Implementing Rural-Urban Disaggregated Food Demand in a Partial Equilibrium Model

Daniel Mason-D'Croz[1], Nicholas Magnan, Siwa Msangi, Laetitia Leroy
International Food Policy Research Institute, EPTD

Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2011 AAEA & NAREA Joint Annual Meeting, Pittsburgh, Pennsylvania, July 24-26, 2011.

[1] Contact author: Daniel Mason-D'Croz – d.mason-dcroz@cgiar.org

Implementing Rural-Urban Disaggregated Food Demand in a Partial Equilibrium Model

Daniel Mason-D'Croz, Nick Magnan, Siwa Msangi, Laetitia Leroy

Environment and Production Technology Division - International Food Policy Research Institute

May 2, 2011

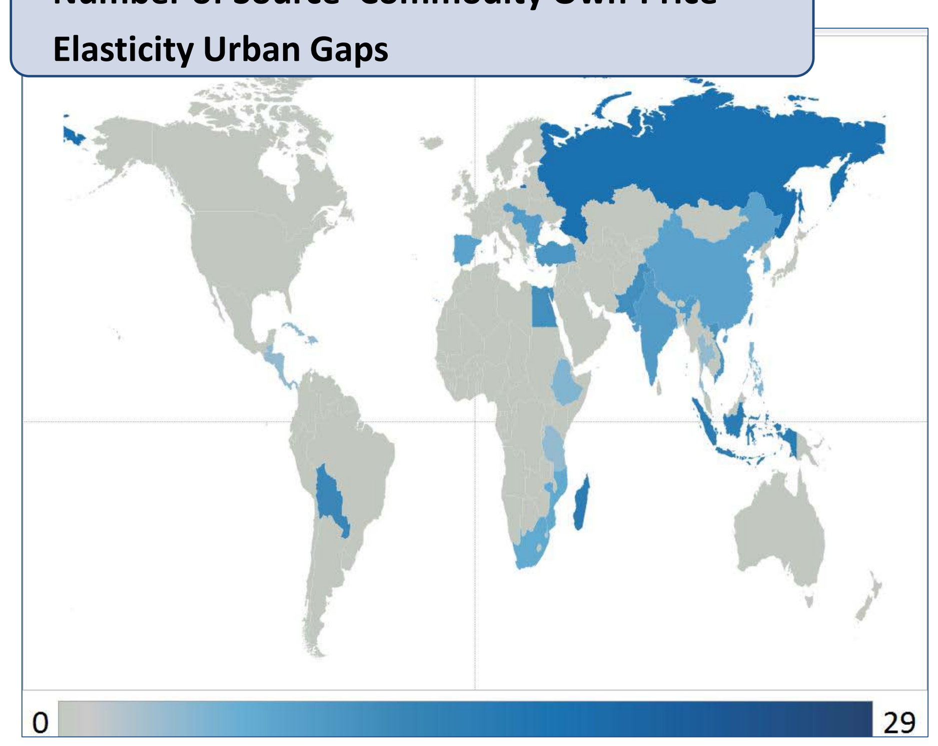
Introduction

Global general and partial equilibrium models focused on the agricultural sector can help policy makers do ex-ante analysis by providing a variety of macro-level outcomes, such as changes in flows of international trade, and changes in the supply, demand, and prices of globally traded commodities. IFPRI's IMPACT model (International Model for Policy Analysis of Agricultural Commodities and Trade) model is one such model. Since its inception nearly 20 years ago the model has evolved to inform increasingly complex and nuanced policy issues, such as the explicit modeling of water use and the productive response of agriculture to climate change. However, on the demand side it has remained a fairly blunt instrument.

