AGRICULTURAL AND RESOURCE ECONOMICS
KASETSART UNIVERSITY

Demand for Food attributes

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Food attributes and preferences

- Food attributes
- Food availability and nutrition
- Nutritional labeling
- Information and preferences
- Food technology
- Food fortification

What are food attributes?

Consumer Demand

Consumer preference helps determine demand for certain foods and diets. This demand reflects people's choices about what foods to acquire, store, prepare, and eat, and how to share food within the household [105]. Income, education, taste preference, convenience, tradition, culture, and values determine consumer preferences and choices [106–108]. The external food environment also influences preference through various means of selecting, purchasing, preparing, and presenting food for consumption [78, 89].

Food purchasing and consumption decisions are influenced by information that people receive from advertising and marketing, labeling, and dietary guidelines. Food companies use branding, social media marketing, and advertisements to promote their food products. Product placement and signage in retail stores also influences dietary behavior. These promotional methods affect food acceptability, consumer preference, purchasing decisions, and consumption [109–112]. Labels, declarations, or warnings on food packaging, in food retail outlets, and on menus are other ways to inform consumers [113–115]. National food-based dietary guidelines provide recommendations on healthy diets that are adapted to the national context [116]. These guidelines can influence consumer preferences and inform both food supply chain actors and policymakers [117].

Convenience and preference are also critical to consumer decision-making. Sensory appeal and desirability are linked to the quality, safety, and familiarity of the food product, as well as the individual's own personal ideology, aspirations, and habits [118]. "Food quality" refers to the attributes of a food product that influence its value and enhance its acceptability to the consumer [103]. Social interactions, availability, and time constraints can affect a consumer's perceptions of convenience [118]. Other attributes that affect preference include the size, shape, and color of a food item or its presentation, the food's texture, flavor, odor, freshness and safety, ingredient and nutrient composition, production method (e.g., "organic" or "cage-free"), and level of processing [119].

Life events and personal experiences also influence food choice. Throughout life, people continuously consider and adjust their food values, preferences, and routines, though these deliberations are not necessarily conscious. These experiences affect consumer interactions with the food environment and guide eating behavior [120]. In turn, food choices influence nutritional status, health, and perceptions of identity, all of which can affect life experience [120].

Image by Welcome to all and thank you for your visit ! ツ from Pixabay

Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p19). https://doi.org/10.1007/978-3-030-72763-5.

Food quality attributes

Attributes				
Food Safety	Nutritional	Value	Package	Process
Examples of variables				
• Foodborne pathogens • Heavy metals • Pesticide residues • Food additives • Naturally-occurring toxins • Veterinary residues	• Fat • Calories • Fibre • Sodium • Vitamins • Minerals	• Purity • Compositional integrity • Size • Appearance • Taste • Convenience of preparation	• Package materials • Labelling • Other information	• Animal welfare • Biotechnology • Environmental impact • Pesticide use • Worker safety

Source: Hooker and Caswell (1996)

Hooker, N.H and J.A. Caswell (1996) “Regulatory targets and regimes for food safe- ty: a comparison of North American and European Approaches” in *The Economics of Reducing Health Risk from Food* (Caswell, ed.), Food Marketing Policy Center, Storrs, CT (pp. 1-17).

BACK-TO-BASICS FOOD ATTRIBUTES ARE MOST POPULAR

PERCENTAGE THAT RATE EACH HEALTH ATTRIBUTE VERY IMPORTANT IN PURCHASING DECISIONS

SUSTAINABLE

INGREDIENTS SOURCED SUSTAINABLY/FAIR TRADE	GLOBAL AVERAGE 35%
ORGANIC	33%
LOCAL HERBS/INGREDIENTS	26%

BACK-TO-BASICS

	GLOBAL AVERAGE
ALL NATURAL	43%
GMO-FREE	43%
NO ARTIFICIAL COLORS	42%
NO ARTIFICIAL FLAVORS	41%
MADE FROM VEGETABLES/FRUITS	40%
NATURAL FLAVORS	36%

LESS IS MORE

	GLOBAL AVERAGE
LOW/NO CHOLESTEROL	38%
LOW SALT/SODIUM	33%
LOW SUGAR/SUGAR FREE	32%
LOW/NO FAT	30%
PORTION CONTROL	27%
LOW/NO CALORIES	27%
NO HIGH FRUCTOSE CORN SYRUP	26%
LOW/NO CARBOHYDRATES	24%
CAFFEINE-FREE	23%
GLUTEN-FREE	21%

