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Some observations from MERGE Uncertainty Modeling Round 2

Steven Rose (with Geoff Blanford)

Uncertainty Modeling Project

Snowmass 2013

Scenario protocol implementation

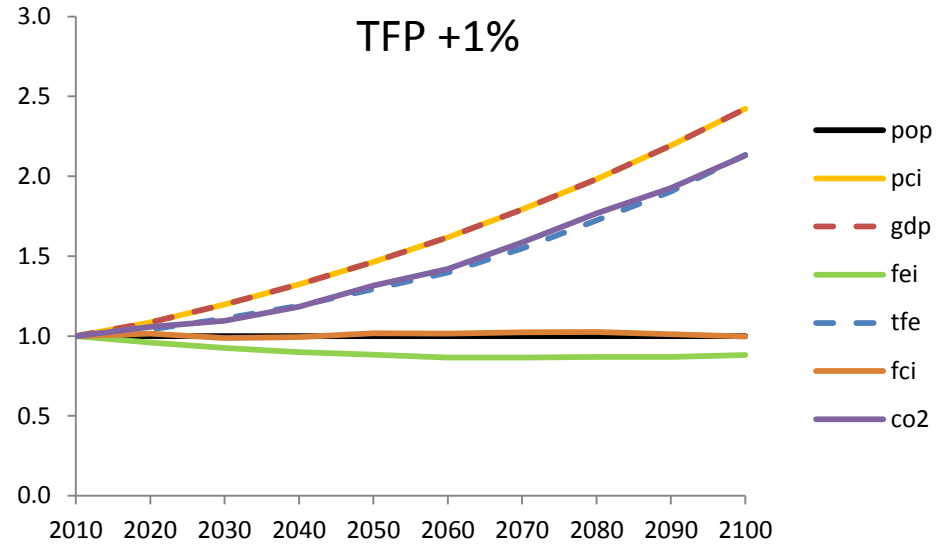
- TSC – Adjusted both CS and actual temperature lag to remain calibrated to observed warming (e.g., longer lag with higher CS)
- TFP growth – Implemented via labor productivity as prescribed
- POP growth – Growth rate adjusted but labor productivity unchanged
- However, for TFP and POP sensitivities, implemented heterogeneous regional growth rates that yield the prescribed global growth rate (larger adjustments in faster growing regions (non-OECD) and smaller adjustments in slower growing regions (OECD)). Tried to avoid negative growth, but not possible; yet, ensured regional per capita income always increasing.

