

AJAE Appendix to Nutrition Transition and the Structure of Global Food Demand*

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MAIDADS price elasticities

The MAIDADS price elasticities can be calculated in the accompanying spreadsheet. They are obtained from the following formulas. From [Preckel, Cranfield, and Hertel \(2010\)](#), the partial elasticities of substitution are

$$(S1) \quad \epsilon_{cij} = \frac{[\hat{x}_{ci} - \gamma_i(u_c)][\hat{x}_{cj} - \gamma_j(u_c)]}{\hat{x}_{ci}\hat{x}_{cj}} \cdot \frac{m_c}{m_c - \sum_{k=1}^I p_{ck}\gamma_k(u_c)}, \text{ for } i \neq j.$$

Using the partial elasticities of substitution, the homogeneity condition for elasticities, the Slutsky equation, and the relation between Slutsky elasticities and partial elasticities of substitution ([Frisch, 1959](#)), we have the uncompensated demand elasticities with respect to price:

$$(S2) \quad e_{cij} = \frac{\phi_i(u_c) \left(m_c - \sum_{k=1}^I p_{ck}\gamma_k(u_c) \right)}{w_{ci}m_c} (\phi_j(u_c) - \xi_{ij}) - w_{cj}\eta_{ci},$$

where $w_{ci} = p_{ci}\hat{x}_{ci}/m_c$ is the budget share and $\xi_{ij} = 1$ if $i = j$ and 0 if $i \neq j$.

Missing prices

This section documents the extent of missing prices in our estimated sample. Our prices come primarily from trade unit values from the Trade Unit Values database ([Berthou and Emlinger, 2011](#)). In the database, values can be missing for a variety of reasons. For example, absence of trade flows (or lack of reporting of them) or absence of information about traded quantities, only traded values being reported. It is important to note that these unit values may not be missing in the commonly used COMTRADE database. However, this difference is explained by the fact that some imputations are done to fill missing values when building COMTRADE. The Trade Unit Values database is constructed from the same tariff-line information used to construct COMTRADE, but without filling the missing values.

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For documenting the missing values, the number of missing prices would make little sense as the number would not account for the fact that some products with missing values may not be consumed at all in a country or contribute very little to overall caloric intakes or expenditures. Instead we report the caloric share of missing prices broke down by food groups in table S1 and by country in table S2.

Table S1. Caloric Share of Missing Prices by Food Group for Countries in the Estimation Sample

Consumption bundle	Caloric share of missing prices (%)
Cereals, roots, and tubers	0.1
Sugar, sugar crops, and sweeteners	3.7
Pulses, nuts, and oilcrops	11.2
Vegetables and fruits	2.2
Oils and fats	2.1
Meat and seafood	1.7
Dairy and eggs	3.0

Table S1 presents the caloric shares in each food group of missing prices. It reads as follows. For the group “cereals, roots, and tubers,” 0.1% of the caloric demand for this group does not have corresponding prices. The other food groups have higher shares of missing prices that stay in the single digit except for “pulses, nuts, and oilcrops” with a 11.2% share. This residual group concerns products consumed and traded in small quantities, which increases the risk of non-reporting, and presents higher consumption levels in poor than in rich countries. Since the share of missing values decrease with per capita income, this could also help explain this high share of missing prices. Table S2 presents the caloric shares of missing prices by countries, but only for countries with a share exceeding 1%. 70 countries are absent from the table because they have shares lower than 1% and, by construction, countries with more than 30% of missing prices have been excluded from the sample. Most of the countries in table S2 are close to the 1% threshold with low shares of missing prices. High shares of missing prices can only be observed in relatively poor countries, where trade statistics are more likely to be incompletely reported.