MORE IS MORE

	GLOBAL AVERAGE
HIGH IN FIBER	36%
HIGH IN PROTEIN	32%
WHOLE GRAIN	30%
CALCIUM-FORTIFIED	30%
VITAMIN-FORTIFIED	30%
MINERALS-FORTIFIED	29%
RICH IN UNSATURATED FATS	25%
MICRONUTRIENT-FORTIFIED	25%

Source: Nielsen Global Health & Wellness Survey, Q3 2014

nielsen AN UNCOMMON SENSE OF THE CONSUMER™

Cognitive resources and dual systems

System 1 uses a fast, reflexive, automatic, and perhaps "mindless" process that operates heuristically and expends little cognitive resources.

System 2 uses a slow, reflective, analytical, and deliberate process that expends many cognitive resources.

Some problems use mainly System 1 and other problems use mainly System 2, but often both will be used.

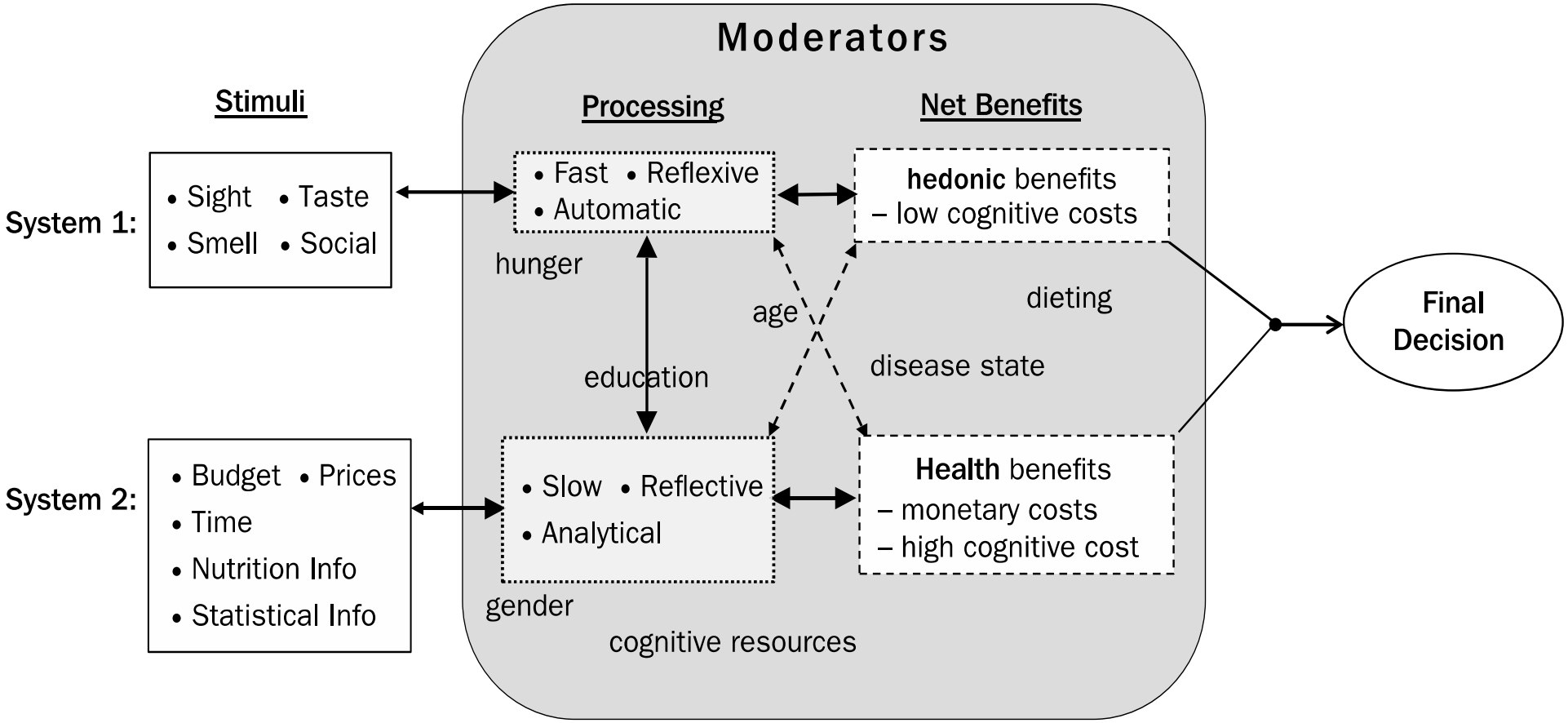
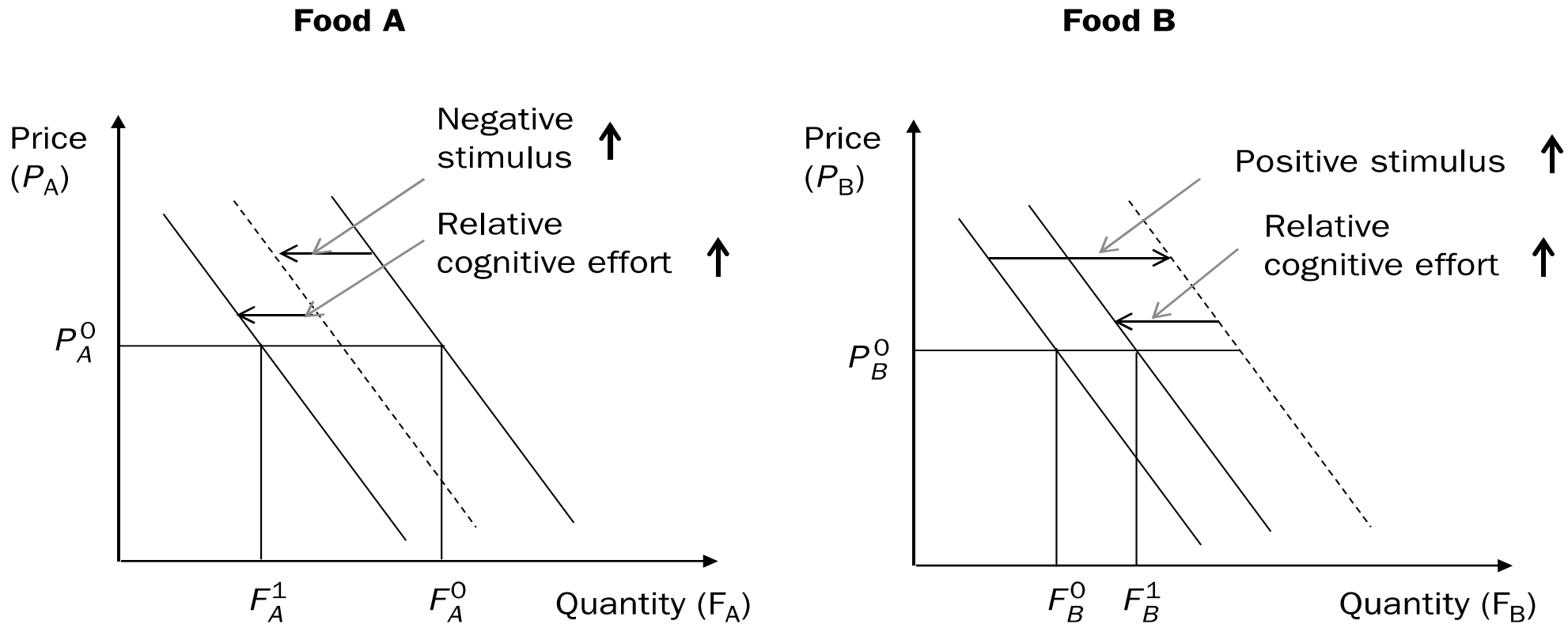


FIGURE 10.1 Dual Systems/Dual Objectives Schematic of Food Choices.

Davis, G. C. & Serrano, E. L. 2016. Food and nutrition economics : fundamentals for health sciences. New York: Oxford University Press (p139).

Examples of Cognitive Effort Moderating Stimulus Effects.



[IAPS] If the cognitive effort associated with a negative stimulus increases, the negative demand shift is accentuated (Food A). If the cognitive effort associated with a positive stimulus increases, the positive demand shift is attenuated (Food B).