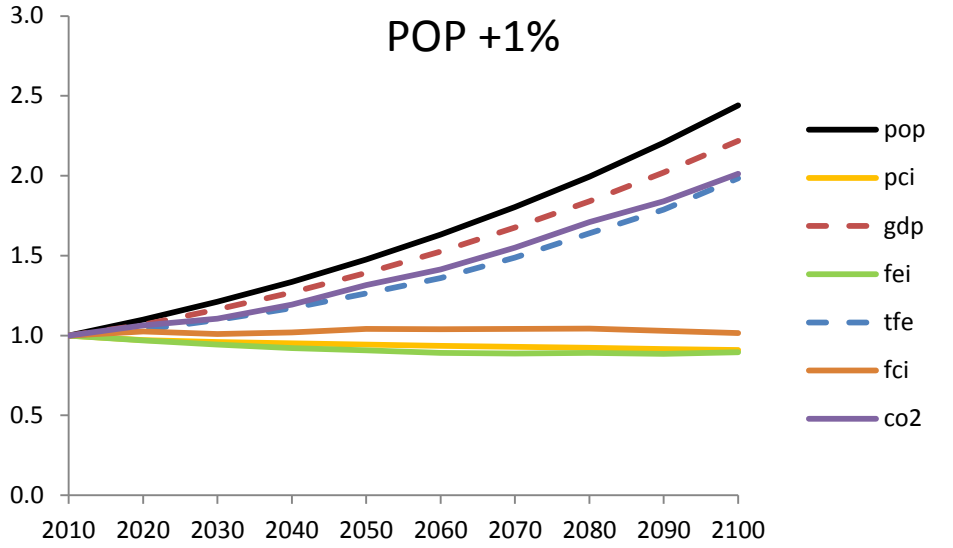
Distinguishing TFP and POP scenarios

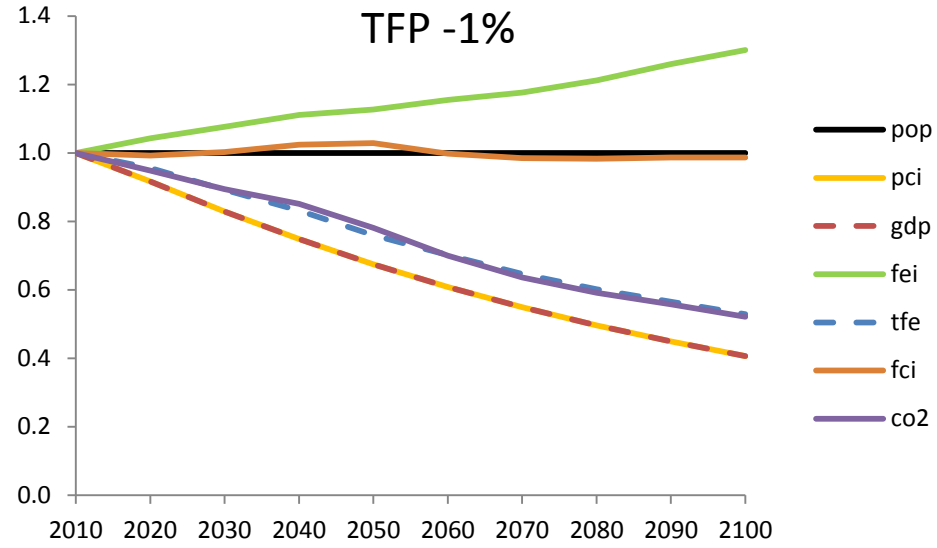
- Perturbation effects qualitatively similar
  - GDP increases (decreases), productivity/endowment effect
  - FE increases (decreases), productivity/demand effect
  - EI decreases (increases) slightly, input substitution effect
  - CO2 increases (decreases) by a little less than GDP, output effect
  - CI decreases (increases) ever so slightly, combination effect
- Only differences:
  - For TFP: POP constant, PCI up (down) vs.

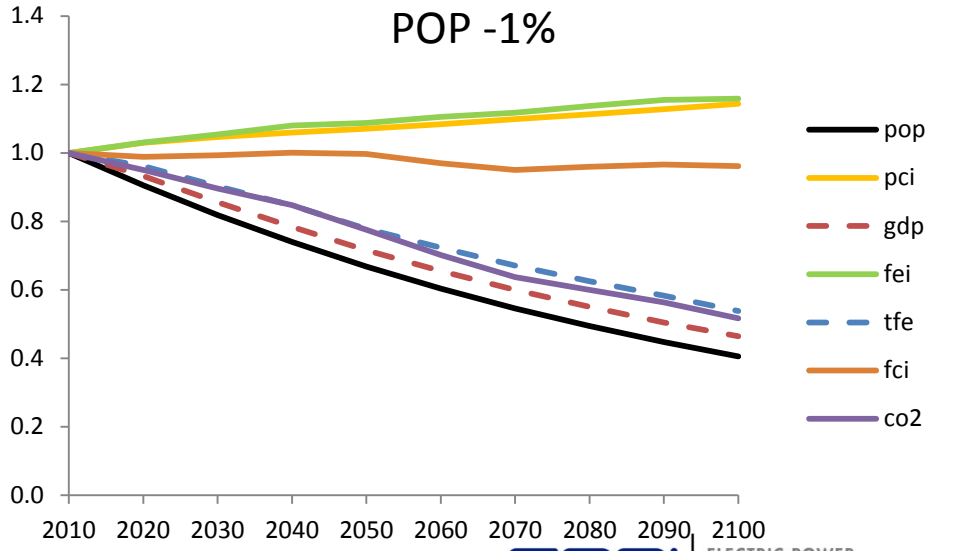
    For POP: POP up (down), PCI almost constant
  - Not a linear transformation, affects scale, regional weighting (however, regional specification was not controlled)