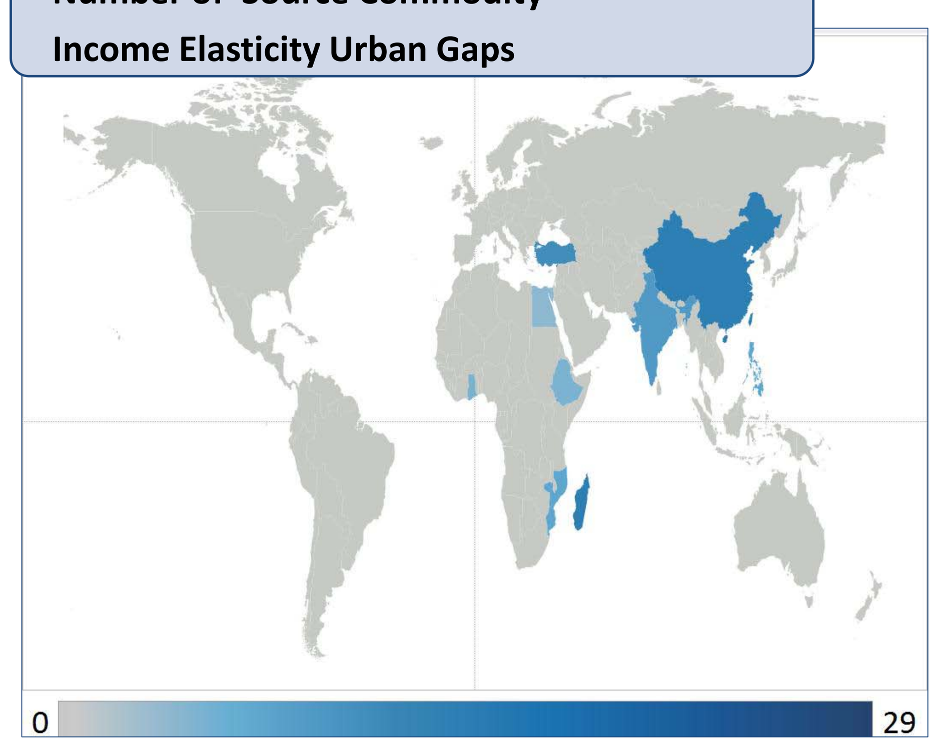
One oft mentioned shortcoming of global food policy models such as IMPACT model is that they treat national populations as a single composite consumer. As (relatively) wealthier urban and poorer rural populations exhibit different demand characteristics, have different base levels of food consumption, and have different levels of wealth, assigning a single representative consumer for an entire country could result in misleading results regarding both global prices and consumption and the food security of the poorer segments of the population. In this poster we present a global partial equilibrium food security model with disaggregated demand. Working from the IMPACT model, we divided national populations into their urban and rural components.

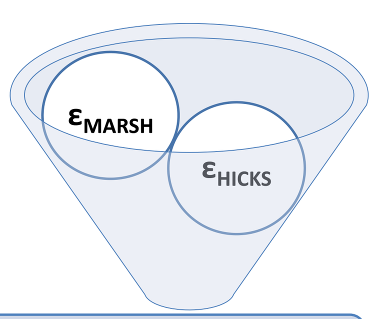
Studies have shown that rural and urban consumers, as well as poor and rich consumers, have structurally different food demands. Accordingly, we assign different demand elasticities (price and income), different base consumption (at the commodity level), and different incomes to sub-populations populations within each country. We have completed an extensive study of the food demand literature, using the findings to develop parameters to represent the structural differences in urban and rural food demand (see right for explanation of this process). We use rural/urban population and income data and projections from the UN to complete the disaggregation.

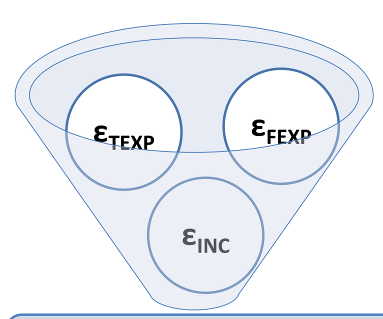
Number of Source Commodity Own-Price Elasticity Urban Gaps



Number of Source Commodity Income Elasticity Urban Gaps







Region x Commodity Descriptive Statistics

Region x Commodity Descriptive Statistics

Consolidated Marshallian Elasticity Gaps

Consolidated Income Elasticity Gaps

Consolidated Gaps
- Non-poor-poor
- Urban-Rural

Predict Urban-Rural Gap using:
- Poverty Gap
- Region x Commodity
- Descriptive Stats

Urban-Rural Consolidated Set
- Ready to be fitted around IMPACT income and own-price elasticities

Objectives

- Disaggregated by urban-rural split for 29 IMPACT Commodity in 115 IMPACT countries/regions:
  - Income Elasticities
  - Own-Price Elasticities
  - Annual food demand

Disaggregated Elasticities

- Reviewed 67 disaggregated food demand studies
- The studies covered 43 countries
- The studies were conducted over various time frames with the earliest study conducted in 1973, and the latest in 2006

	Type of Elasticity				
Number of Commodities	Marshallian	Hicksian	Food Expenditure	Total Expenditure	Income
Average per source	10.1	3.9	7.4	3.1	4.4
Maximum	25	25	24	25	24

Process

- Step 1: Measure differences between rural and urban elasticities ("elasticity gaps")
- Step 2: Consolidate elasticity gaps into a set of price and income elasticity gaps
- Step 3: Use differences in elasticities between non-poor and poor to predict missing urban-rural gaps
- Step 4: Use descriptive statistics and region controls to predict a complete set of elasticity gaps
- Step 5: Fit gaps around the current IMPACT elasticities