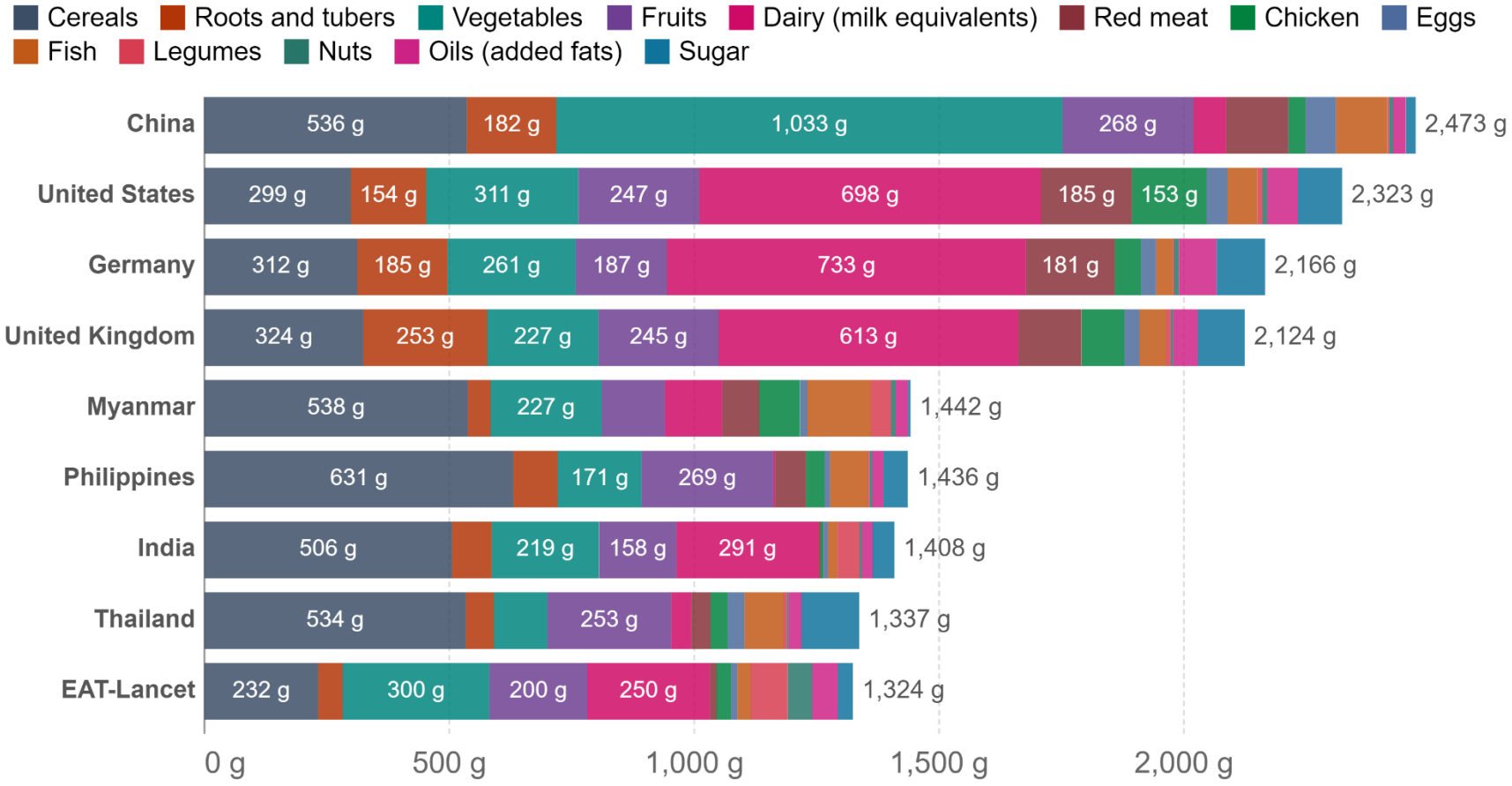
Davis, G. C. & Serrano, E. L. 2016. Food and nutrition economics : fundamentals for health sciences. New York: Oxford University Press (p143).

Food availability and nutrition

How do actual diets compare to the EAT-Lancet diet?