Table S2. Caloric Share of Missing Prices for Countries Included in the Estimation with Shares Exceeding 1%

Country	Caloric share of missing prices (%)	Country	Caloric share of missing prices (%)
Algeria	1.2	Laos	14.7
Bangladesh	15.7	Libya	1.3
Belgium	1.1	Malaysia	1.1
Benin	6.7	Mexico	1.2
Bolivia	1.7	Namibia	1.6
Burkina Faso	1.9	Panama	1.0
Cambodia	4.0	Saudi Arabia	1.5
Cameroon	5.6	Senegal	1.8
Canada	1.4	Sri Lanka	2.0
Costa Rica	18.6	Switzerland	1.3
Dominican Republic	6.2	Tajikistan	27.4
El Salvador	13.9	Tanzania	14.3
Gabon	14.9	Thailand	1.1
Hong Kong	1.9	Trinidad and Tobago	1.7
India	2.8	Uruguay	1.0
Israel	1.8	Venezuela	1.7
Japan	1.0	Vietnam	25.4

Supplementary figures and tables

Table S3. Mapping Between Current Study' Food Groups and Food Products in FAOSTAT Food Balance Sheets

Food group	Food product	Food group	Food product	
Cereals, roots, and tubers	Wheat and products	Oils and fats	Coconut Oil	
	Rice		Cottonseed Oil	
	Barley and products		Groundnut Oil	
	Maize and products		Maize Germ Oil	
	Rye and products		Oilcrops Oil, Other	
	Oats		Olive Oil	
	Millet and products		Palm Oil	
	Sorghum and products		Palmkernel Oil	
	Cereals, Other		Rape and Mustard Oil	
	Potatoes and products		Ricebran Oil	
	Sweet Potatoes		Sesameseed Oil	
	Cassava and products		Soyabean Oil	
	Roots, Other		Sunflowerseed Oil	
	Yams		Butter, Ghee	
	Sugar, sugar crops, and sweeteners		Sugar Beet	Cream
			Sugar Cane	Fats, Animals, Raw
Sugar		Fish, Body Oil		
Sugar, Non-Centrifugal		Fish, Liver Oil		
Honey		Meat and seafood	Bovine Meat	
Sweeteners, Other			Meat, Other	
Pulses, nuts, and oilcrops	Beans	Mutton & Goat Meat		
	Peas	Pigmeat		
	Pulses, Other and products	Poultry Meat		
	Nuts and products	Cephalopods		
	Soyabeans	Crustaceans		
	Groundnuts	Demersal Fish		
	Sunflowerseed	Freshwater Fish		
	Rape and Mustardseed	Marine Fish, Other		
	Cottonseed	Molluscs, Other		
	Coconuts - Incl Copra	Pelagic Fish		
	Sesameseed	Offals, Edible		
	Palm kernels	Meat, Aquatic Mammals		
	Olives (including preserved)	Aquatic Animals, Others		
	Oilcrops, Other	Aquatic Plants		
	Vegetables and fruits	Tomatoes and products	Dairy and eggs	Milk - Excluding Butter
		Vegetables, Other		Eggs
Onions				
Oranges, Mandarines				
Lemons, Limes and products				
Grapefruit and products				
Grapes and products (excl wine)				
Fruits, Other				
Citrus, Other				
Apples and products				
Bananas				
Pineapples and products				
Plantains				
Dates				

