ON THE CLIMATE POLICY IMPLICATIONS OF SUBSTITUTABILITY AND FLEXIBILITY IN THE ECONOMY

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Overview

- Bottom-up model diagnostic of the Integrated Assessment Model (IAM) MERGE
- Joint sensitivity analysis on the elasticity of substitution parameter between capital/labour and energy and the rate at which new technologies can be deployed within the energy system
- In a more complementary world, the model opts to decrease the carbon-intensity of the energy system whereas in a more substitutable world it opts to decrease the energy-intensity of the economy
- Model behaviour may be more a function of model parameterisation than structure
- Both elasticity and technology parameters are critical to model behaviour, insights and output
- There is danger in relying too heavily on historical data when parameterising a model that projects into the future ("The Big Mistake" [1])

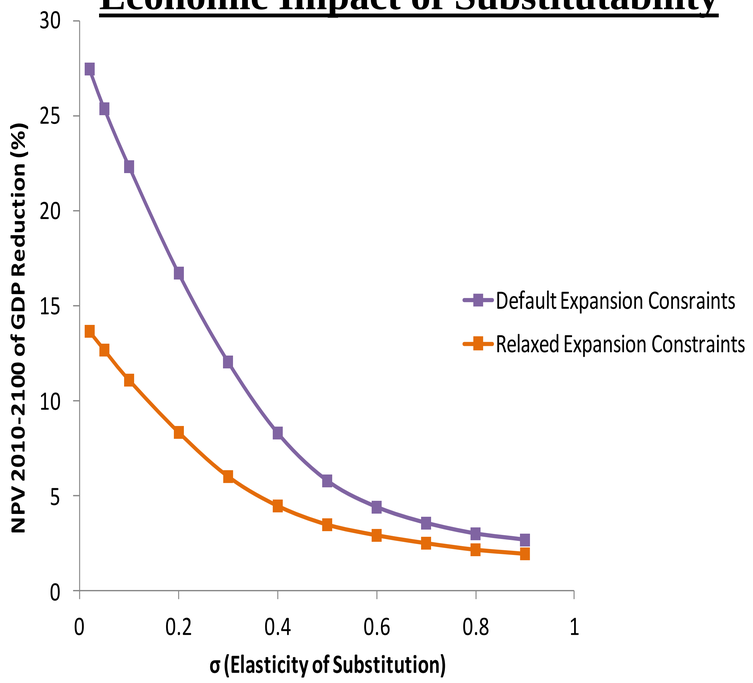
Highlighted Scenarios

Elasticity of Substitution	Policy Cases	Technology Expansion Cases
0.02	BAU & 3 W/m^2	Default (7.2% annual limit) & Relaxed (30% annual limit)
0.5	BAU & 3 W/m^2	Default & Relaxed
0.9	BAU & 3 W/m^2	Default & Relaxed

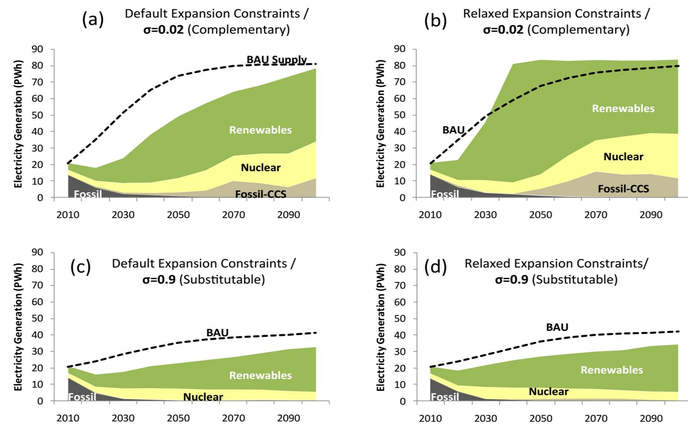
Results

- Order of magnitude difference in NPV of %GDP reduction through 2100 between most complementary and substitutable cases
- Model targets carbon-intensity first in more complementary scenarios
- Model targets energy-intensity first in more substitutable scenarios
- Optimal technology mix not sensitive to expansion constraints in more substitutable cases

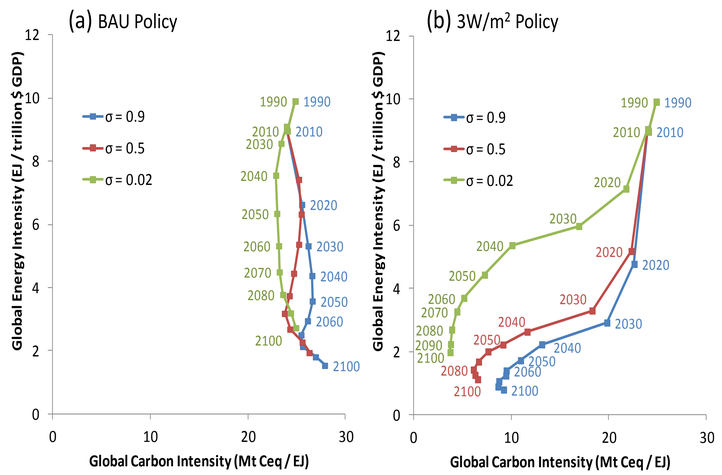
Economic Impact of Substitutability



Disaggregated Impact on the Electricity Sector



Carbon Intensity vs. Energy Intensity



Conclusions

- Impact and cost of tight climate policy as determined by an IAM is extremely sensitive to its parameterisation
- MERGE's classification as a 'high-response' model is perhaps a greater reflection of its parameterisation than its structure [2]
- In a more complementary world, R&D may be a more effective policy lever whereas in a more substitutable world, energy efficiency may be
- Important to undertake scenario analysis on parameters calibrated to historical data when considering future worlds
- Potential avenue for future work: structurally incorporating a time-varying elasticity of substitution
- Potential avenue for future work: a more systematic inter-model comparison of similar bottom-up diagnostic exercises

References

- [1] Koomey, Jonathan, 2002. Avoiding the "the Big Mistake" in Forecasting Technology Adoption. Technology Forecasting and Social Change. 69(5), 511-518.
- [2] Kriegler, Elmar, Nils Petermann, Volker Krey, Valeria Jana Schwanitz, Gunnar Luderer, Shuichi Ashina, Valentina Bosetti, Jiyong Eom, Alban Kitous, Aurélie Méjean, Leonidas Paroussos, Fuminori Sano, Hal Turton, Charlie Wilson, and Detlef P. Van Vuuren, 2015. Diagonstic Indicators for Integrated Assessment Models of Climate Policy. Technology Forecasting and Social Change. 90:A, 45-61.