Our World in Data

Diets are shown as average daily per capita supply of different food groups, compared to the EAT-Lancet diet. The EAT-Lancet diet is a diet recommended to balance the goals of healthy nutrition and environmental sustainability for a global population.

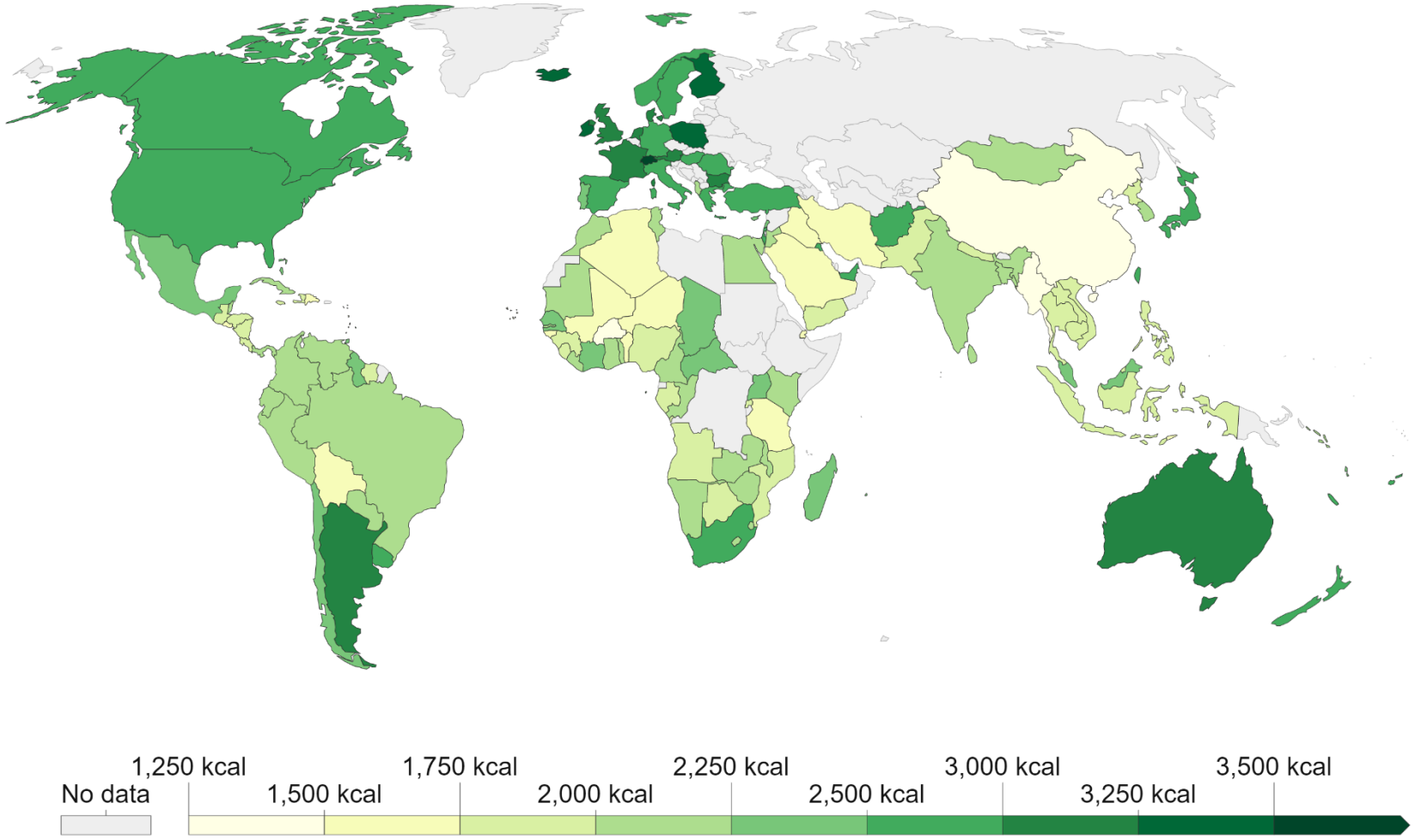


Source: Food and Agriculture Organization of the United Nations; EAT-Lancet Commission OurWorldInData.org/diet-compositions • CC BY

Note: Diets by country are given as food supply – this is higher than actual intakes because it does not correct for consumer waste.