Change relative to default case in Kaya terms









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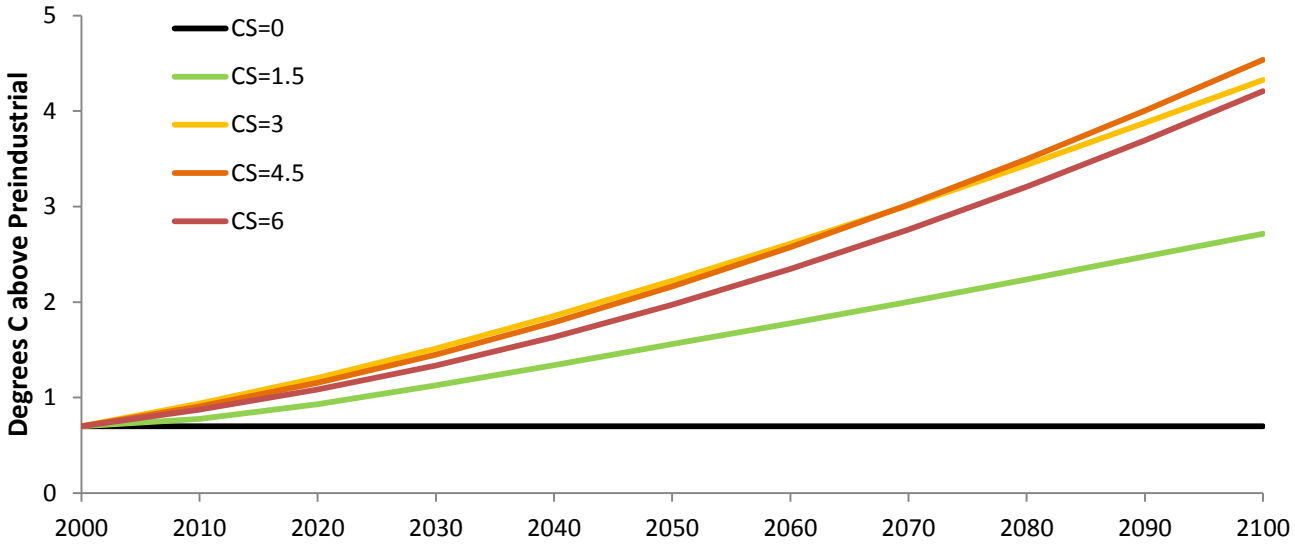
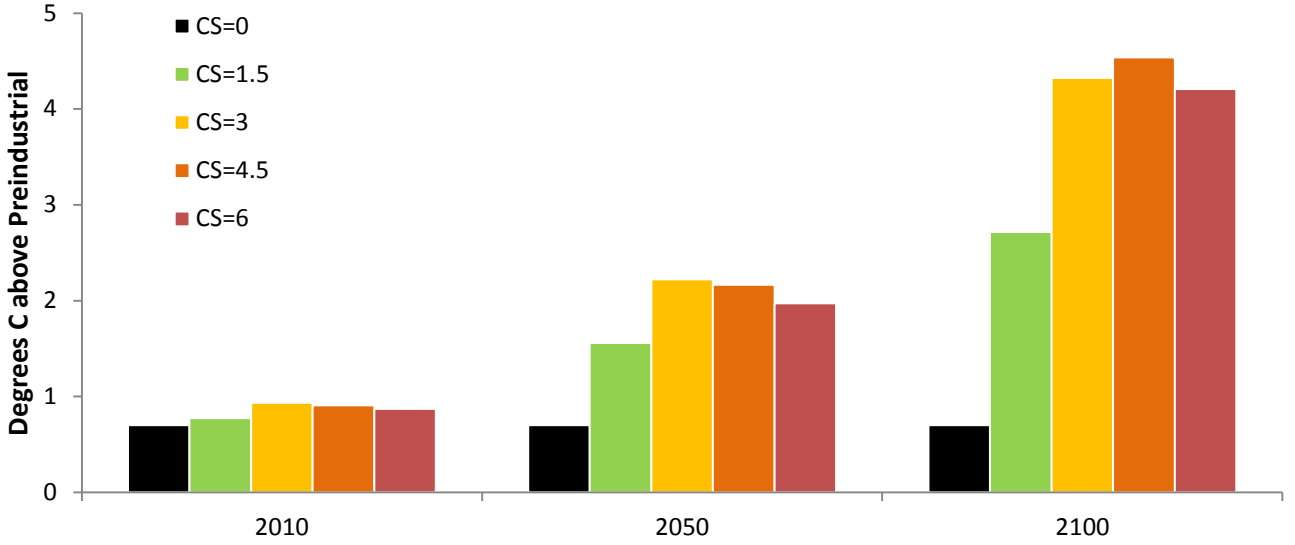
Are income elasticity and productivity shock type important?

