Comments on Bauer & Rudebusch, “The Rising Cost of Climate Change: Evidence from the Bond Market

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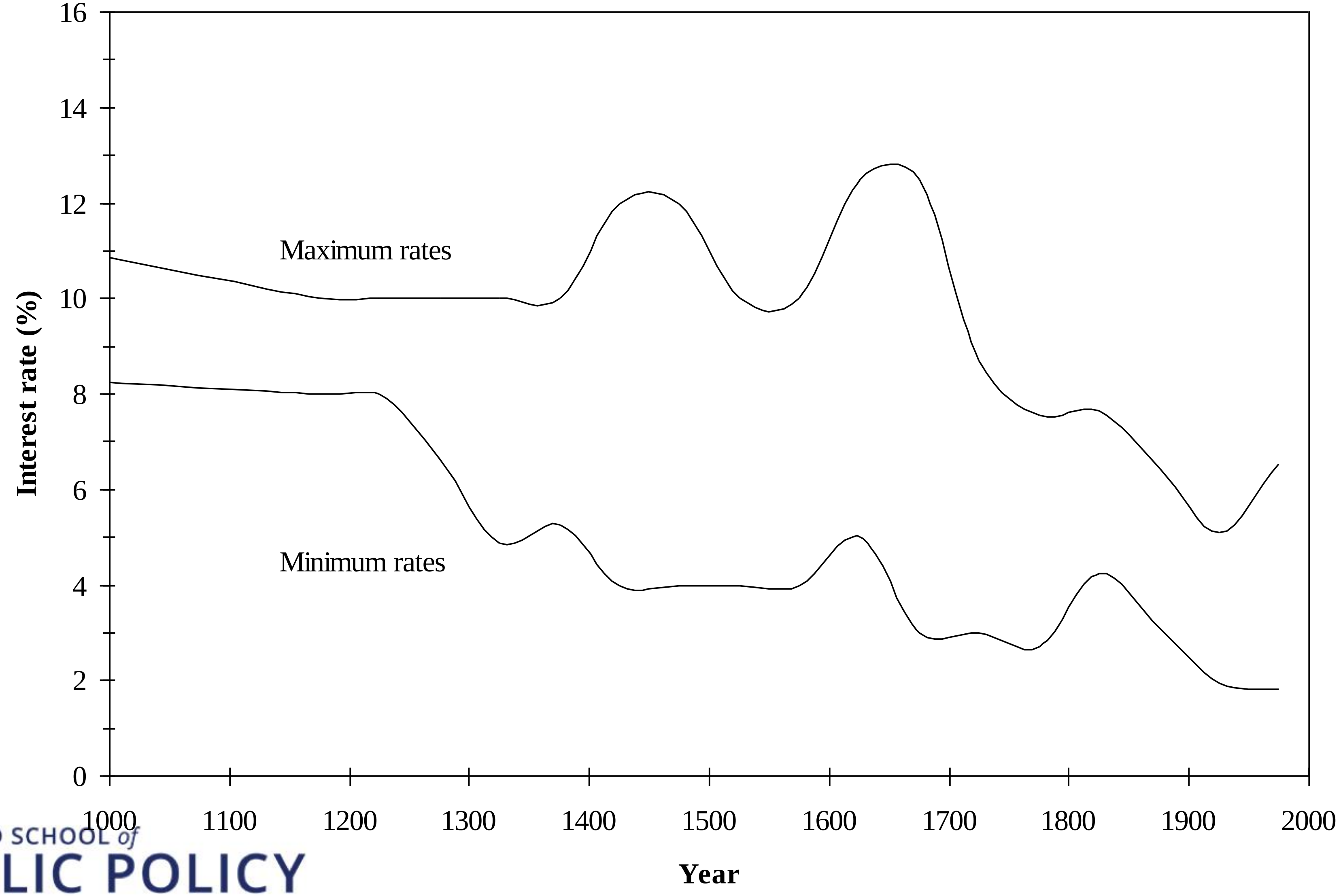
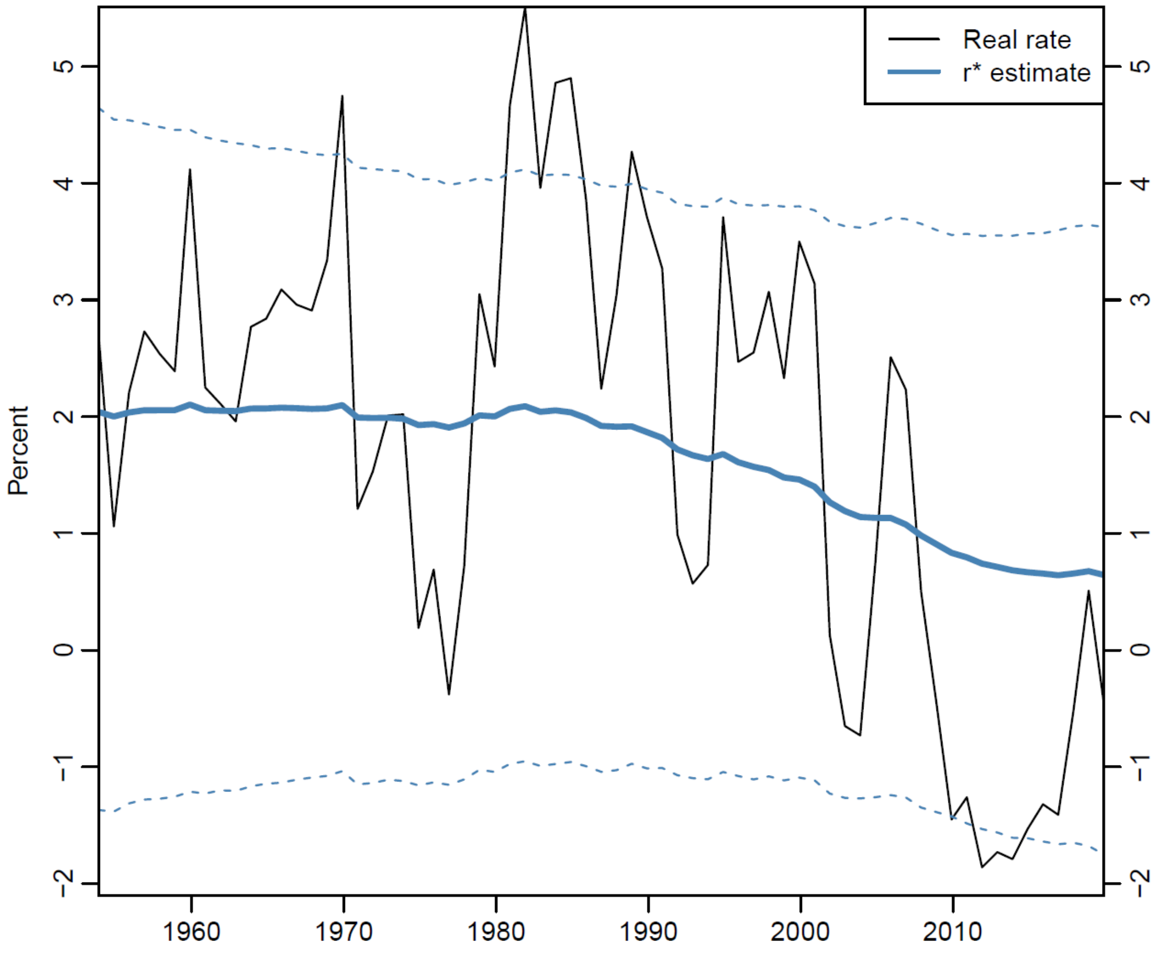
Perspective on long-term rates?



