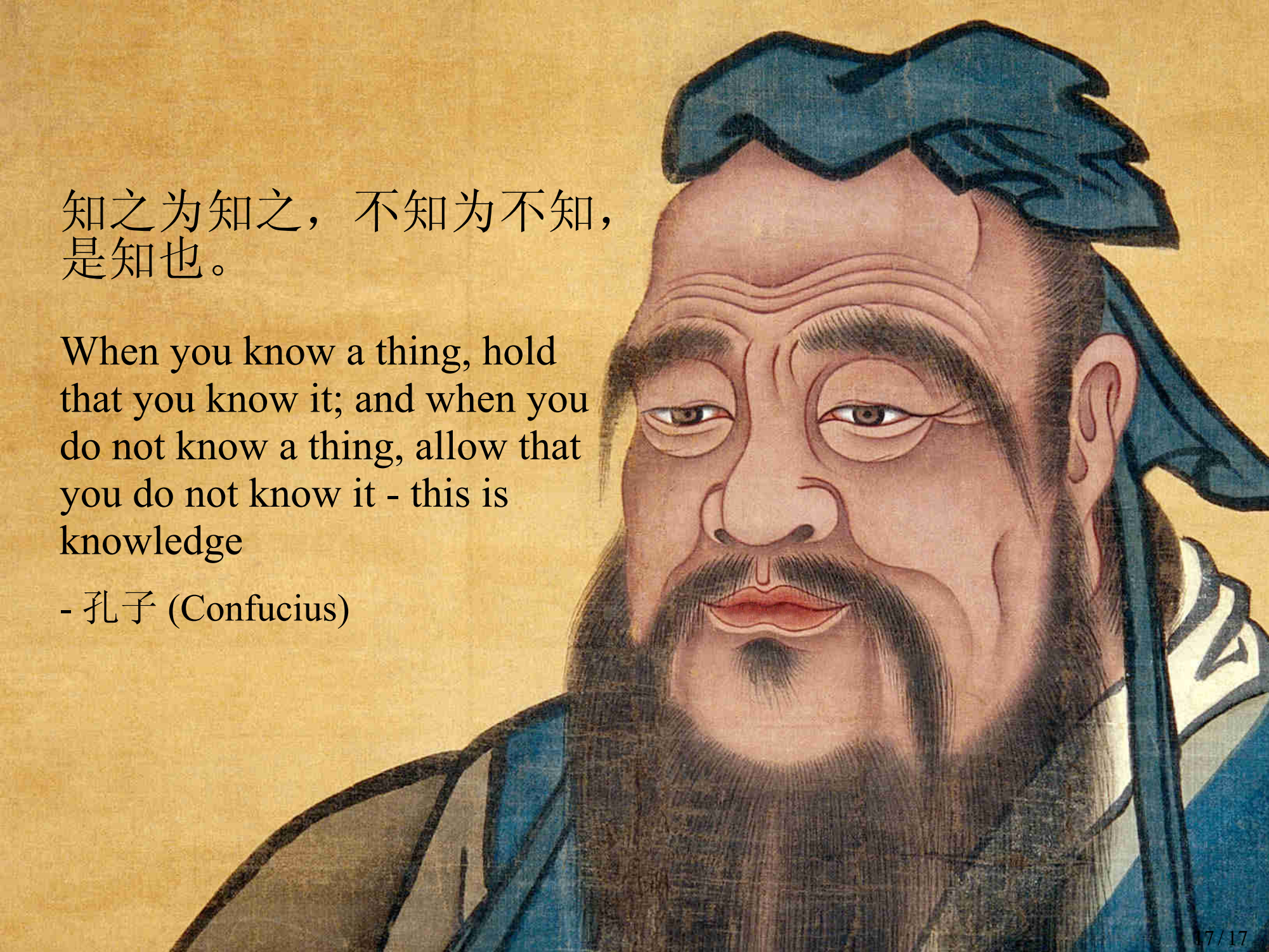
中美两国的政策日程

计划:

- 中国
  - 短期计划：5 年内减少相对碳排放 18%
  - 长期计划：2060 年前实现碳中和
- 美国
  - 短期计划：2030 年前减少排放 50%
  - 长期计划：2050 年前实现碳中和

问题:

- 这些宏伟的计划如何实现？
- 最有前景的政策手段是哪些？
- 如何重组激励措施？



知之为知之，不知为不知，
是知也。

When you know a thing, hold that you know it; and when you do not know a thing, allow that you do not know it - this is knowledge

- 孔子 (Confucius)