Will Income or Population be the Main Driver of Food Demand Growth to 2050?

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Will Income or Population be the Main Driver of Food Demand Growth to 2050?

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Objectives

We test whether income or population will be the main driver of global food demand to 2050.

- A key element in this study is to understand how the income elasticities of demand for food will evolve as incomes rise.
- For this purpose, we develop a long-run, non-homothetic, partial equilibrium **SIMPLE-MAIDADS** Model.
- We use this framework to determine the relative importance of income and population growth in driving global food output to 2050.

What is the key driver?

Baldos and Hertel (2014) → Income

- Population grows more in poorer countries where consumption is low.
- Strong income-driven demand for dietary upgrading in rich countries.

Gouel and Guimbard (2018) → Population

- Population persists as the main driver of global food demand to 2050.
- Their analysis abstracts from the supply side of the puzzle.

We seek to solve this puzzle by incorporating a new demand system (MAIDADS) into the SIMPLE model of global food **supply and demand**.

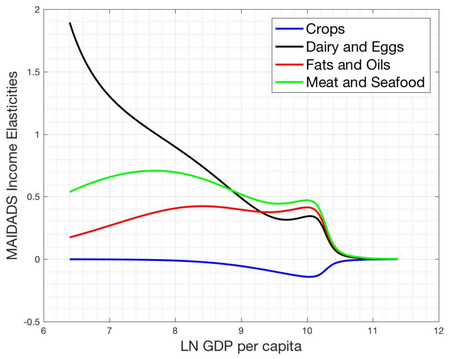


Figure 1: MAIDADS Elasticities based on calorie consumptions.

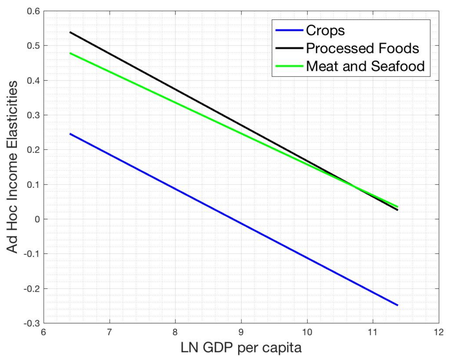


Figure 2: Standard SIMPLE Elasticities based on qty. consumptions.

Demand Model

The origin of MAIDADS dates back to Richard Stone (1954)'s Linear Expenditure System (LES) :

- Derived from Roy Geary (1950).
- An origin-displaced Cobb-Douglas utility.
- Fixed discretionary consumption.
- Fixed subsistence consumption.

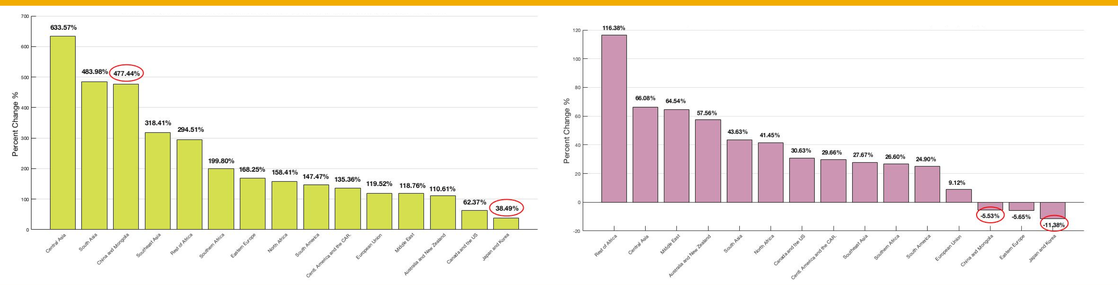
whereas MAIDADS (*Modified An Implicitly Directly Additive Demand System*):

1. Generalized from Rimmer and Powell (1996).
2. Discretionary demand varies with expenditure.
3. Subsistence demand varies with utility level.

Data and Methods

1. We build the MAIDADS demand system into the TABLO program of GEMPACK based on the standard SIMPLE Model across modified 15 geographic regions and 5 demand categories.
2. The MAIDADS parameters are estimated using constrained maximum likelihood following Gouel and Guimbard (2018).
3. We then design a new structure of the CES production (see below).
4. For projections and simulations, we use the latest update of the macroeconomic data for the transformed "middle of the road" Shared Socioeconomic Pathways (SSP2) version 9 scenarios from 2010 to 2050.
5. Finally, we address our question using the numerical decomposition technique of Harrison, Horridge and Pearson (2000) to identify the relative contribution of different drivers of endogenous drivers.