Source:
Homer & Sylla
(1998)

Paper summary – model and econometrics

Figure 2: Estimates of equilibrium real interest rate from baseline UC model



The real rate shows annual data for the one-year U.S. Treasury yield adjusted for inflation expectations over the sample from 1953 to 2019. Based on this series, the resulting estimate of the equilibrium real rate, r_t^*, is a Bayesian posterior mean from the univariate UC model. Dashed lines show the 95% Bayesian credibility intervals for r_t^*.

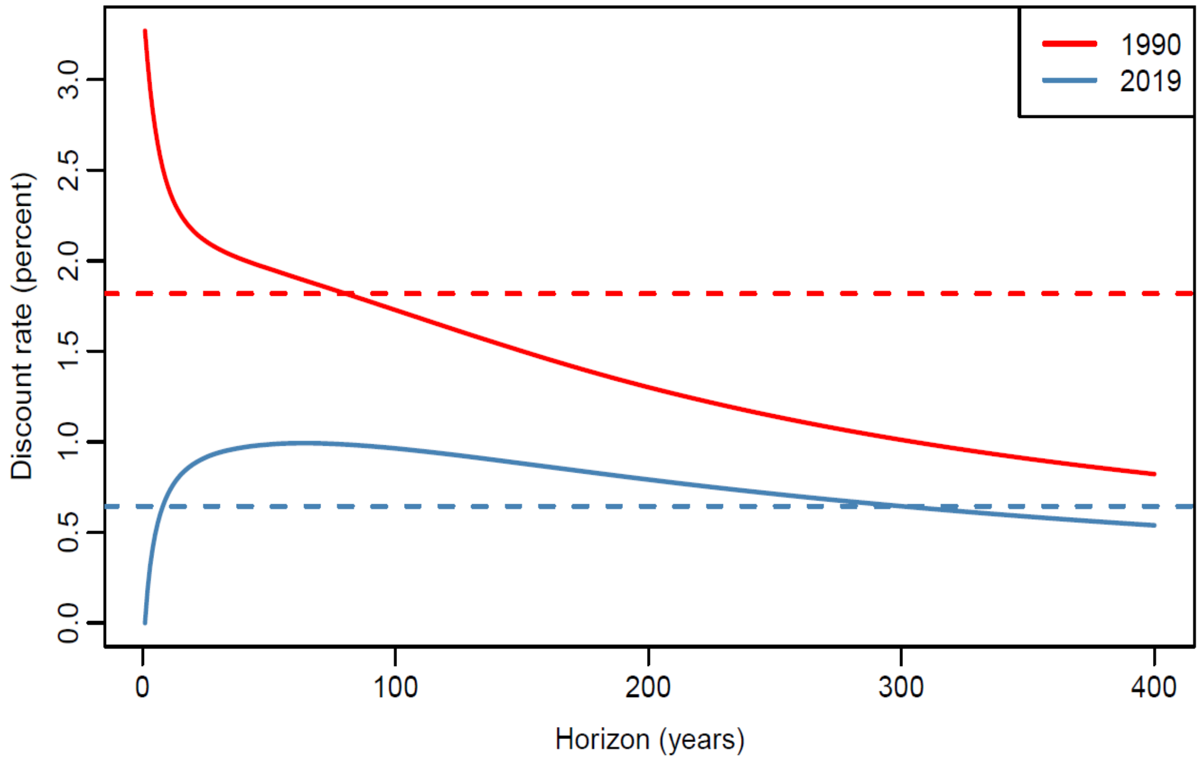
- "certainty-equivalent discount rate" or "real zero-coupon bond yield":

