Macroeconomic drivers of baseline scenarios in dynamic CGE models: review and guidelines proposal

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Introduction

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Macroeconomic drivers of baseline scenarios
Motivation I

- Current trends in CGE and baseline model comparison/convergence
  - The GTAP database is a reference for base year data
  - Energy Modelling Forum (EMF): energy-related modelling and data issues
  - Agricultural Model Intercomparison and Improvement Project (AgMIP)

- No comparable initiative regarding baseline in CGE models
  - Best candidate: IPCC’s Shared Socioeconomic Pathways (SSPs), narratives for baseline scenarios
  - The SSP initiative do not discuss the implementation (a fortiori in CGE models)
Motivation II

- GTAP workshop “Shaping long-term baselines with CGE models”
  - Held in January 2018
  - Our focus: Macroeconomic drivers
Results of the contributions: 24 teams/models responded:
Introduction

What are “macroeconomic drivers”? 

- Obvious: sources for projection data
  - GDP projections
  - Factors
- But also details on implementation
  - Often, the projections are embedded in the model through specific assumptions
  - The implementation of external projections can also be different
- Objective to stay generic-enough to fit all models
Introduction II

What are not “macroeconomis drivers”?

- Structural change
  - Calibrating supply-side driven structural change in CGE baselines (lead author: J. Chateau)
  - Demand side and consumer behavior (lead author: M. Ho)
- Issue-specific considerations
  - Energy and environment (lead author: T. Fæhn)
  - Agriculture and land-use (lead author: K. Kavallari)
  - Trade baseline (lead author: E. Bekkers)
Outline of the presentation

1. Introduction
2. Review of practices
3. Issues
4. Research agenda
5. Conclusion
Review of practices

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Macroeconomic drivers of baseline scenarios
There are two alternatives:

- Assume a certain trajectory in productivity within the CGE
- Calibrate the productivity in the baseline by targeting external GDP projections
  - Taken from external sources
  - and/or generated by a Solow growth model
GDP – Methodology II

Solow (1957)-based growth models behind projections

- Aggregated production function, accumulation of factors (supply-side) and productivity
  - Assume / estimate behavioral relations
  - Project accumulation and deduce GDP

- Two examples in the literature:
  - Duval and De La Maisonneuve (2010):
    \[ Y = K^\alpha (A \times h \times L)^{1-\alpha} \]
  - Fouré et al. (2013):
    \[ Y = \left[ (A \times K^\alpha \times L^{1-\alpha})^{\frac{\sigma-1}{\sigma}} + (B \times E)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \]
GDP – Projection sources

- More diversity: 9 possible sources across models
  - Most common: “SSPs” (5 different scenarios)
    - SSP projections producers: IIASA, OECD, PIK, CEPII
  - Alternative: Only one baseline, sources mentioned only one or twice
    - 2 models mix different sources together
    - 2 model allow for several sources
- 3 models have endogenous GDP growth possible (i.e. technological assumptions)
  - Iterative convergence with macroeconomic model (1)
  - Time series trend (as an alternative in 2 models)
GDP – Implementation

- Methodology is common: an endogenous productivity is calibrated in the baseline exercise.
- But the factors impacted by this productivity vary.
Many features were “Optional”, I retained the default (or “best”)

For each factor and model, four alternatives are considered and compared:
- Fixed (constant from calibration value)
- Exogenous (not constant but imposed exogenously – ad-hoc or sourced)
- Endogenous (with specific mechanisms, e.g. supply function)
- Calibrated (endogenously calibrated to target another variable that is exogenous, e.g. natural resources and fossil fuel prices)

Plus two non-response categories:
- Not relevant: the model does not have this specific factor (e.g. natural resources included in capital)
- Not provided: the templates suggest the feature is present, but baseline assumptions are not provided :(. 

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Macroeconomic drivers of baseline scenarios
Rules for factor supply in the baseline I

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Macroeconomic drivers of baseline scenarios
Rules for factor supply in the baseline II

- Compared to GDP assumptions:
  - Much more diversity, not only in data sources
  - A bit less transparency (cf. “Not provided” category)
    - This is a tentative classification based on the contributed templates only, not yet on the full documentation.
  - Very dependent on the model’s main focuses (e.g. Migration or Water)
Regarding the labor force, several issues at stake:

- Population
- Participation to the labour force
- Skill level
- International migrations
- Inner migrations (e.g. rural to urban)
Labor II

Population:

- Only 2 global sources for population: IIASA (SSP scenarios) or UN Population Division (with variants)
  - UNPD 4 – IIASA 7
  - 4 models allow to switch from one source to the other
- Country-level sources otherwise (Canada, U.S.), with sub-national data
Labour III

Labour force:

- Close to consensus...
  - Exogenous growth rate, from external sources
  - UN Population Division, IIASA SSP, ILO
  - Exceptions: 2 models endogenize participation (competition with leisure)
- ... but is it a best practice?
  - What is limiting to endogenizing participation and employment? In real life, depends on economic growth, wages, sector specialization, etc.

Type:
- Endogenous
- Calibrated
- Exogenous
- Fixed
- Not provided
- Not relevant

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Macroeconomic drivers of baseline scenarios
Skill level:

- GTAP provides 5 skill levels, but often aggregated to 2 only
- Only 4 models target differently skills in the baseline
- 24 others: working-age population (or population)
- Why?: problem of data availability? (but: IIASA SSP, EconMap) or consistency between education (IIASA,EconMap) and occupations (GTAP)?
Labor V

Migrations

- International migrations
  - Even less common explicit feature
    - Only mentioned explicitly once, where it is endogenous
    - Although implicit in any population projection
  - Is it a good thing?
    - Migration have impacts on savings, education level, etc.
    - Consistency with other baseline assumptions?

