Modeling Consumption and constructing long-term baselines in final demand

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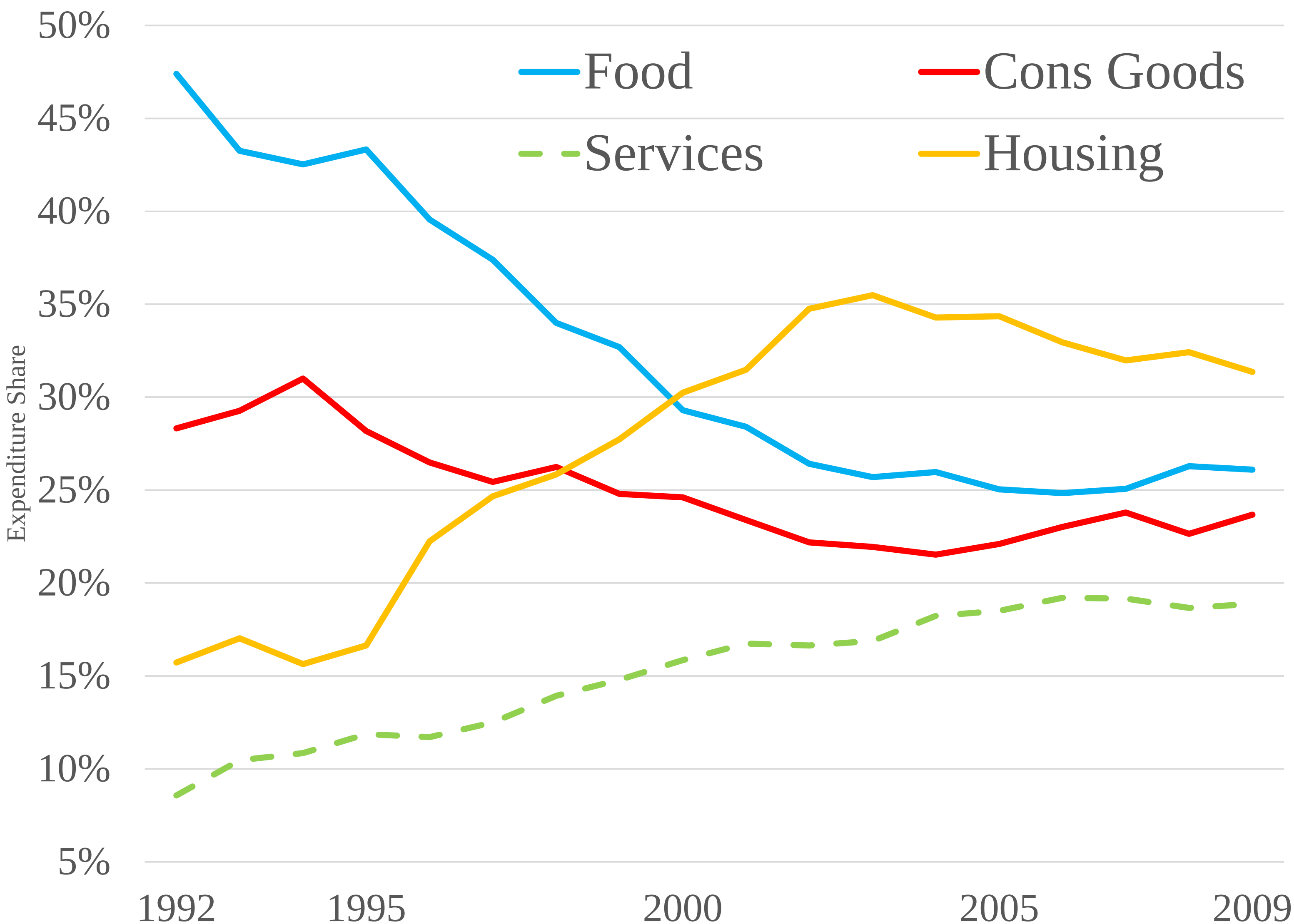
Sections

2. Observed consumption behavior and elasticities
3. Modelling of consumption in current CGE models
4. Projection of consumption demand and model comparisons
5.1 Investment
5.2 Government
6. Observations and Recommendations

Extra sub-sections on food and energy demands

China Consumption Shares, Urban Households 1992-2009

From: Cao, Ho, Hu, Jorgenson (2020)