$$y_t^{(n)} = r_t^* + \frac{1}{n}\sum_{j=0}^{n-1} E_t\tilde{r}_{t+j} + z_t^{(n)}$$

- Changes in r_t^* change the entire term structure.
- Evidence suggests r_t^* has declined over the past 30 years.

Paper summary – projecting future rates

Figure 3: Term structure of discount rates from baseline UC model



Term structures of discount rates (real yields) calculated using simulations from UC model in equations (5), (10) and (11), the posterior mean estimates for parameters and state variables, and a shadow-rate constraint for the real short rate that ensures non-negative discount rates. The red term structure is based on the real rate and estimated r_t^* in 1990, and the blue term structure uses the values for 2019. The dashed lines show the model-based estimates of r_t^* in those two years.

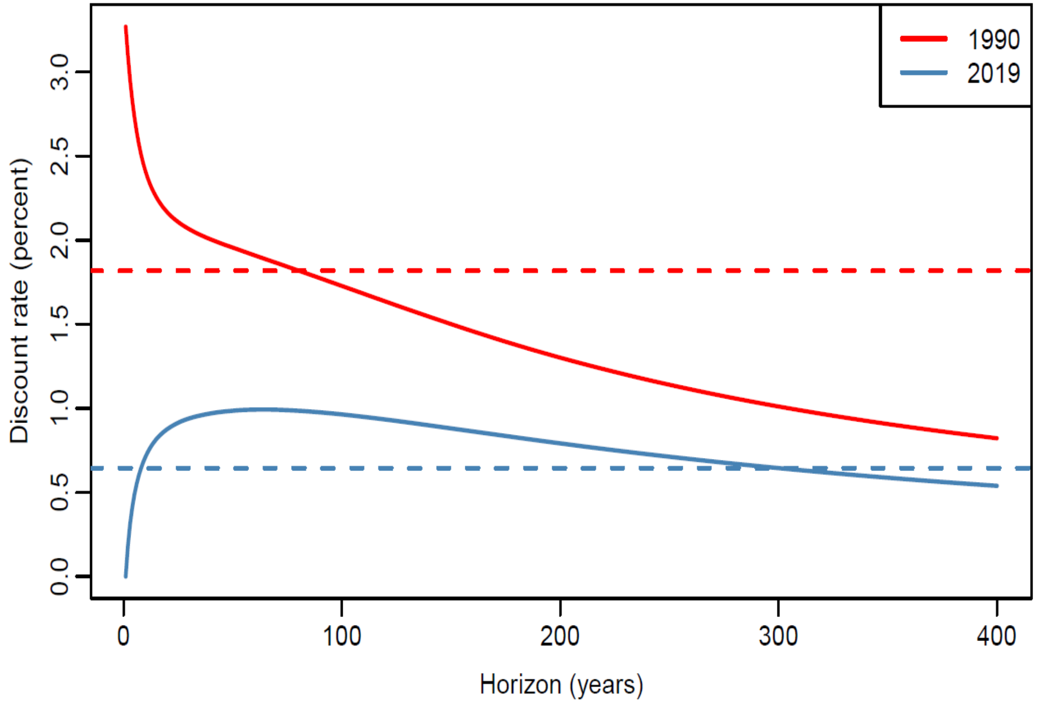
- Compared to 1990, expected long-term equilibrium discount rate r_t^* is ~1% lower.
- $z_t^{(n)}$ drives long term decline in both cases.
- Near-term cyclical component $E_t\tilde{r}_{t+j}$ is high in 1990; low then high in 2020.
- Apply this to a pattern of damages from one ton CO2 today = SCC: $32 in 1990, $69 in 2020.

Great paper!