- Inner migrations
  - TBC

Type

- Endogenous
- Exogenous
- Calibrated
- Fixed
- Not provided
- Not relevant
**Land**

- **Method:** around 50% endogenous, 50% exogenous
  - Endogenous: Supply function, not always the same (logistic, isoelastic, not indicated)
  - Exogenous: From specialized models (IMPACT, MagPIE, IMAGE, GLOBIOM), not uniform

- **Which one should be preferred?**
  - What should be preferred between a simple endogenous supply function or a more refined exogenous source?
  - Endog.: Do we have rationale to choose a specific supply function?
  - Exog.: Any distinct features from the different sources?
Natural resources – Fossil

- **Method:** Close to consensus...
  - Natural resources calibrated to match fossil fuel prices (external sources, IEA WEO) or other variables (energy supply, oil reserves)
  - Alternative: Endogenous reserves depletion (resources supply function or extraction cost curves)
  - (2 models calibrate on capital or GDP growth)

- **but consensus not necessarily a best practice**
  - **Drawbacks**
    - Fossil fuel demand heavily depends on economic activity, what is the consistency with using external source?
    - Although the best potential source to my knowledge, WEO prices projections have been known to be wrong (mechanisms not consistent with economic theory?)

- **Limits to endogenizing?**
  - Data: is information available and reliable?
  - Modelling: How to account for strategic interactions (e.g. OPEC)?
Natural resources – Other (Fishery, Forestry, Minerals)

- (when documented!) two competing alternatives: fixed or endogenous?
  - Fixed: to GTAP values
  - Endogenous: Supply curve (kinked)
  - (2 models calibrate on capital or GDP growth)

Discussion

- Is it relevant to do something when not focused on these sectors?
- If it is, any rationale? (no details in contributed templates)
The issue with capital is more complex

- Savings → investment, but there are international flows (current account)
- Investment → capital, at the sector level with depreciation
- Large heterogeneity between models

Savings:

- Majority for “exogeneity”
  - i.e. incl. endogeneity with (exogenous) population determinants
  - but: significant share of models consider savings fixed at calibration value

Is it a best practice?

- well documented in the literature, simple relations with ageing available but also exogenous projections
- but: consistency with growth assumptions
Current account and total investment (linked through $S - I = CA$)

- I and CA exogenous
  - Most common approach (8): no CA imbalances because $I = S$
  - Most common alternative (4): Specific assumptions (ad-hoc convergence, exogenous source for I/Y or capital)

- Alternative: I and CA endogenous
  - Based on return on investment, or fixed real exchange rate

Is there a best practice?

- In the data, imbalances are not decreasing over time.
- Simple accounting relation $S - I = X - M$
- Is it better to rely on macroeconomic determinants or to endogenize in the model?
Sector allocation of investment

- Near perfect consensus
  - All models seem to consider an endogenous allocation depending on the return on investment
  - 3 exceptions: exogenous allocation (1) or energy-specific investment modification (2)

- Is it the best alternative?
  - e.g. new backstop technologies will require specific investment

Capital depreciation

- Lack of explicit documentation
  - Does that mean: fixed at GTAP calibration level?
  - Models which responded: constant (ad-hoc or PWT, 2.5) or calibrated (no capital abandonment, 1)
Water

- An uncommon feature, with baseline not documented in the templates
  - Only 2 models are explicit: exogenous (indus., irrigation) and endogenous (municipal) or calibrated.

- Is it a good thing?
  - Should water resource be considered a minimal feature for models with agricultural results?
  - If yes, what are then the limitations? data, baseline?

<table>
<thead>
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Issues

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Macroeconomic drivers of baseline scenarios
Very often well documented sources, often with published papers.

Minimal feature: indicate which data source the model is using (incl. GTAP version) and which baseline data.

Limitation: When several sources are mixed together (e.g. several sources for GDP growth), documentation was less clear.

Maybe in the model technical documentation?
Replicability

- Very good news: the time when people were crafting their baseline on their own, with no public availability, seems to be over
  - But maybe there is a selection bias in the workshop?
Sensitivity analysis

- IIASA SSP database itself a good example: three outcomes of the same assumptions are provided
  - Do the users implement the three and compare?
  - But what about alternative interpretations of SSP narratives?
- Only 3 models allow explicitly for sensitivity analysis for GDP baseline, 4 for Population baseline
  - The example of the SSPs show how results depend on the baseline.
- 2 models have endogenous GDP growth, so sensitivity analysis could also be conducted, but is it?
Methodology

Model assumptions and sources (IMO no “best” alternative)

- What makes the difference between all-factor-augmenting and labor-augmenting TFP? Is it relevant?
- Is it better to have one all-sector TFP or relatively ad-hoc assumptions on sector-specific TFP?
Research agenda
Research agenda

- Thorough review of the literature
- Illustration of key issues
  - Comparison of projection sources (SSP scenarios)
    - [JF: I will add a graph on SSP comparison]
  - How some assumptions impact the results
    - [JF: If enough time, I will add an illustration on current account using MIRAGE]
Best practices and low-hanging fruits?

For the moment, only a **tentative** summary of the workshop:

- **Consistency**
  - Ensure the consistency between the different assumptions (e.g. are the current account assumptions the same in the model and in the macro model underlying GDP projections?)

- **TBC**
Thank you for your attention
References I