Income elasticities for commodity groups.
Seale & Regmi (2006); Muhammad et al. (2011)

	Vietnam		Mexico		United States	
	1996	2005	1996	2005	1996	2005
Food, bev, tobacco	0.74	0.78	0.59	0.65	0.09	0.35
Clothing & footwear	0.88	0.97	0.85	0.97	0.82	0.96
Housing	1.25	1.07	1.19	1.07	1.15	1.06
House furnishing	1.18	1.05	1.14	1.05	1.12	1.05
Medical care	1.67	1.60	1.35	1.29	1.24	1.21
Education	1.01	0.93	1.01	0.92	1.01	0.91
Transport & commun	1.22	1.20	1.17	1.15	1.14	1.13
Recreation	2.20	2.11	1.45	1.38	1.28	1.25
Other	1.73	1.62	1.36	1.30	1.25	1.21

Uncompensated own-price elasticities

	Mexico		United States	
	1996	2005	1996	2005
Food, bev, tobacco	-0.49	-0.474	-0.07	-0.254
Clothing & footwear	-0.72	-0.708	-0.69	-0.707
Housing	-1	-0.781	-0.97	-0.778
House furnishing	-0.96	-0.77	-0.94	-0.768
Medical care	-1.13	-0.949	-1.04	-0.89
Education	-0.85	-0.675	-0.85	-0.668
Transport, commun	-0.98	-0.844	-0.95	-0.826
Recreation	-1.22	-1.011	-1.08	-0.92
Other	-1.14	-0.951	-1.04	-0.891

Food and energy

Food have non-monotonic income effects, some items reach a saturation point

	Low-income	Middle-income	High-income
Cereals	0.23	0.12	0.09
Meats	0.13	0.17	0.12
Fish	0.06	0.04	0.04
Dairy	0.08	0.10	0.07
Oils & Fats	0.05	0.03	0.01
Fruits & Vegetables	0.18	0.15	0.10
Other Food	0.15	0.21	0.37
Beverage & Tobacco	0.12	0.19	0.21