Table S4. List of Countries Included in the Estimation or Projections

Afghanistan [†]	Dominican Republic	Lebanon	Rwanda [†]
Albania	Ecuador	Lesotho [†]	Saint Lucia [†]
Algeria	Egypt	Liberia [†]	Saint Vincent and the Grenadines [†]
Angola [†]	El Salvador	Libya	Saudi Arabia
Argentina	Estonia	Lithuania	Senegal
Armenia	Ethiopia [†]	Luxembourg [†]	Sierra Leone [†]
Australia	Fiji [†]	Macao [†]	Slovakia
Austria	Finland	Macedonia	Slovenia
Azerbaijan	France	Madagascar [†]	South Africa
Bahamas [†]	Gabon	Malawi [†]	Spain
Bangladesh	Gambia [†]	Malaysia	Sri Lanka
Barbados [†]	Georgia	Maldives [†]	Sudan [†]
Belarus	Germany	Mali [†]	Suriname [†]
Belgium	Ghana	Malta [†]	Swaziland [†]
Belize [†]	Greece	Mauritania [†]	Sweden
Benin	Guatemala [†]	Mauritius	Switzerland
Bolivia	Guinea-Bissau [†]	Mexico	Tajikistan
Bosnia and Herzegovina	Guinea [†]	Moldova	Tanzania
Botswana	Guyana [†]	Mongolia [†]	Thailand
Brazil	Haiti [†]	Morocco	Togo
Brunei Darussalam [†]	Honduras	Mozambique [†]	Trinidad and Tobago
Bulgaria	Hong Kong	Namibia	Tunisia
Burkina Faso	Hungary	Nepal	Turkey
Cabo Verde [†]	Iceland [†]	Netherlands	Turkmenistan [†]
Cambodia	India	New Zealand	Uganda [†]
Cameroon	Indonesia	Nicaragua	Ukraine
Canada	Iran	Nigeria [†]	United Arab Emirates [†]
Central African Republic [†]	Ireland	Niger [†]	United Kingdom
Chile	Israel	Norway	United States
China mainland	Italy	Pakistan [†]	Uruguay
Colombia	Jamaica	Panama	Uzbekistan [†]
Congo [†]	Japan	Paraguay	Vanuatu [†]
Costa Rica	Jordan	Peru	Venezuela
Cote d'Ivoire	Kazakhstan	Philippines	Vietnam
Croatia	Kenya [†]	Poland	Yemen
Cyprus	Kuwait [†]	Portugal	Zambia
Czech Republic	Kyrgyzstan [†]	Republic of Korea	Zimbabwe [†]
Denmark	Laos	Romania	
Djibouti [†]	Latvia	Russian Federation	

Note: [†] Countries not included in the estimation sample but included in projections.

