Challenges of modelling physical nutrient flows

GTAP seminar "Modelling Nutrition and Food Loss and Waste in a CGE Framework

September 20, 2022 - Marijke Kuiper (Wageningen Economic Research)

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Background: MAGNET-based work on nutrition

- MAGNET (www.magnet-model.eu) has a nutrition module
  - tracing quantities & macro nutrients (calories, fats, carbs, proteins) based on FAO data developed in the FoodSecure project (2012-2017)
  - used to judge food consumption in baseline calibration
  - basis for implementing diet shifts (e.g. Eat-Lancet diet)
- Technical specs:
  - iteratively computed within the model run (less precise on indirect use)
  - initialized at private household consumption values

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Lessons learned - 3 main challenges

- **Start balanced**: value-based calculations of physical flows violate material balances
- **Some products are less equal than others**: product heterogeneity leads to improbable changes in nutrition indicators
- **Exploding people**: in long run simulations calorie consumption explodes due to lack of technical change in processed food

Start balanced – remove non-material flows

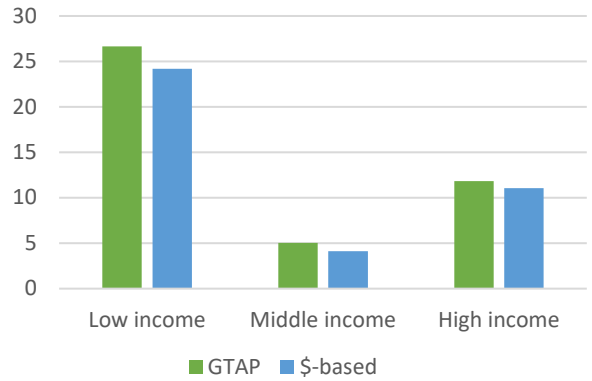
- Common approach: use the (base year) $ values as proxies for quantities when computing physical flows (also used in MAGNET)
- Does not use all information available in the GTAP database: part of the value flows do not contain materials (taxes & transport margins)
- **Removing these non-material flows** (output taxes, import duties, export subsidies, transport costs)
    - provides a better proxy of quantities ($-based quantities)
    - data satisfy material balances in the BaseData

Start balanced: example processed food (ofd)

Per capita quantities using GTAP headers vs correcting for taxes etc.:

		Low income	Middle income	High income
Domestic	VDPB	46	160	860
	$-based quantity	45	159	843
Imported	VMPB	17	8	115
	$-based quantity	14	7	105

Import share in private household processed food (ofd) consumption (%):



- Value shares are used to combine GTAP data with physical flow data
- Correcting for taxes etc. means **imports get a lower weight** compared to using standard GTAP headers

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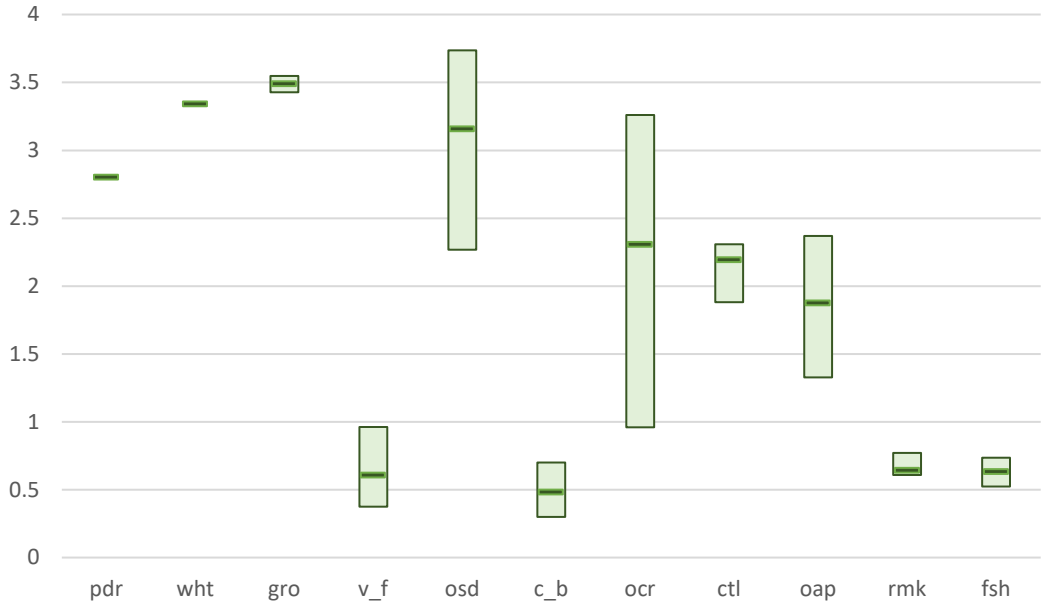
Some products are less equal: heterogeneity

