Modelling the global energy system feedback to welfare in developing energy secure climate policy scenarios

James Glynn, Maurizio Gargiulo, Dr. Brian Ó’Gallachóir

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Methodologies linking energy systems models and economic models
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Outline

• Rationale
  – First steps in understanding energy system feedback methods

• Learning to use ETSAP-TIAM-MSA

• Input data

• Calibration
  – Data requirements
  – Default parameters

• Example results

• Learning outcomes thus far
Rationale

• Understanding of Energy System – Macro economy Feedback tools
• MACRO Stand Alone was tested with ETSAP-TIAM 2010
  – Safe place to start (“The TIAM Monster”)  
  – Plug in an Play? (not so much)
• Plan: Learn by doing
  – Explore MSA parameter sensitivities
• Model Questions?
  – Cost/Value of a Climate mitigating energy system?
  – Macro-economy response to future scenario energy systems?
  – Energy service demands response to macro-economy adjustments?
• Implement lessons learned to provide some first steps in initial macro-feedback in Irish-TIMES
ETSAP-TIAM

• TIMES Integrated Assessment Model
• Global 15 Region Energy Systems Model
  – Least cost optimisation
  – Energy Technology choice
  – Elastic Demands
  – Energy Commodity Trade
  – Climate Module
• Using ETSAP-TIAM 2010 “Common Version”
  – DISCLAIMER: Results are for illustration of MSA only
• ETSAP-TIAM working group project
  – Newer version, updated, improved & stable
  – Shale Resources, Iron & Steel, Gas Trade, China,...
Macro Stand Alone

- Implemented in VEDA_FE
- Cumulative Utility Maximisation
  - Energy Service Demand adjustment
  - Energy System Cost
- VAR_Macro result variables (VEDA_BE)
  - Production
  - Consumption
  - Investment
  - Energy System Cost
  - Reference GDP
  - Loss in GDP
TIAM - MACRO interaction schema

Energy sector
(ETA or MARKAL sub-model)

Energy

Energy cost

Macro-economy
(MACRO sub-model)

Labour

Consumption

Investment

Capital
MSA Calibration (CSA)

• Critical Data requirements
  – Initial Regional GDP
  – Regional GDP growth rates for each period
    • Synchronous with TIAM/TIMES Demand Drivers
  – Calibration of default input parameters

• Calibration runs of reference case scenario
  – Create Demand Decoupling factors
    • For each Energy service demand, by region and time period
## Input Parameters

**TIMES-MSA**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Default Value</th>
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<tbody>
<tr>
<td>TM_ARBM</td>
<td>Arbitrary multiplier for the last period replication</td>
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<tr>
<td>TM_DEFVAL(item)</td>
<td>Default values for regional Macro constants</td>
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<td>Depreciation rate (percentage)</td>
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<td>TM_GR(r,y)</td>
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## Initial GDP Values & Regional Rates

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REF Case MSA Calibration + 3p5 Case

Primary Energy Requirement (PJ)

- Renewable except hydro and biomass
- Oil
- Nuclear
- Hydro
- Gas
- Coal
- Biomass

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</tr>
</tbody>
</table>
Demand Adjustment – Non ElasDem

Primary Energy Requirement (PJ)

- Renewable except hydro and biomass
- Oil
- Nuclear
- Hydro
- Gas
- Coal

![Graph showing energy demand adjustment for different scenarios over years 2030, 2040, and 2050.](chart)

- ET_3p5
- ET_3p5_MSA
- ET_NED_3p5
- ET_NED_3p5_MSA
- ET_Ref

2030  .  2040  .  2050
Terminal Condition Effects on Macro Investment Period T-1

Macro Investment (bn US$ 2000)

2005  | 2007  | 2012  | 2020  | 2030  | 2040  | 2050  | 2060
---|---|---|---|---|---|---|---
ET_3p5_MSA | ET_Ref_MSA | ET_3p5_MSA | ET_Ref_MSA | ET_3p5_MSA | ET_Ref_MSA | ET_3p5_MSA | ET_Ref_MSA

Regions:
- WEU
- USA
- SKO
- ODA
- MEX
- MEA
- JPN
- MEX
- IND
- FSU
- EEU
- CSA
- CHI
- AUS
- AFR

Energy Policy & Modelling Group
Learning Outcomes

- Initially VEDA_FE did not solve ETSAP-TIAM-MSA
  - Missing MACRO attributes
  - Some Data import bugs
  - Solved with recent updates

- Grappling with scale of TIAM
  - Some results seem questionable in 2010 version
  - Possible Interesting GDP benefits to carbon capture/ afforestation mitigation technologies? – AUS, CAN

- Initial MSA DDF calibration method working

- Next Steps with ETSAP-TIAM-MSA
  - Estimation of regional elasticity's of substitution
  - Adjust/calibrate default parameters

- Start Smaller with Irish-TIMES-MSA

Thank you for your attention