- In MERGE, aggregate energy demand and utility are the same whether we have 100 people earning $10,000 or 1 millionaire
- One exception is in the passenger vehicle module, where vehicle ownership saturates with income (the millionaire would own fewer cars than the 100 factory workers combined)
- Other models with more detailed demand specification may have stronger income elasticity effects on demand and fuel mix
- By protocol, a labor PFP shock is implemented. A TFP shock would have stronger output and demand response for all inputs

Temperature "insensitive" to climate sensitivity?

Temperature Increase in Default BAU Case





Higher TSC implies slower response to be consistent with observations through 2000 (assuming median values of Kz and aerosol forcing)

So temperature in first century follows similar path for 3° < TSC < 6°

In fact, TSC=3° leads to the highest temperature in 2050, and TSC=4.5 temperature highest in 2100!

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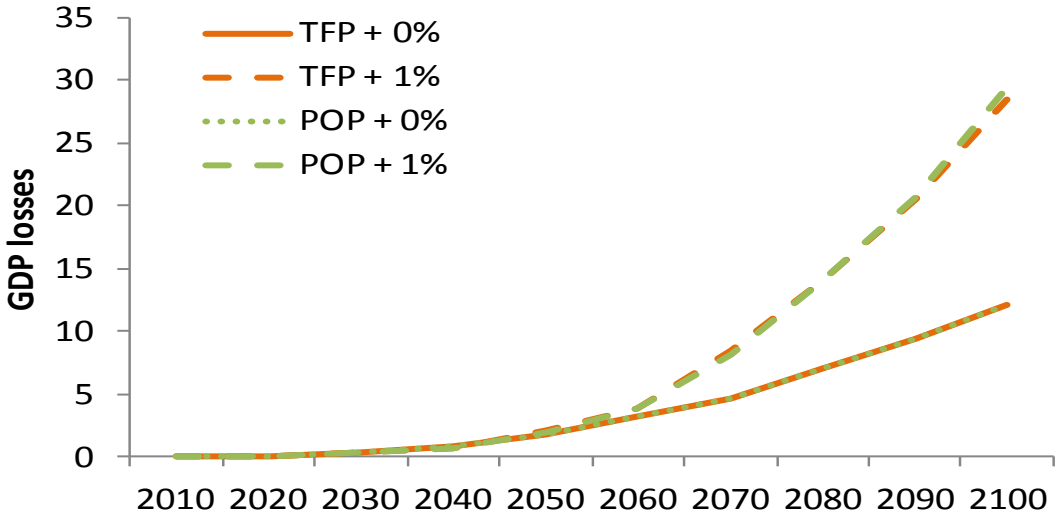
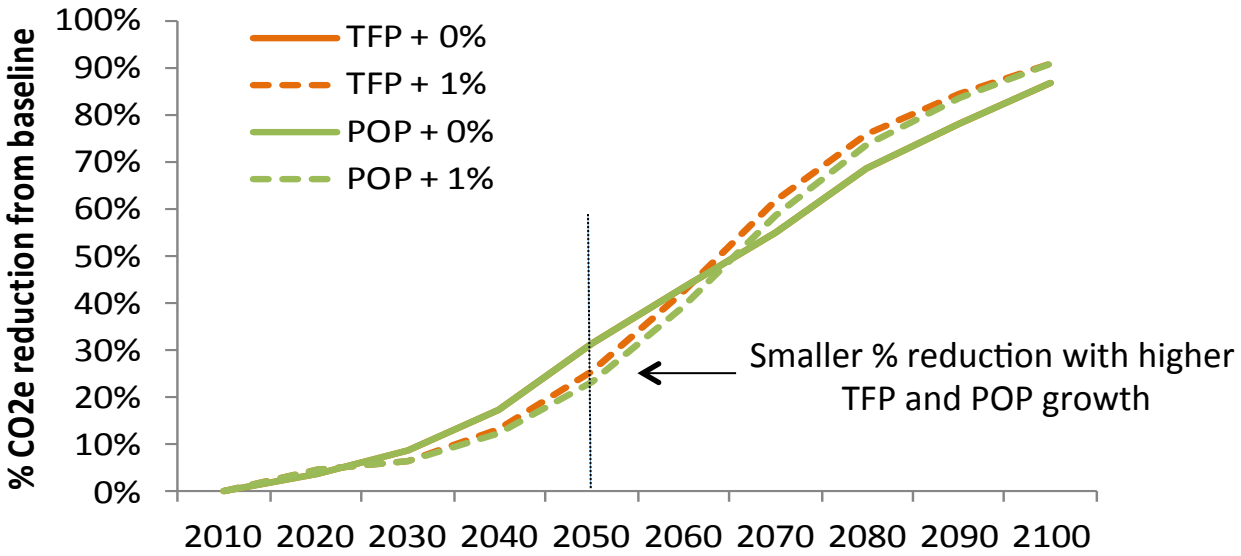
Tax scenario – GDP losses and marginal abatement costs increase with TFP and POP