- FAO commodity data is much more detailed than GTAP
    - Aggregating to GTAP sectors results in different compositions in terms of FAO commodities (eg fruit & veg may be tropical crops for some but temperate crops in other regions)
    - Nutritional content expressed in kg of product or $ of purchase is then different depending on the source region
- Changing trade flows can then induce **(large) swings in calories**, **even if total consumption of the good remains the same**
- This also affects the indirect flows computed through the Leontief inverse underlying the nutrition database

Kcal/gram shows heterogeneity of GTAP sectors

Kcal/gram for the primary GTAP food commodities (spread computed from a 8 region model aggregation)

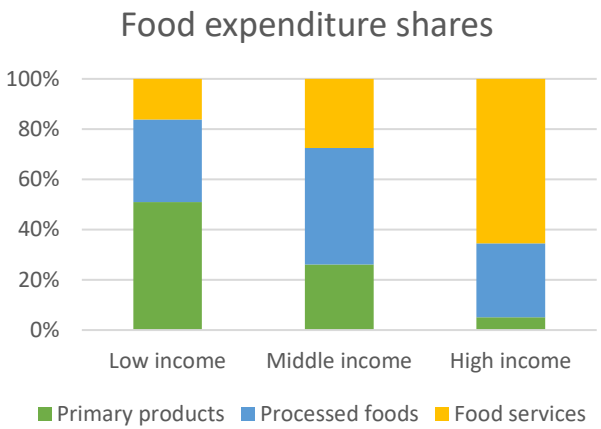


- Grains, raw milk and fish are pretty homogenous (in terms of calories/gram)
- Other primary GTAP sectors show much larger variation
- Changing source region then affects calorie consumption

Some products are less equal: some options

- Remove (or minimize) nutritional differences of primary commodities
    a) Ignore the differences and use a **global average nutritional content** for GTAP primary sector
    b) Disaggregate sectors to capture heterogeneity
- Does not fix the issue with Leontief based nutritional data for processed commodities as regions use different intermediate inputs:
    a) Ex-post calculations: **rerun the Leontief inverse** and recalculate nutritional content
    b) Adjust **Armington elasticities** to reflect product heterogeneity

Exploding people: excessive calorie intake



- "**Nutrition transition**": with rising incomes, share of processed food increases
- Picked up by demand system (through income elasticities) so expenditure shares trace the historical patterns
- All is well from an economic point of view, but computing the calories/capita:
  - High income countries: increases in calories although already near physical limits at start
  - Low income countries: physically impossible calories/capita with rapid income growth

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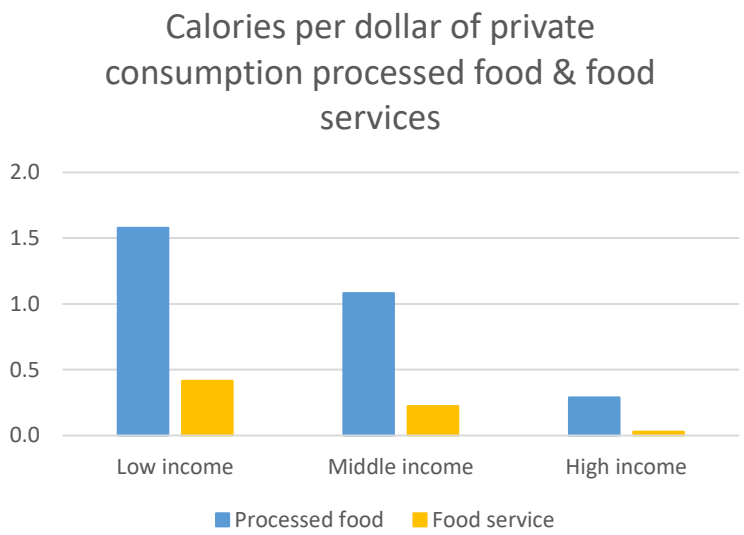
Exploding people: excessive calorie intake



- "**Processed food chain transformation**": with rising income processed food contains less calories per dollar, as more is spent on non-food components (like packaging, advertising, machines)
  - High income countries: likely to switch to higher quality food (i.e. less calories per dollar) not captured by commodities
  - Low income countries: radical change in cost structure of processed foods generally not captured by technical change shifters

Challenges modelling nutrition/physical flows

- **Start balanced**: value-based calculations of physical flows (unadjusted for taxes & trade margins) violate material balances
- **Some products are less equal than others**: product heterogeneity for most commodities (primary & processed) may lead to improbable changes in nutrition indicators
- **Exploding people**: in long run simulations calorie consumption explodes due to lack of technical change in processed food and not capturing demand for higher quality products (NB also overestimates need for primary products and thus environmental impacts)

Questions, comments?

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More info on MAGNET:

www.magnet-model.eu

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