Income and Population Growth: 2010-2050 (Authors' Calculations, SSP2)



Mathematical Section

The MAIDADS is developed by Preckel, Cranfield and Hertel (2010):

$$x_{i,g} = \underbrace{\frac{\delta_i + \tau_i e^{\omega u_g}}{1 + e^{\omega u_g}}}_{\text{Subsistence Consumption}} + \underbrace{\overbrace{\frac{\alpha_i + \beta_i e^{u_g}}{1 + e^{u_g}}}^{\text{Marginal Budget Share}} \frac{1}{p_{i,g}}\left(\mu_g - \sum_j p_{j,g} \frac{\delta_j + \tau_j e^{\omega u_g}}{1 + e^{\omega u_g}}\right)}_{\text{Discretionary Consumption}} \quad (1)$$

Where

$x_{i,g}$: consumed quantities;
μ_g: income;
$P_{i,g}$: price;
$\alpha_i, \beta_i, \delta_i, \tau_i$: (M)AIDADS parameters;
ω: speed of adjustment of subsistence consumption.

The interest of the MAIDADS is that it allows an important flexibility in income by making function of income the subsistence consumption and the marginal budget shares of an LES (Eq. 1).

$$\frac{\alpha_i + \beta_i e^{u_g}}{1 + e^{u_g}} \quad (2)$$

The discretionary consumption level is governed by the marginal budget share but also by the discretionary income (Eq. 2).

$$\frac{\delta_i + \tau_i e^{w u_g}}{1 + e^{w u_g}} \quad (3)$$

As per capita incomes rise, subsistence consumption converges to τ and marginal budget share to β. They increase or decrease with per capita income depending on the signs of $\tau - \delta$ and $\beta - \alpha$ (Eq. 3).

Supply Structure

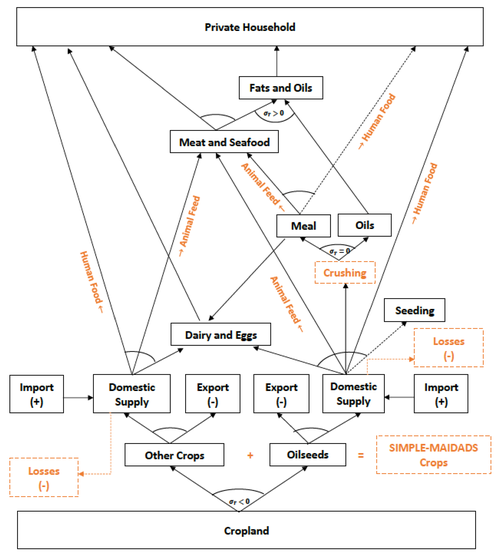


Figure 3: Authors' Design of SIMPLE-MAIDADS Supply System.

Results (Demand Side)

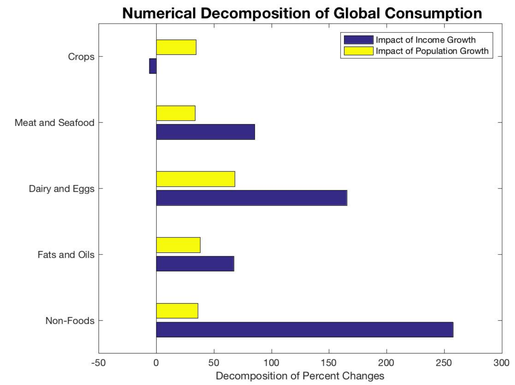


Figure 4: Simulation Results on the Demand Side.

- As income rises from 2010 to 2050, the impact of income is negative on *global* crop consumption, contrary to standard SIMPLE Model.
- On the other hand, the impact of population is positive on *global* crop consumption.
- In addition, the impacts of the two drivers are positive on all other food demand categories.
- We also look at the numerical decomposition at *regional* level, the significance and direction of the demand drivers vary across regions.

Concluding Remarks

- We are still working on the new production structure to look more closely at the demand drivers, as the central finding will eventually depend on the supply side results.
- Currently, the prices in these simulations are constant. When price is fixed, the impacts of drivers on future food consumptions strictly vary by geographic regions and across demand categories.
- Our next step is to understand the endogenous price mechanism on the flexible demand system, which will hopefully help us better understand the issue of resource uses in the future.

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