Incorporating Social Influence Effects in Global Energy-Economy Models

Charlie Wilson, Hazel Pettifor

BE4 Workshop
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Improving **behavioural realism** of global energy-economy models: model-pull or evidence-push

```
model <- observed behaviour

= observed behaviour -> model

?  
```
(1) What ‘behavioural features’ are there?

(2) Are behavioural features included in models?

(3) Is there robust evidence for behavioural features?

(4) Is there a conceptual basis for behavioural features?

(5) How strong is effect of behavioural features?

(6) How can behavioural features be modelled?
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Many **features** of human **behaviour** could be modelled to improve mitigation **policy analysis**

Typology of ‘behavioural features’ (relating to energy demand)

- **decision making**: e.g., non-monetary preferences, non-optimising heuristics
- **social influences**: e.g., imitation, conformity, status, social networks
- **contextual influences**: e.g., infrastructure, governance, culture

*and an enabler*

- **heterogeneity**: e.g., end-user preferences

‘**behavioural features**’ =

*anything beyond price-responsiveness under income constraints*  
*(or: a narrowly financial utility maximiser)*
(1) What are important ‘behavioural features’?

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Global energy-economy models analyse long-term climate change mitigation potentials, costs ...

Energy-Economy Models
Complete the crossword below

many differences between models

technological resolution & endogenous technical change

macroeconomic feedback

optimisation v simulation

growth constraints

...
Global energy-economy models have limited and partial representations of behavioural features.

1) variable ‘behavioural modelling’: 
2) logit formulations for market heterogeneity (simulation models)
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Extensive literatures of empirical studies (stated & revealed preferences)

- **systematic review** of empirical studies (n>70)
- focus on **vehicle choice**

- good evidence of moderate-to-strong effects across typology of behavioural features
  - non-monetary preferences
  - **social influence**
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Social influence on technology adoption has strong conceptual foundations

Diffusion = communication over time about an innovation among members of a social system

- early adopters reduce perceived risks:
  - social influence

- high initial risk aversion

- high adoption propensity

- Innovators 2.5%
- Early Adopters 13.5%
- Early Majority 34%
- Late Majority 34%
- Laggards 16%
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A meta-analysis of 21 empirical studies found robust evidence of moderate **social influence** on vehicle choices.

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Social Influence Type</th>
<th>Corr ’r’</th>
<th>CI Lower</th>
<th>CI Upper</th>
<th>Z Value</th>
<th>P Value</th>
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<td>Zhu et al 2013</td>
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<td>0.020</td>
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<td>Summary Effect</td>
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<td>0.241</td>
<td>0.157</td>
<td>0.322</td>
<td>5.505</td>
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</table>

Mean effect size of 0.241**

Social Influence → Vehicle choice / Propensity to purchase

+1 s.d. increase → +0.24 s.d. increase
Social influence effect size varies between countries, as predicted by measures of **cultural difference**

**Pragmatic**: greater individuality, acceptance of change, old traditions replaced

**Normative**: traditions and norms important, looking to others for support

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Empirical evidence can support existing modelling efforts (shaped by model structure and function)

```
model < - - - - observed behaviour
```
Social influence is captured in declining **risk premiums** of risk-averse vehicle purchasers (MA3T / MESSAGE)

Lin, Z. & Greene, D.L.

http://cta.ornl.gov/ma3t/

- **Early Adopter** (8%): negative risk aversion
- **Early Majority** (38%): risk aversion
- **Late Majority** (54%): very high risk aversion

Risk aversion declines as market penetration increases → **social influence effects**

Meta-analysis effect size: **calibration check**

MA3T assumptions
Relationship between social influence effect and cultural values enables **regional parameterisations**

use of empirical relationship to rescale US data

**Social Influence Effect Sizes Predicted for Countries in Empirical Studies**

Score on pragmatic versus normative scale

- **Iran**
- **USA**
- **Germany**
- **Malaysia**
- **China**
- **Taiwan**

**y = -0.428x + 0.4497**

**MESSAGE regions**

<table>
<thead>
<tr>
<th>Social influence effect ‘multiplier’</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
</tr>
<tr>
<td><strong>US</strong> 1.00</td>
</tr>
<tr>
<td>Latin America</td>
</tr>
<tr>
<td><strong>Mexico</strong> 0.94</td>
</tr>
<tr>
<td>Centrally Planned Asia</td>
</tr>
<tr>
<td><strong>China</strong> 0.13</td>
</tr>
<tr>
<td>Western Europe</td>
</tr>
<tr>
<td><strong>Germany</strong> 0.36</td>
</tr>
</tbody>
</table>

A generalisable approach to global modelling
Can empirical evidence also determine direction of model development ... in existing models?

model <- observed behaviour

observed behaviour -> model
Implementing a meta-analytic effect size in global energy-economy models is ... problematic

modelling constraints
no direct match for x & y variables
<= 3 representative decision agents
no network structure
...

meta-analytic effect size provides slope

MA3T assumptions

Social Influence
Vehicle choice / Propensity to purchase

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   - **model-pull**: modified, improved <-> complicated, assumed
   - **evidence-push**: bespoke, unconstrained <-> usefulness
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