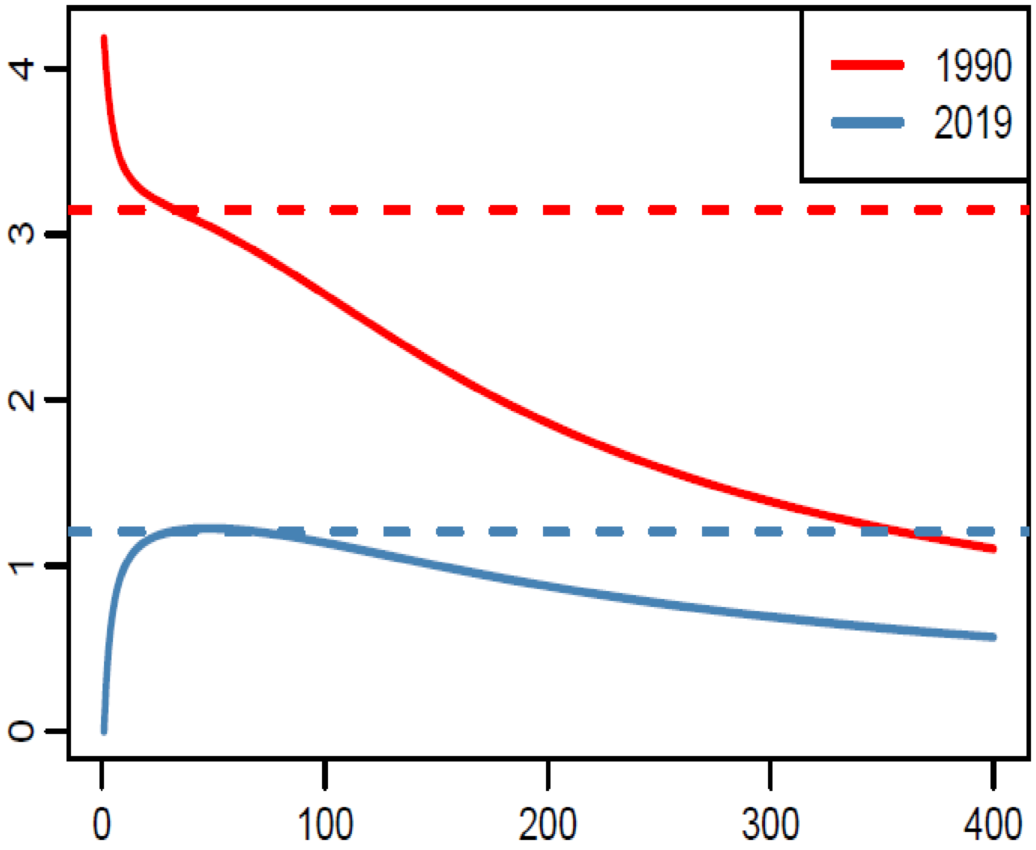
- Totally believe it.
- Important evidence to inform and update federal discounting guidelines.
- Who will be Director of OIRA???

Comment 1: Does estimation strategy vary by horizon? What horizon makes the most sense?

Figure 3: Term structure of discount rates from baseline UC model



UC model, 10y rate



Comment 2a: How frequently / when should we update the discount rate for public policy?

- US history / OMB guidelines: 10% (1969), 7% (1992) 7 & 3% (2003).
- CEA (2017) report: “Though the guidelines in A-4 are continually monitored, they have been updated approximately once per decade in recent years… Given the passage of time and the continued evolution of the economy and our understanding of it, a review of the discount rate guidance in A-4 is overdue… plausible estimates based on past data and current market- and survey-based forecasts of at most 2 percent.”
- Great timing!

Comment 2b&c: But, include $\tilde{r}_t$? Focus on estimate r_t^* or Δr_t^*?