Energy income elasticities follow inverse-U;
Price elasticities are U-shaped

Modeling of Consumption in current CGE models

CD, CES, LES, CDE, AIDADS, AIDS, Translog

Fig 5. Demand systems used in surveyed CGE models

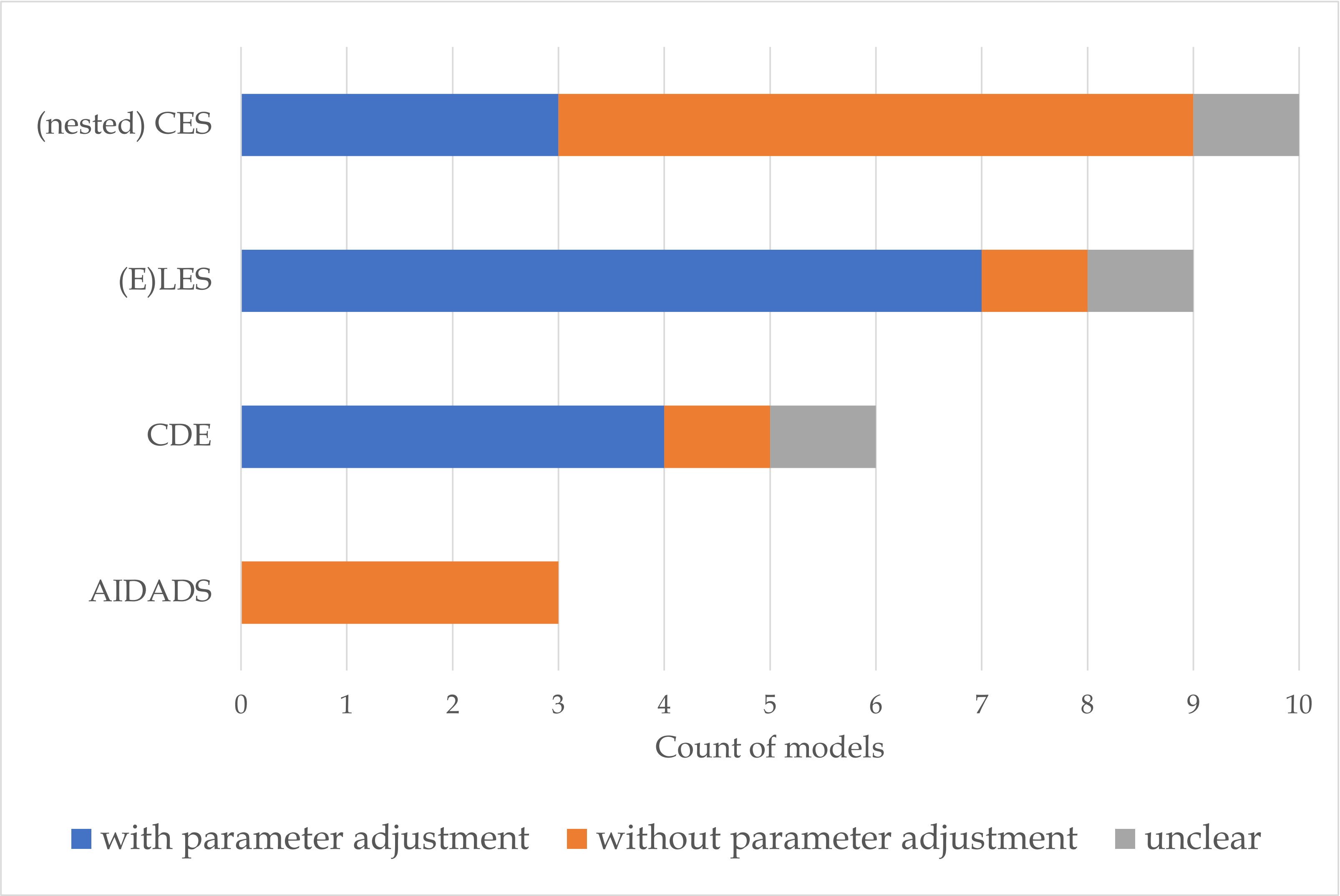


Table 6. Demand systems currently used in CGE models

Model; institution/authors	**Key features**	**Consumption function**	**Energy demand treatment**	**Cons. fn features**	**Income elasticity treatment**
ADAGE; RTI	Global or US; myopic; 24 sectors + 10 biofuels	nested CES			
AIM CGE; Japan NIES	Global or national; myopic; 19 sectors + 19 energy	LES	LES or Logit	Food uses FAO projections	η^M adj. over time
DART; IfW Kiel	Global; myopic;	LES	Mixed Cobb Douglas & CES	η^M from GTAP; use Dellink (2005)	
Envisage; World Bank	Global; myopic; flexible no. of sectors (~30);	CDE and CES; options for LES, AIDADS		use FAO projections	
ENV-Linkages; OECD	Global; myopic; 22 sectors +7 elect.	ELES and CES		params from GTAP	LES params adj. over time
EPPA; MIT JPGC	Global; myopic; 9 sectors + 8 energy + 8 elect.	CES and CDE; LES in v6L	Detailed household transportation	CDE for food, converge to rich country shares; detailed transp	η^M from Reimer & Hertel (2004)

Functions used

CES

$$U_t = \left[\alpha_{1t} c_{1t}^{\frac{\sigma-1}{\sigma}} + \alpha_{2t} c_{2t}^{\frac{\sigma-1}{\sigma}} + .. \; + \; \alpha_{nt} c_{nt}^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}$$

$$\eta_i^M = 1$$

$$\eta_i = -\sigma + \frac{\alpha_i^{\sigma}(\sigma-1) p_i^{1-\sigma}}{\sum \alpha_j^{\sigma} p_j^{1-\sigma}}$$

NP = 2n-2

LES

$$u = \sum_i \alpha_i \ln(c_i - \gamma_i); \quad \sum_i \alpha_i = 1$$

$$p_i c_i = p_i \gamma_i + \alpha_i (M - \sum_j p_j \gamma_j)$$

$$\eta_i^M = \frac{\alpha_i M}{p_i c_i} \to 1; \quad \eta_i = -\frac{\alpha_i p_i \gamma_i + \alpha_i (M - \sum_j p_j \gamma_j)}{p_i \gamma_i + \alpha_i (M - \sum_j p_j \gamma_j)}$$