However, % GDP losses similar across all the sensitivities



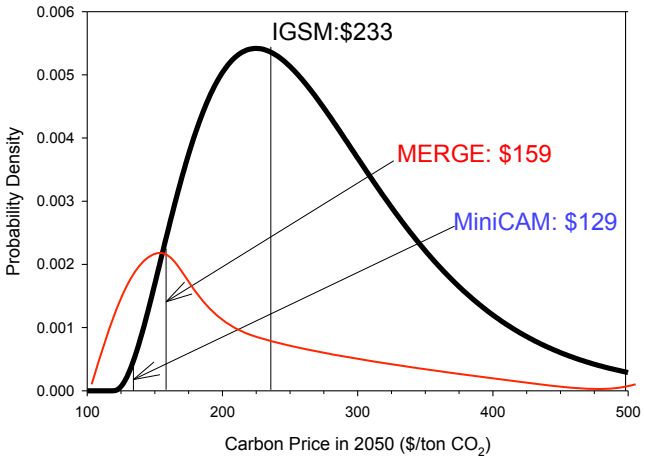
Scenario not ideal for revealing marginal abatement cost curve

Scenario design comments

- Do we want to implement TFP adjustments (vs the labor PFP adjustments implemented)?
- Additional scenario guidance could increase comparability – e.g., homogeneous v heterogeneous TFP growth changes
- Science based sensitivity ranges would increase the utility of the results
- Climate or emissions targets (vs carbon tax) would generate insights regarding, among other things, differences in and the sensitivity of (a) marginal costs and (b) climate modeling and marginal benefits

Explore uncertainty implications for policy benefits and costs (Steve Snowmass 2011 proposal)

Uncertainty about costs



(MERGE pdf made-up for illustration)

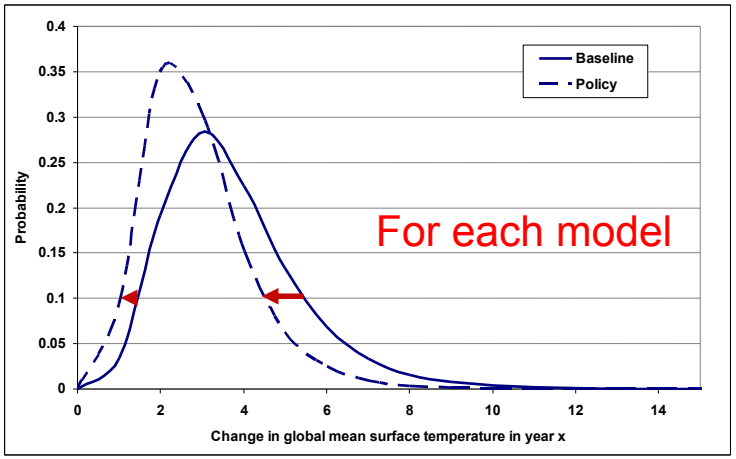
Also uncertainty about:

GDP, consumption, PE, FE, land-use, distributional effects

Policy certainty

Fix global emissions pathway (at least to 2050, no banking)

Uncertainty about benefits



Also uncertainty about:

Concentrations, RF, SLR, extreme events, monetized damages

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