

***UNCERTAINTIES IN ECONOMIC COSTS OF
CLIMATE CHANGE***

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WHO MIGHT BE AFFECTED?

Firms

Workers

Consumers

Taxpayers

BY WHAT?

- Costs of emission reductions***
- Costs/benefits of change in climate***

The existing economic modeling has focused more on the former than the latter.

HOW ARE PEOPLE AFFECTED?

COST OF EMISSION REDUCTIONS

Loss of profit

Loss of income/wages

Unemployment

Higher prices

COST/BENEFIT OF CLIMATE CHANGE

- Impact on profit**
- Impact on income/wages**
- Unemployment**
- Impact on prices**
- Change in input quantity**
- Change in input quality**
- Disruption of production**
- Loss of capital assets**
- Loss of wellbeing**
- Increased uncertainty**
- Loss of options/flexibility**

Not easy to capture some of these in commonly used models.

The existing economic models are general equilibrium models; they provide comparative statics results.

The major economic effects of climate change may be associated with temporary, out-of-equilibrium behavior.

Adaptation, ability to anticipate need for change, ability to implement change – especially collectively -- are of the essence. Determinants of change in technology and preferences are crucial.

Researchers have begun to pay attention to these on production side.

Stages:

- **Model specification**
- **Model estimation/calibration**
- **Model forecast**

TYPES OF ERROR/UNCERTAINTY (Lee)

Inaccuracy/inadequacy of data

Estimation uncertainty

Model specification uncertainty

Behavior heterogeneity/uncertainty

At the individual level, behavioral actions are probabilistic, not deterministic. This means that, in any finite population, aggregate behavior necessarily has a probabilistic component.

Uncertainty in forecasts of future values of exogenous variables

Temporal heterogeneity/uncertainty

Unpredictable variation in determinants of behavior over time.

Structural change over time

Shift in technology, preferences, policy, etc.

A PARADOX

These forms of uncertainty are generally *not* incorporated in most existing climate impact analyses.

Both the climate change scenarios and the assessment of their economic impact are deterministic rather than probabilistic.

This is not because the modelers have a high level of confidence in the accuracy of their model projections (predicting the global climate, or the US economy, 50 or 100 years from now); rather, they feel that uncertainty is so pervasive – there are so many distinct elements of uncertainty that underlie the model outputs – that it is impractical to attempt to quantify this.

WHAT IS IT THAT IS HARD ABOUT ECONOMIC MODELING OF CLIMATE CHANGE COSTS?

It is not just the long time frame.

There can be substantial economic uncertainty about economic predictions over even, say, a 5 year period.

It is the type of thing that we are trying to predict:

- Human behavior or preference**
- Involving *disaggregated* commodities**

There are no “laws” of human behavior like the laws of physics. At best there are “social mechanisms” – contingent tendencies.

DISAGGREGATED COMMODITIES

Most economic theory is conceptualized in terms of broad commodity aggregates.

Many of the empirical and policy applications of economics deal with disaggregated commodities:

Specific items

With specific characteristics

By specific groups of individuals

E.g. lemon-flavored diet coke in plastic, 20 ounce bottle vs “beverages”.

AGGREGATION HIDES A GREAT DEAL OF IGNORANCE.

It is easier to predict the aggregate budget share of beverages in the US ten years from now than, say, the market share of lemon-flavored diet Coke in Pittsburgh.

Modeling economic costs of climate change is more like the latter.

MODELLING DISAGGREGATED COMMODITIES IS HARD

Which attributes are relevant?

How are these perceived?

What is the choice set?

**These are likely to be tremendous source
of heterogeneity**

**Among decision makers
Across decisions**

**The conventional approach based on a
“representative” producer or consumer
is likely to be especially inadequate.**

**Potential policy importance of within
sector heterogeneity.**

SPECIFICITY OF DETAIL

There is a tradeoff between breadth of coverage of all sectors of the economy and specificity of detail.

CGE models tend to be highly aggregated both spatially and in terms of commodity definition.

Partial equilibrium models (e.g. Mendelsohn, Nordhaus hedonic model) can provide more spatial disaggregation.

ESTIMATION OF ECONOMIC MODELS

- **CGE models often calibrated, rather than estimated.**
- **Partial equilibrium models often estimated from available data.**

Both are problematic.

Calibration may lack validity.

Econometric estimation plagued by missing variables and problems inherent in observational data. Regression equations may be frail and unstable.

THE PROBLEM OF MODEL MISSPECIFICATION

Model misspecification and uncertainty is likely to be a greater problem than parameter uncertainty – both econometrically and in terms of policy.

This is also a problem for adaptive management strategies.

There is scope for application of:

- mixture model estimation**
- Bayesian model averaging**

WHAT FORM SHOULD THE MODEL TAKE?

**Is there one correct economic model,
regardless of the question to be answered?
Should the answer be different if:**

- The objective is to forecast 30 years from now rather than 5 years from now?**
- The objective is to measure the consequences of specific changes in RHS variables?**

We estimate $y = f(x)$ rather than $\partial y = g(\partial x)$

Is this a good idea?

THE NEED FOR MORE SERIOUS MODEL ATTEMPTS AT MODEL VALIDATION

Does model forecast quality deteriorate with time? If so, how and why?

- Back casting the past**
- Starting the model in past and forecasting the “future”**

IS THERE AN IRREVERSIBILITY EFFECT?

Should the presence of uncertainty influence the decision made now? How?

The sharp result by Arrow and Fisher (1970) and Henry (1970) that the case for being cautious – preserving future options – is strengthened by the presence of uncertainty combined with the prospect of future learning arises only with a binary decision. It does not hold in general with a *continuous* decision variable.

Epstein (1980) provides a sufficient condition for the irreversibility effect to hold with a continuous decision.

This is widely, but wrongly, taken as a necessary condition. Hence, its violation tells you little. Fisher, Hanemann, and Narain (2003) have shown cases where there is an irreversibility effect when Epstein's condition does not hold.

The scope for the irreversibility effect remains unclear.

HOW CAN WE INTRODUCE UNCERTAINTY INTO MODELS?

Now being discussed in macroeconomics literature.

Model Error Modeling approach: estimate reference model; regress model residuals on general set of variables; combine both.

Information based complexity modeling; set membership approach. Robust stochastic dynamic programming.

Random coefficient models.

Mixture model estimation.

HOW TO REPRESENT UNCERTAINTY?

Distinction between “soft uncertainty,” when the decision makers’ beliefs may be represented by a unique, fully reliable, additive probability distribution, and “hard uncertainty” when the beliefs may only be represented in terms of a non-additive probability distribution or in terms of a multiplicity of probability distributions, none of which is fully reliable.

Types of hard uncertainty:

- 1) Associated with the use of Choquet capacities as non-additive measures of uncertainty.**
- 2) Dempster (1967) – Shafer (1976) belief function model**
- 3) Theory of fuzzy sets introduced by Zadeh (1965).**
- 4) Beyond hard uncertainty there is “complete ignorance in which no conceivable probability distribution is reliable enough to be considered more plausible than the others. In this case, Arrow and Hurwicz’s (1972) maximin theory or the case-based decision theory of Gilboa and Schmeidler (1994) may apply.**

