

21st Annual Conference on Global Economic Analysis
"Framing the future through the Sustainable Development Goals"

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

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Introduction

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

Motivation III

- Results of the contributions: 24 teams/models responded:



Introduction I

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** “macroeconomic 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

GDP – Methodology I

There are two alternatives:

- Assume a certain trajectory in productivity within the CGE
- Calibrate the productivity in the baseline by targetting 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 Maisonnette (2010):

$$Y = K^{\alpha} (A \times h \times L)^{1-\alpha}$$

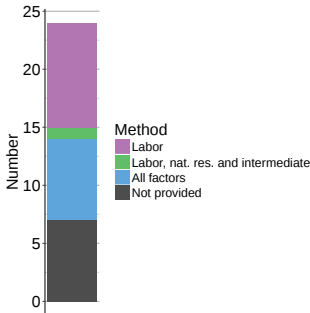
- Fouré et al. (2013):

$$Y = \left[(A \times K^{\alpha} \times L^{1-\alpha})^{\frac{\sigma-1}{\sigma}} + (B \times E)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

GDP – Projection sources

- More diversity: 9 possible sources accross 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

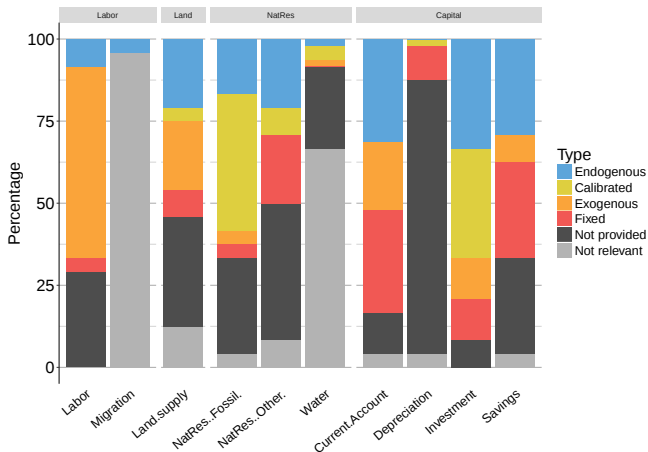


- Methodology is common: an endogenous productivity is calibrated in the baseline exercise
- But the factors impacted by this productivity vary.

Factors – General considerations

- 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 suggests the feature is present, but baseline assumptions are **not provided** :(.


Rules for factor supply in the baseline I



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)

Labor I

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)

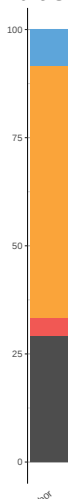
Labor II

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

Labor 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	Exogenous	Not provided
Calibrated	Fixed	Not relevant

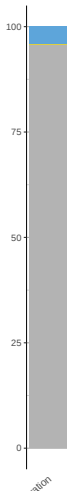
Labor IV

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)?

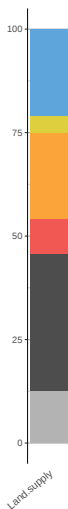
Labor V

Migrations



- International migrations
 - Even less common explicit feature
 - Only mentionned 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 | ■ Not provided |
| ■ Calibrated | ■ Fixed | ■ 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?

Type

Endogenous	Exogenous	Not provided
Calibrated	Fixed	Not relevant

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)

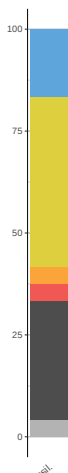
■ but consensus not necessarily a best practice

■ Drawbacks

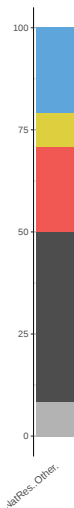
- Fossil fuel demand heavily depends on economic activity, what is the consistency with using external source?
- Although the best potential source to my knowledge, WEO prices projections have been known to be wrong (mechanisms not consistent with economic theory?)

■ 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)

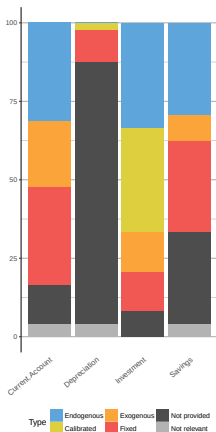


- (when documented!) two competing alternatives: fixed or endogenous?
 - Fixed: to GTAP values
 - Endogenous: Supply curve (kinked)
 - (2 models calibrate on capital or GDP growth)
- Discussion
 - Is it relevant to do something when not focused on these sectors?
 - If it is, any rationale? (no details in contributed templates)

Type

Endogenous	Exogenous	Not provided
Calibrated	Fixed	Not relevant

Capital I



■ The issue with capital is more complex

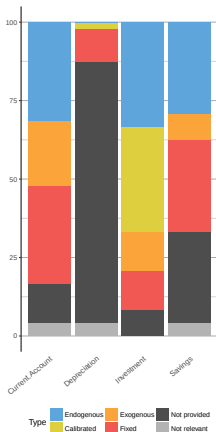
- Savings → investment, but there are international flows (current account)
- Investment → capital, at the sector level with depreciation
- Large heterogeneity between models

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

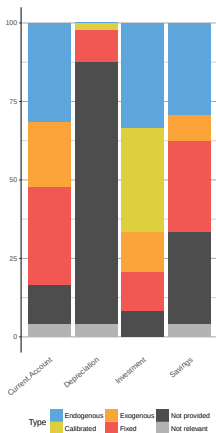
Capital II

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?

Capital III



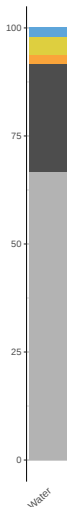
Sector allocation of investment

- 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?
- Type
- | | | |
|------------|-----------|--------------|
| Endogenous | Exogenous | Not provided |
| Calibrated | Fixed | Not relevant |

Issues

Documentation

- 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

- Thourough 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**

Conclusion

Thank you for your attention

References I

Duval, R. and De La Maisonnette, C. (2010). Long-run growth scenarios for the world economy. *Journal of Policy Modeling*, 32(1):64–80.

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