Daily supply of calories per person, 1961

Daily per capita caloric supply is measured in kilocalories per person per day. This indicates the caloric availability delivered to households but does not necessarily indicate the number of calories actually consumed.



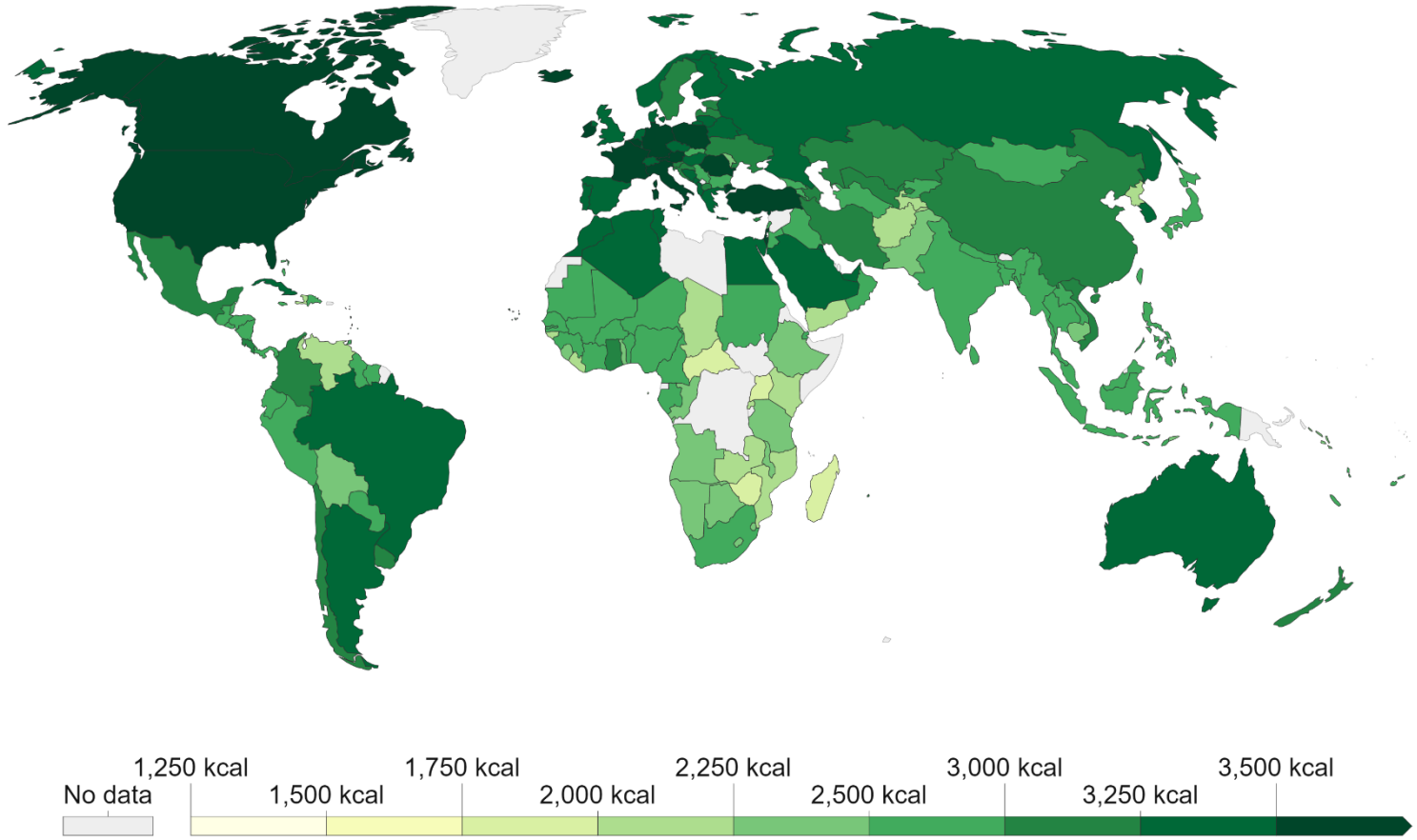
Source: Our World in Data based on the UN FAO & historical sources

OurWorldInData.org/food-supply • CC BY

Daily supply of calories per person, 2018

Daily per capita caloric supply is measured in kilocalories per person per day. This indicates the caloric availability delivered to households but does not necessarily indicate the number of calories actually consumed.