- Probably do not want to updating discount rate policy every year…

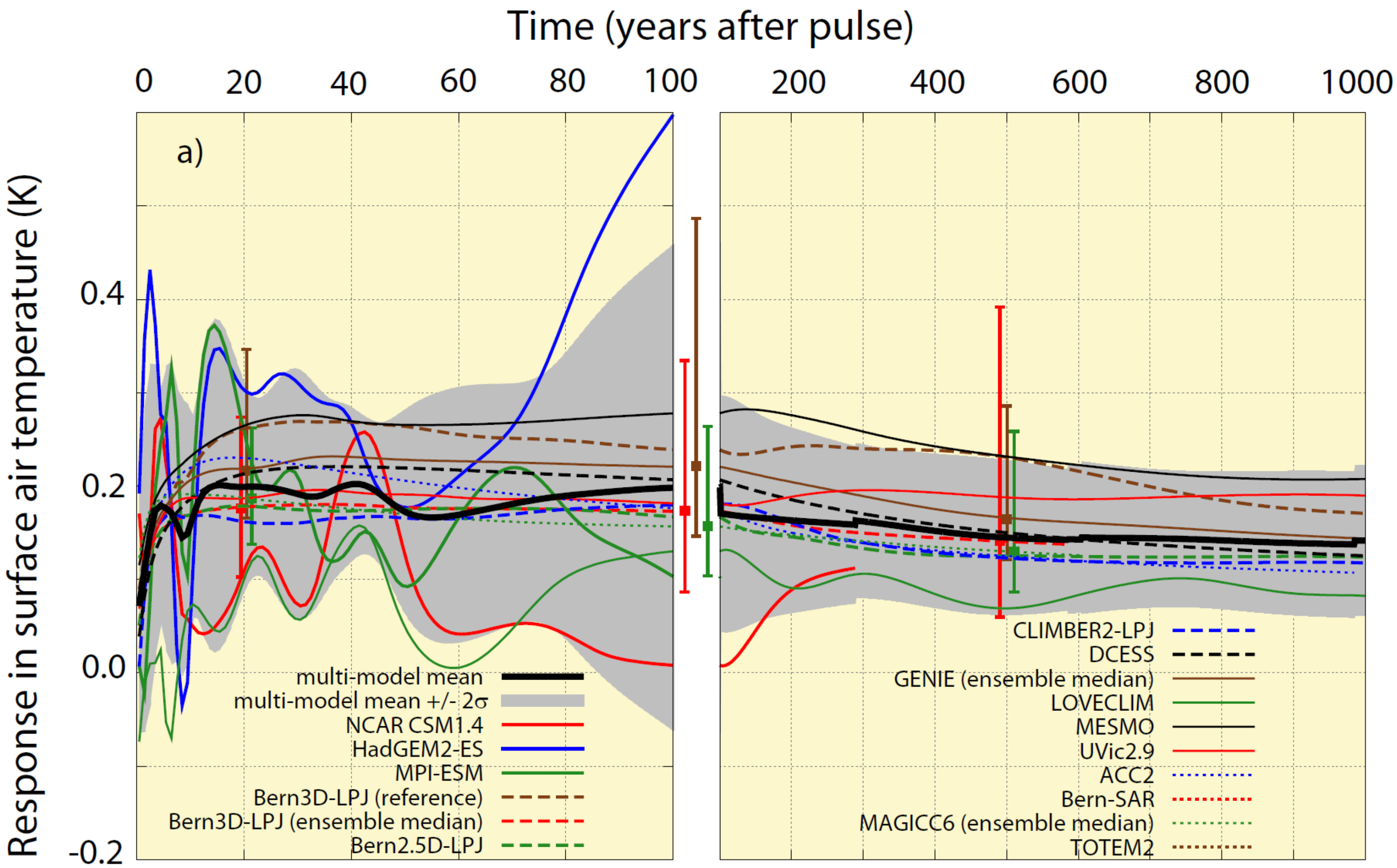
- Redo analysis without short-term cyclical component?

- Redo analysis using 3% and $3\% + \Delta r_t^*$?

Comment 3: Importance of relating uncertain discount rates to uncertain growth

- Climate damages generally assumed (a) to vary with global temperature change and (b) to be proportional to income (or income per capita) in an unchanging way. E.g., 3 degrees warming = 2% loss of income forever.
- Temperature change from a ton of CO_2 emitted today is now estimated to reach a roughly constant value after a few decades and remain at that level for over a millennium.
- Recent estimates of uncertainty about long-term per capita economic growth range from 0 to 4%.
- Need to consider whether discount rate can be lower than growth rate.