Urban-Rural Price Elasticity Gap Regressions

	1	2	3	4	5
GDP per capita	2.60e-05***	2.40e-05***	2.60e-05***	2.41e-05***	2.40e-05***
	(4.36e-06)	(6.11e-06)	(4.29e-06)	(6.00e-06)	(6.07e-06)
GINI Coefficient	0.0326***	0.0386***	0.0327***	0.0390***	0.0390***
	(0.00307)	(0.00495)	(0.00302)	(0.00486)	(0.00492)
Middle East, North Africa,		-0.526***		-0.523***	-0.410
Central Asia		(0.146)		(0.144)	(0.599)
South and Southeast Asia		0.0812		0.0846	0.359
		(0.144)		(0.141)	(0.549)
East Asia		-0.0347		-0.0358	0.0297
		(0.149)		(0.146)	(0.618)
Central, Eastern, Southern, and		-0.317**		-0.321**	-0.715
Western Africa		(0.152)		(0.149)	(0.561)
Latin America		-0.184		-0.191	-0.779
		(0.168)		(0.165)	(0.572)
Region Fixed Effects (F-stat)		14.55		15.14	2.728
(Prob>0)		0		0	0.0185
Commodity Fixed Effects (F-stat)			2.548	2.701	0.345
(Prob>0)			1.79e-05	4.72e-06	0.999
Region x Commodity Fixed Effects (F-stat)					1.491
(Prob>0)					0.000128
Observations	1,292	1,292	1,292	1,292	1,292
R-squared	0.094	0.142	0.142	0.191	0.264

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Obstacles

- Studies come from various years
- Studies calculate different types of elasticities, use different demand systems to do these calculations and have different commodity disaggregation and commodity coverage
- Studies disaggregated demand in different ways (i.e. Poor-Non-Poor, Urban-Rural)
- There was an overall poor global coverage of disaggregated food demand

Results

Most foods, and aggregated food, are necessity (and normal) goods for which the relationship between income and consumption is represented by a monotonic and concave Engel curve (Figure 1). For an income increase of size X, consumption of would more for poorer rural households (A) among wealthier urban households (C). The increase in consumption for the representative household used currently used in IMPACT and other models would fall somewhere between (C). Consequently the sum of the increase in food consumption in response to an income increase of X for a poor rural household and for a wealthy urban household (A+C) is greater than twice the increase for a single representative household (2B). If figures 2, 3, and 4 it is evident that disaggregating the population while holding total population and total income constant increases both aggregate consumption and world prices of food.