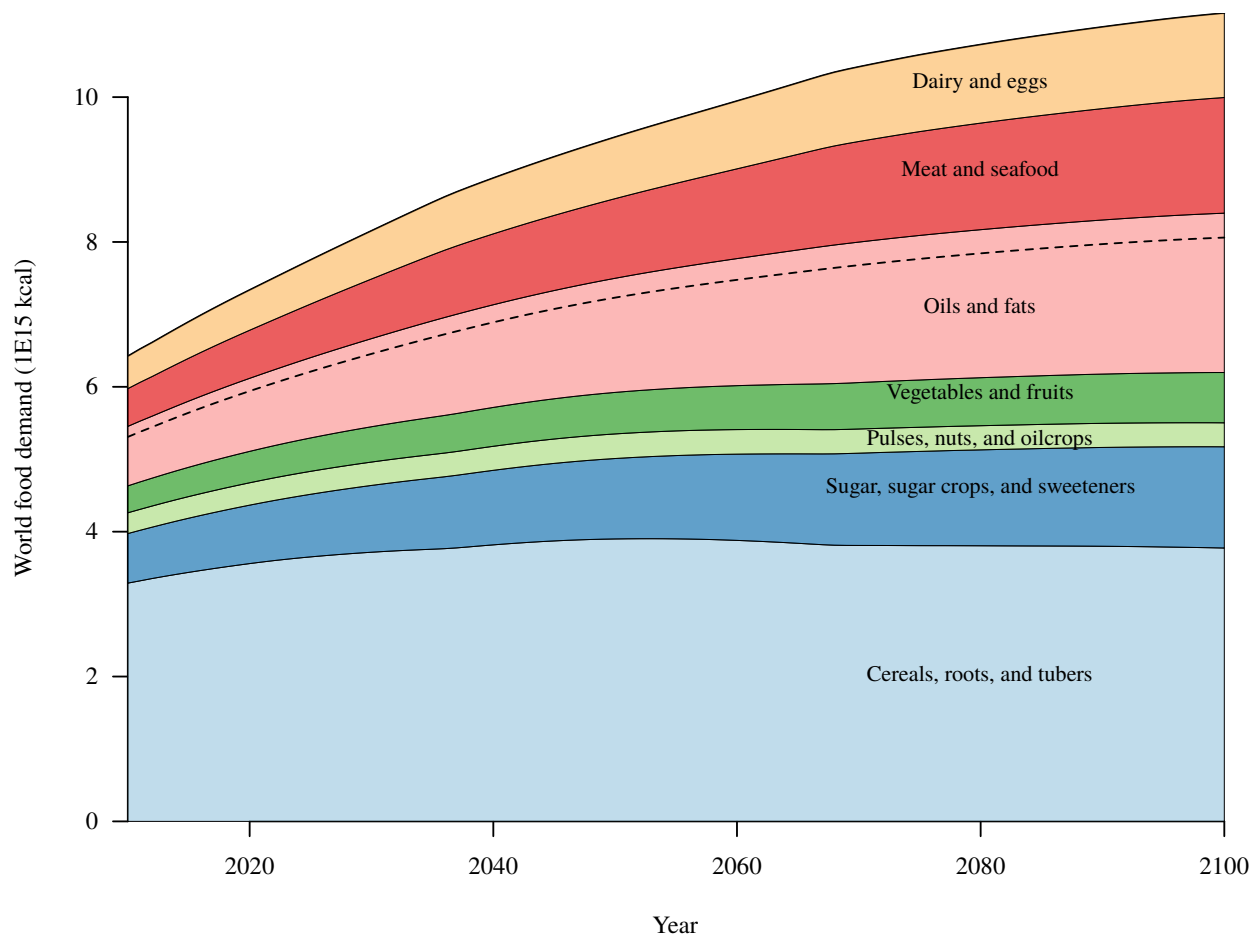


Figure S1. Food Demand projections from 2010 to 2100 for the trend scenario

Table S5. Past and Projected Annualized Growth Rates (Percentage) of GDP per Capita and population.

Region	1961–2010		2010–2050	
	GDP per capita	Population	GDP per capita	Population
World	2.90	2.44	2.33	1.74
High income	3.30	1.87	2.14	1.51
Upper middle income	4.29	2.43	3.72	1.52
China	7.43	2.30	4.67	1.41
Other upper middle income	3.18	2.63	2.59	1.67
Lower middle income	3.35	2.78	3.28	1.87
India	3.46	2.70	3.73	1.72
Other lower middle income	3.27	2.85	2.92	1.99
Low income	2.37	3.11	3.26	2.50

Sources: WDI for past GDP per capita, UN Population Division for past population, and EconMap for projections.

Note: Income groups based on World Bank country classification established in July 2015.

Table S6. Contribution in Percentage of Each Income Group to Total Food Demand Change Between 2010 and 2050, and Decomposition into Population and Income Effects

Region	Total	Income effect	Population effect
High income	6.2	3.2	8.0
Upper middle income	16.9	31.5	14.0
Lower middle income	57.1	54.6	57.3
Low income	19.8	10.7	20.7

Note: Income groups based on World Bank country classification established in July 2015.

Table S7. Projected 2010–2050 Annualized Growth Rates (Percentage) of GDP per Capita and Population for Shared Socioeconomic Pathways Scenarios

Region	GDP per capita					Population				
	SSP1	SSP2	SSP3	SSP4	SSP5	SSP1	SSP2	SSP3	SSP4	SSP5
World	2.70	2.37	1.76	2.42	3.10	1.60	1.70	1.79	1.69	1.62
High income	2.31	2.09	1.66	2.45	2.59	1.56	1.55	1.42	1.49	1.68
Upper middle income	4.00	3.74	3.16	3.49	4.34	1.39	1.45	1.52	1.39	1.39
China	4.95	4.73	4.17	4.37	5.29	1.29	1.32	1.35	1.25	1.29
Other upper middle income	2.86	2.58	2.03	2.50	3.20	1.55	1.64	1.76	1.57	1.54
Lower middle income	3.79	3.37	2.60	2.75	4.35	1.69	1.83	2.01	1.83	1.68
India	4.15	3.70	2.89	3.17	4.69	1.63	1.77	1.94	1.68	1.63
Other lower middle income	3.48	3.09	2.36	2.41	4.06	1.74	1.88	2.07	1.96	1.71
Low income	3.88	3.32	2.55	2.56	4.35	2.08	2.30	2.52	2.50	2.05

Source: EconMap.

Note: Income groups based on World Bank country classification established in July 2015.