Comment 3: Importance of relating uncertain discount rates to uncertain growth

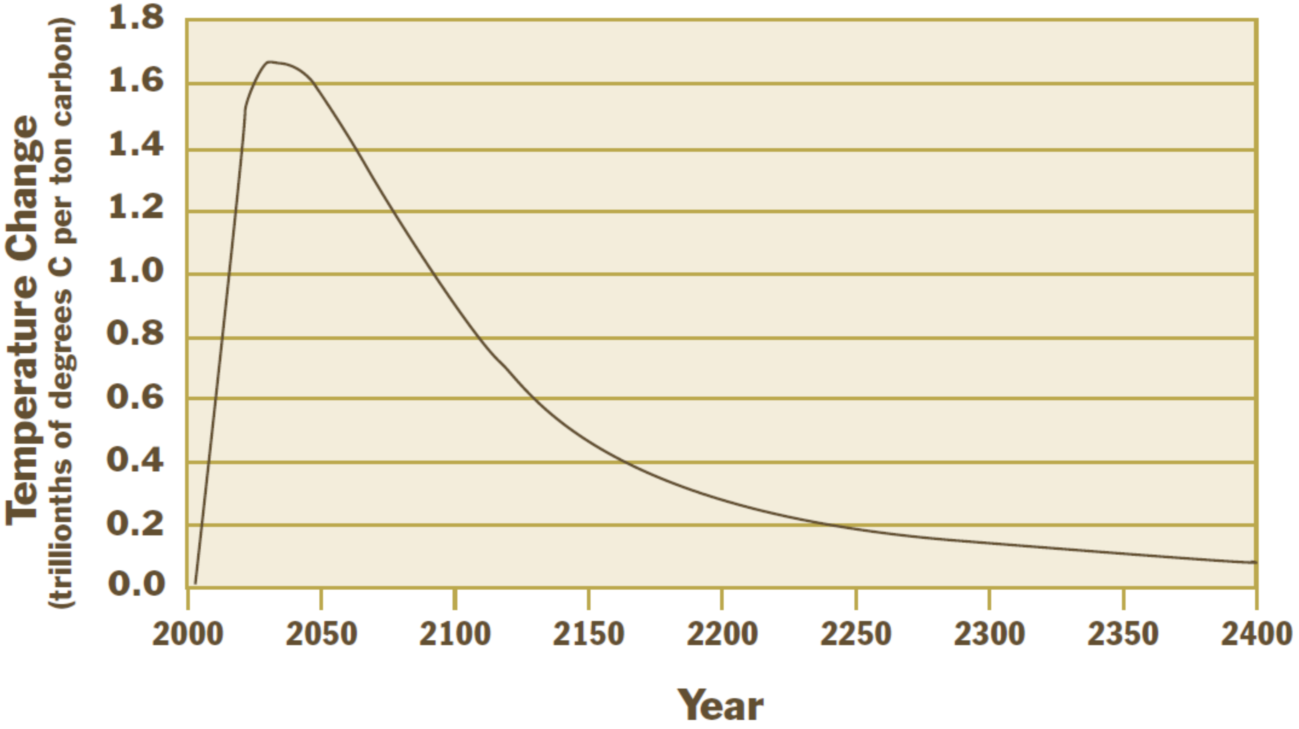


- Joos et al (2013)
- Warming from a pulse of CO2 peaks at 0.2 after 10 years (pulse of 100 GtC).
- Warming persists with only slight decline for a millennium.