NP = 2n-1

Const diff of elasticities (CDE)

$$\sum_i B_i U^{\beta_i \gamma_i} \left[\frac{p_i}{E(p,U)} \right]^{\beta_i} = 1$$

$$w_i = \frac{Z_i}{\sum_k Z_k}; \quad Z_i = B_i \beta_i U^{\beta_i \gamma_i} (p_i / M)^{\beta_i}$$

$$\alpha_i = 1 - \beta_i$$

$$\eta_i^M = \frac{\sum_k w_k \gamma_k \alpha_k + \gamma_i (1-\alpha_i)}{\sum_k w_k \gamma_k} + \alpha_i - \sum_k w_k \alpha_k$$

$$\varepsilon_{ij} = w_j [\alpha_i + \sum_k w_k (1-\alpha_k) - (1-\alpha_i)] - \delta_{ij} \alpha_i$$

NP=3n

AIDADS

$$\sum_i \frac{\alpha_i + \beta_i e^u}{1+e^u} \ln \left[\frac{c_i - \gamma_i}{A e^u} \right] = 1$$

$$\sum_i \alpha_i = 1 = \sum_i \beta_i$$

$$c_i = \frac{\phi_i (M - \gamma' P)}{p_i} + \gamma_i ; \phi_i = \frac{\alpha_i + \beta_i e^u}{1+e^u}$$

$$\eta_i^M = \frac{\psi_i (c_i, u)}{w_i}$$

NP = 3n-1

Flexible; AIDS, Translog

Special energy functions

Projection of consumption and model comparison

Projection of consumption demand

2 general methods :

1. *Complete demand system approach*
   Parameters are fixed and only exogenous variables may change over time (e.g. demographic composition). Not allow preference changes.

2. *Exogenous parameter adjustment approach*
   Parameters initially calibrated to estimated elasticities, but then adjusted over time based on beliefs about income effects and other time-varying changes.
   (2 adjustments: for demographic changes and
   for income changes)

Paper discusses advantages of each method

Adjusting parameters for expected income effects

Adjust to get shares of consumption that are projected externally (due to income, demographic or preference shifts).

May need to iterate to get a consistent GDP path and consumption shares. Discussions in iPETS Ren et al (2018); GEM-E3 (2018); Chen et al (2015); WTO (2018); MAGNET Woltjet et al (2014); G-RDEM Britz and Roson (2019);

Caron et al. (2017) uses EASI to project shares and then calibrate LES function.

Comparison of 4 functions in 2050 baseline: CDE, LES, AIDADS, AIDADS-CES

Use 4 different functions in same G-RDEM (Britz & Roson 2019); modified GTAP-AEZ and GTAP-E.

CDE params from GTAP
LES params calib. from CDE
AIDADS without sub-nests
AIDADS with CES sub-nests (standard G-RDEM)

All versions TFP-calibrated to the same GDP path.

Table 5. Differences in global 2050 output, relative to AIDADS-CES

	LES		CDE		AIDADS	
	Quant	Price	Quantity	Price	Quantity	Price
ALL sectors	8%	-5%	11%	-10%	0%	0%
Paddy rice	8%	236%	20%	383%	-1%	-8%
Wheat	5%	185%	11%	264%	0%	-4%
Vegetables, fruit, nuts	9%	206%	5%	214%	0%	-5%
Cattle,sheep,goats,horses	102%	41%	64%	28%	-8%	-2%
Raw milk	121%	54%	88%	32%	0%	-1%
Petroleum	-3%	-15%	-24%	-23%	12%	3%
Water	48%	-16%	37%	-20%	-1%	1%
Transport nec	9%	-9%	10%	-12%	0%	1%
Dwellings	-37%	-23%	1%	-23%	-1%	1%

Investment and Government demand functions

Investment composition models

Fixed shares (or Leontief) $\widehat{I}_{it} = \widehat{I}_{t}^{agg}$

CES $I_{it} = \alpha_{it}^{I} \left(\frac{PI}{PB_{it}^{I}} \right)^{\sigma^{I}} I_{t}^{agg}$

Translog $w_{it} = \alpha_{it}^{I} + B \ln p + f_{it}$

Most models seem to fix the shares at base year levels except for IGEM use of time trends in the translog function.

Research Agenda for Consumption Modeling

1 Data
2 Income and price elasticities
3 Specialized projections (expert judgements)
4 Adjustment of parameters to (3)
5 Model comparisons

Good if modeling teams document their final demand functions and the process to define parameter values.

Model comparisons are costly, collaborations would be valuable –

comparing different methods of calibrating elasticities;

comparing with flexible forms requiring homoth nesting;

comparing different energy functions;