Table S8. Decomposition of Food Demand Change 2010 to 2050 into Population and Income Effects for Shared Socioeconomic Pathways Scenarios (Percentage Change)

Consumption bundle	Total	Income effect	Population effect	Total	Income effect	Population effect
	SSP1: Sustainability			SSP2: Middle of the road		
Cereals, roots, and tubers	-1.2 ± 2.9	-19.6 ± 2.4	20.4	12.5 ± 3.0	-16.5 ± 2.3	31.3
Sugar and sweeteners	50.6 ± 8.5	27.2 ± 7.2	17.2	57.2 ± 8.9	24.0 ± 7.2	25.3
Pulses, nuts, and oilcrops	-0.9 ± 5.4	-19.3 ± 4.9	21.1	12.5 ± 4.8	-16.5 ± 4.2	32.3
Vegetables and fruits	40.4 ± 11.6	18.0 ± 9.9	17.0	48.8 ± 12.9	16.3 ± 10.2	25.4
Oils and fats	87.3 ± 5.6	60.5 ± 4.9	17.5	87.9 ± 5.1	51.9 ± 4.4	24.5
Meat and seafood	109.6 ± 10.1	80.6 ± 8.8	15.6	107.3 ± 10.2	69.4 ± 8.5	21.3
Dairy and eggs	83.0 ± 20.8	56.4 ± 18.1	15.0	85.3 ± 21.2	49.4 ± 17.4	21.2
Vegetal-based	19.8 ± 3.4	-0.7 ± 2.8	19.5	30.6 ± 3.8	-0.2 ± 2.9	29.4
Animal-based	95.4 ± 12.7	68.1 ± 11.0	15.4	95.3 ± 12.9	58.9 ± 10.7	21.4
All food	32.9 ± 4.3	11.2 ± 3.6	18.7	41.8 ± 4.8	10.0 ± 3.7	28.0
	SSP3: Fragmentation			SSP4: Inequality		
Cereals, roots, and tubers	31.5 ± 3.1	-11.5 ± 2.2	43.9	16.0 ± 2.8	-14.2 ± 2.2	30.3
Sugar and sweeteners	59.0 ± 9.1	18.7 ± 7.0	32.6	47.4 ± 7.9	20.2 ± 6.6	22.2
Pulses, nuts, and oilcrops	31.0 ± 3.2	-11.9 ± 3.2	45.3	16.4 ± 3.5	-14.1 ± 3.6	31.6
Vegetables and fruits	54.3 ± 14.0	13.5 ± 10.4	33.4	41.1 ± 11.7	13.5 ± 9.6	22.3
Oils and fats	76.3 ± 4.0	38.1 ± 3.5	29.4	70.2 ± 3.8	44.3 ± 3.6	21.1
Meat and seafood	88.5 ± 9.8	51.4 ± 8.1	23.7	83.5 ± 8.9	59.1 ± 7.9	16.8
Dairy and eggs	76.3 ± 21.3	37.8 ± 17.0	25.2	66.9 ± 18.5	41.7 ± 16.2	16.8
Vegetal-based	42.5 ± 4.1	0.5 ± 2.9	40.1	28.9 ± 3.5	-0.4 ± 2.7	27.7
Animal-based	81.3 ± 12.7	44.1 ± 10.3	24.5	74.4 ± 11.3	50.1 ± 9.9	16.9
All food	49.2 ± 5.2	8.0 ± 3.8	37.4	36.8 ± 4.4	8.4 ± 3.6	25.8
	SSP5: Conventional development					
Cereals, roots, and tubers	-4.8 ± 3.1	-23.1 ± 2.6	21.2			
Sugar and sweeteners	58.6 ± 8.7	31.3 ± 7.2	20.1			
Pulses, nuts, and oilcrops	-4.3 ± 6.6	-22.5 ± 5.6	21.9			
Vegetables and fruits	46.0 ± 11.9	20.5 ± 9.9	19.6			
Oils and fats	104.2 ± 6.1	70.5 ± 5.2	21.7			
Meat and seafood	131.3 ± 10.7	93.8 ± 9.0	20.9			
Dairy and eggs	98.2 ± 22.4	65.3 ± 18.8	19.3			
Vegetal-based	20.9 ± 3.4	-1.1 ± 2.8	21.1			
Animal-based	114.1 ± 13.3	79.2 ± 11.2	20.2			
All food	37.1 ± 4.3	12.9 ± 3.5	20.9			

Note: Central estimation and standard deviation calculated using bootstrap replicates where applicable.

References

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