Comment 3: Importance of relating uncertain discount rates to uncertain growth

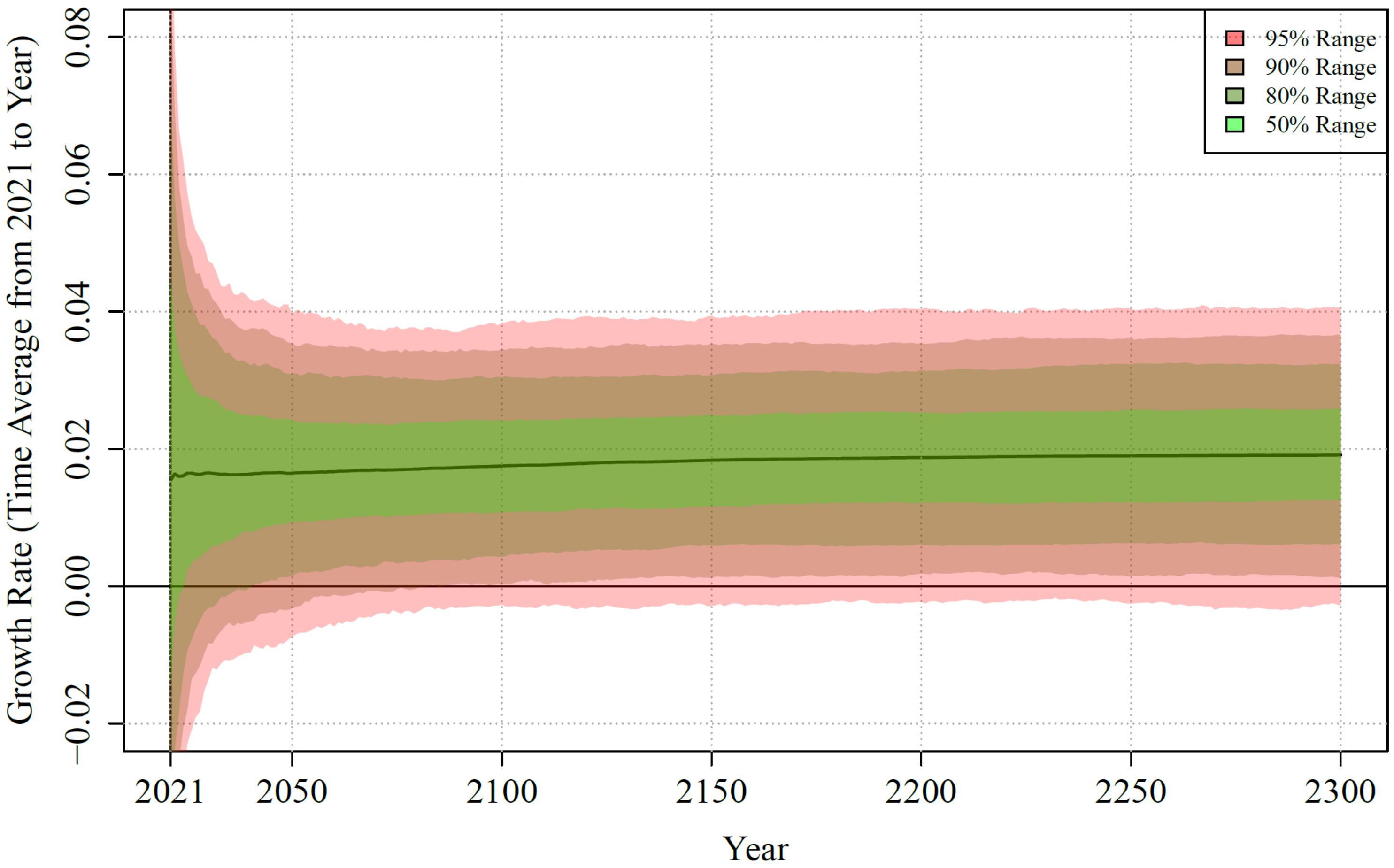
Figure 2

Influence of **Carbon Emissions** on Temperature Change



- Very different from thinking in Nordhaus / Newell & Pizer / Bauer & Rudebusch.
- … But same basis in Obama-era SCC estimates…

Comment 2: Importance of relating uncertain discount rates to uncertain growth



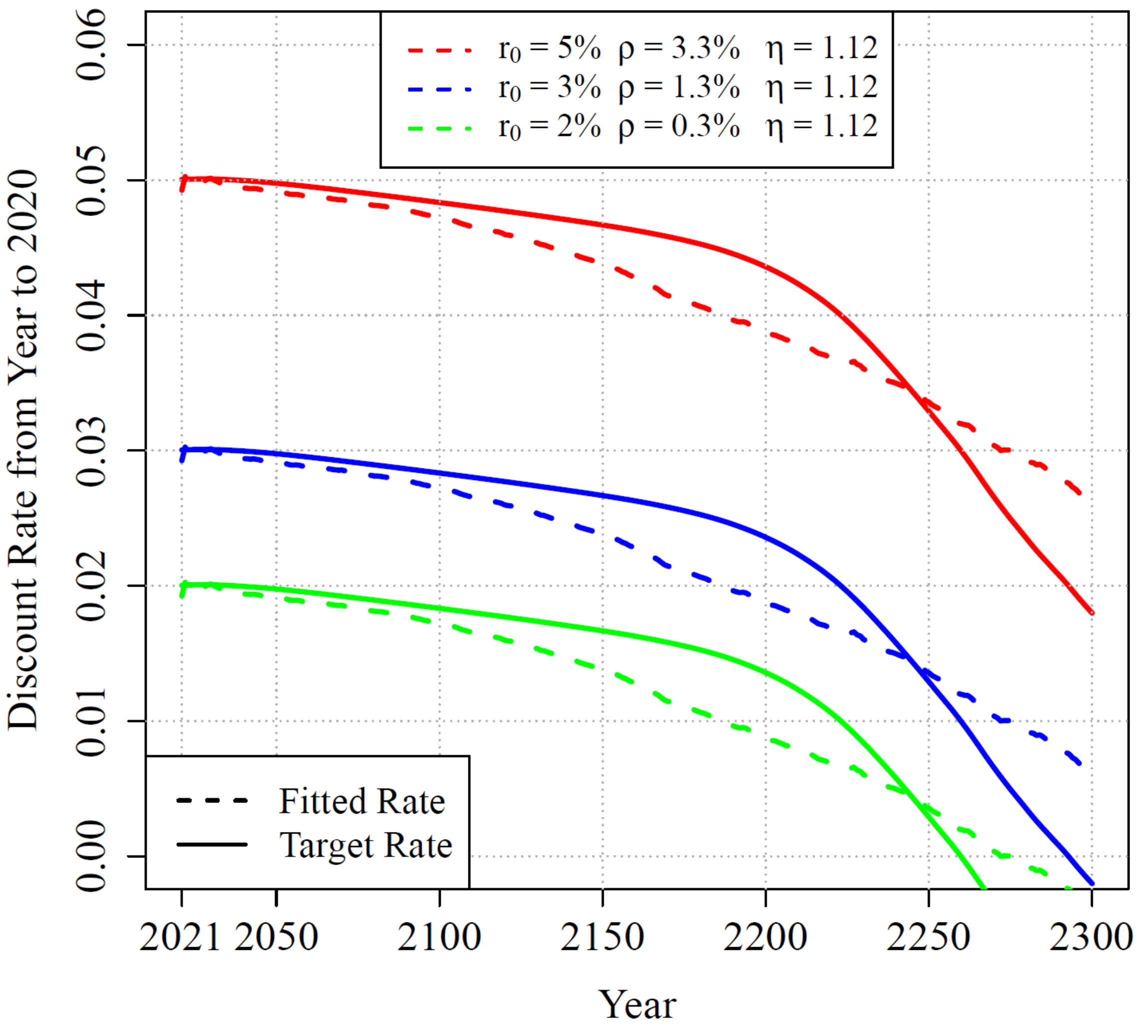
- Meanwhile, state of the art estimates of long-term global GDP per capita growth rates vary from ~0-4%.
- Muller, Stock, and Watson (forthcoming)