Our World in Data

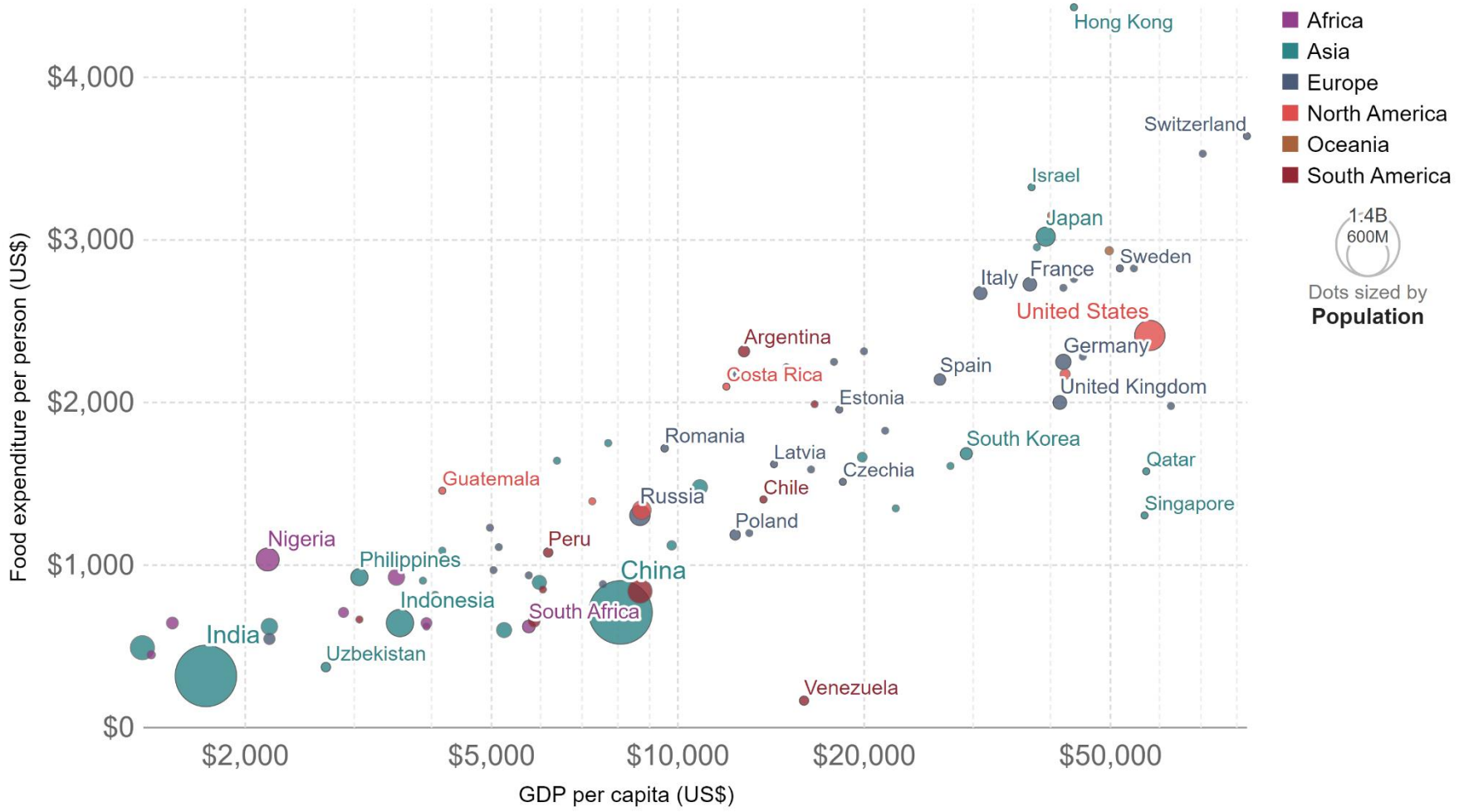


Source: Our World in Data based on the UN FAO & historical sources

OurWorldInData.org/food-supply • CC BY

Annual food expenditure per person vs. GDP per capita, 2016

Average annual food expenditure per person, versus gross domestic product per capita, both measured in US$.
Food expenditure relates only to food bought for consumption at home (i.e. it excludes out-of-home food purchases).