Fig. 1

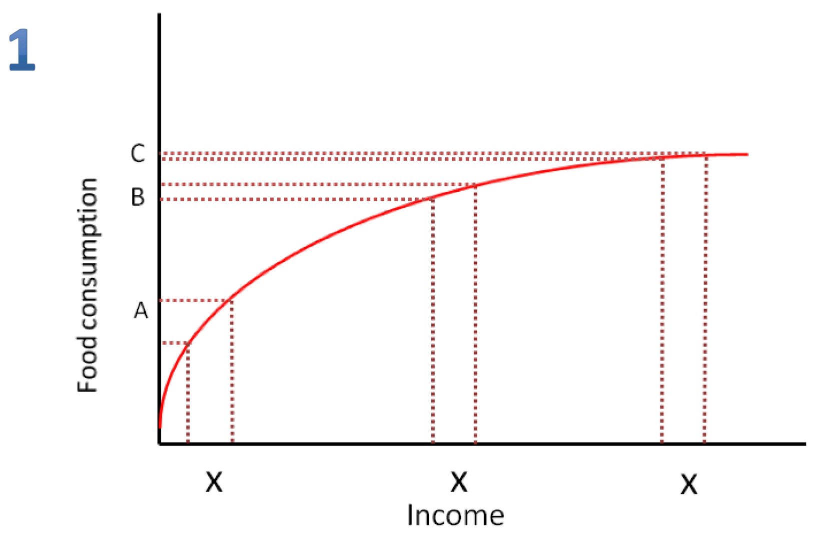


Fig. 2

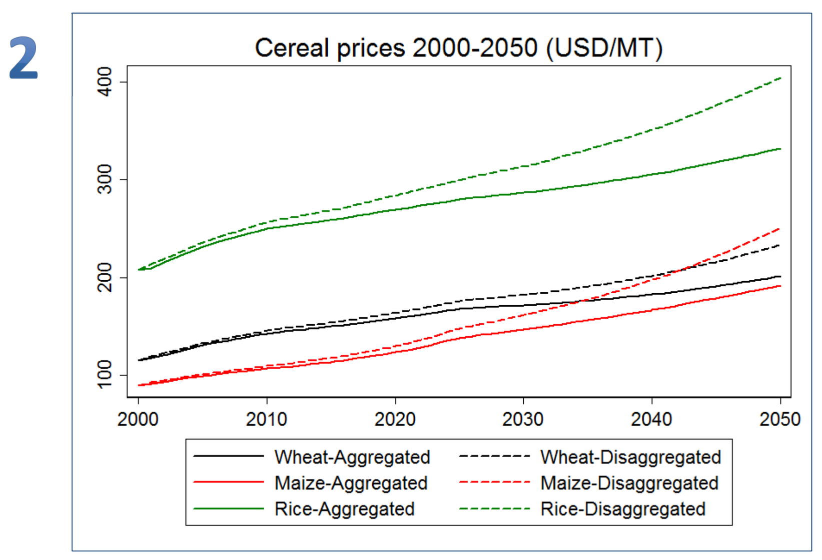


Fig. 3

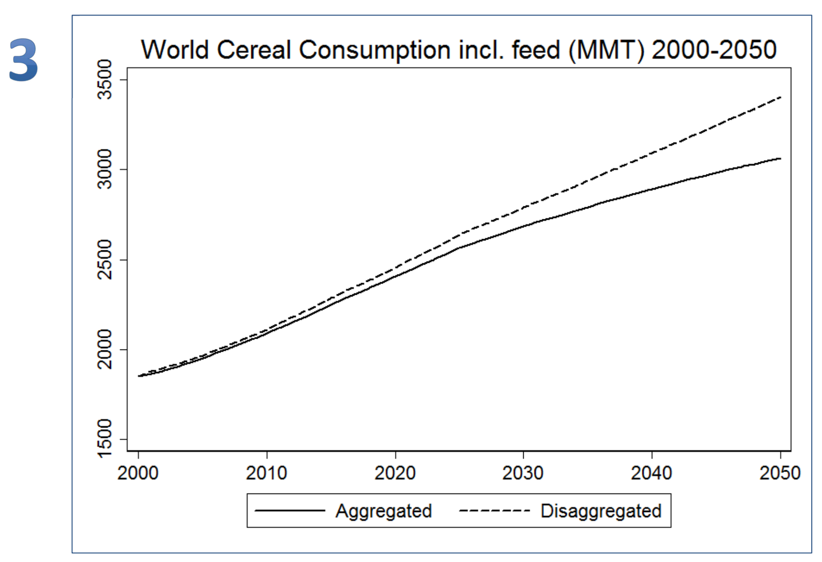
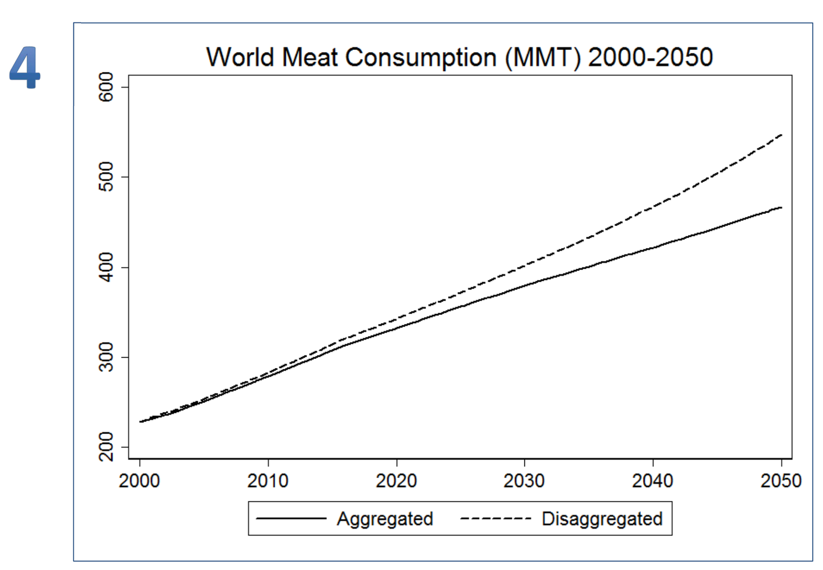


Fig. 4



Conclusions

Disaggregating demand clearly impacts aggregate outcomes. For this reason alone, policy modelers should consider taking on this endeavor. However, the differential food security impacts of policy simulations on poorer rural households compared to wealthier urban households will likely be even more illuminating. Next steps for this line of research include examining per-capita kilocalorie consumption for these sub-populations using a disaggregated model, and comparing these results with those obtained for the world population using an aggregated model. We can also test how different rates of urbanization in different parts of the world will impact regional and global food security.