Comment 3: Importance of relating uncertain discount rates to uncertain growth

- Under these conditions, if there is any probability of long-term growth > discount rate, the SCC become essentially infinite (above ~$300 / ton it does not matter; we would mitigate all emissions).
- NAS report:

RECOMMENDATION 6-1 The Interagency Working Group should develop a discounting module that explicitly recognizes the uncertainty surrounding discount rates over long time horizons, its connection to uncertainty in economic growth, and, in turn, to climate damages. This uncertainty should be modeled using a Ramsey-like formula, $r = \delta + \eta \cdot g$, where the uncertain discount rate r is defined by parameters δ and η and uncertain per capita economic growth g. When applied to a set of projected damage estimates that vary in their assumptions about per capita economic growth, each projection should use a path of discount rates based on its particular path of per capita economic growth. These discounted damage estimates can then be used to calculate an average SC-CO_2 and an uncertainty distribution for the SC-CO_2, conditional on the assumed parameters.

Comment 3: Importance of relating uncertain discount rates to uncertain growth



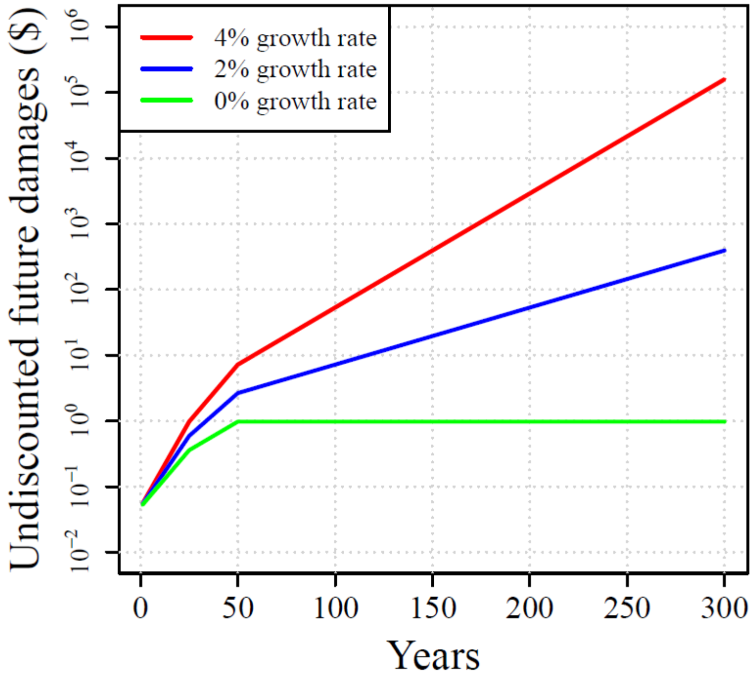
- Could use Bauer and Rudebusch term-structure (maybe without the $\tilde{r}_t$) and fit a term-structure derived from MSW growth rates and a Ramsey-like model.
- See Newell, Pizer, Prest (2020).
- …Uncertainty does not have as a large of an effect, but level shift does…

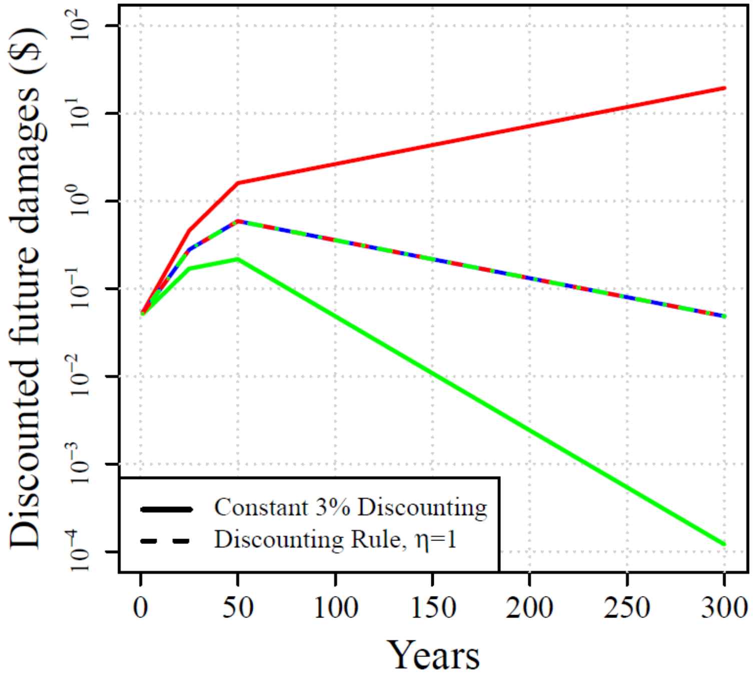
Comment 3: Importance of relating uncertain discount rates to uncertain growth

- Stylized example from Newell, Pizer, Prest.

- Undiscounted damages from one ton CO_2 emitted today that do not decay and grow at the per capita growth rate.

- What happens to discounted damage pattern with $\eta = 0, \rho = 3\%$ versus $\eta = 1, \rho = 1\%$?





Thanks!