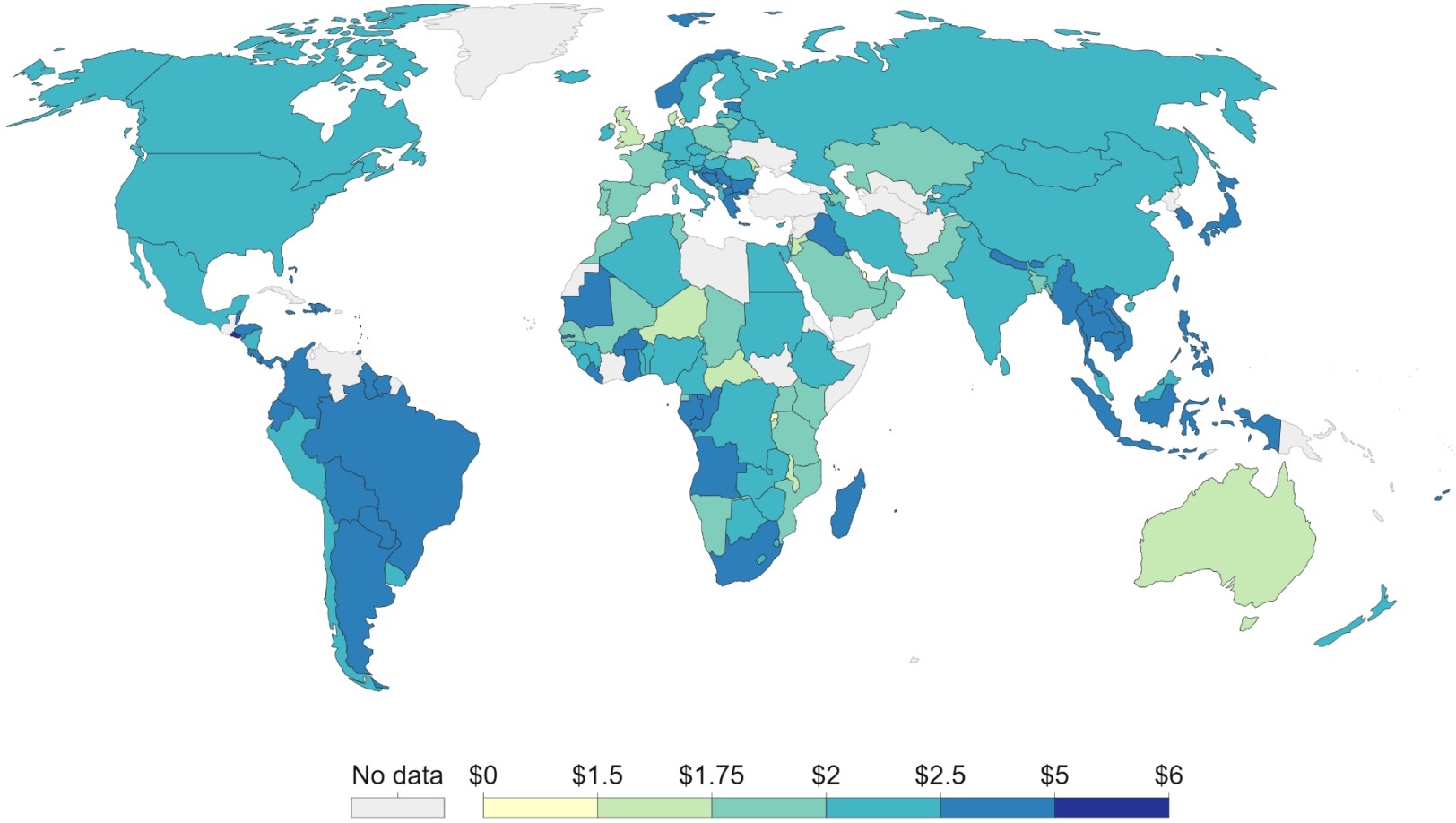


Source: Consumer expenditure on food - USDA (2017), World Bank and OECD

OurWorldInData.org/food-prices/ • CC BY

Cost of a nutrient adequate diet, 2017

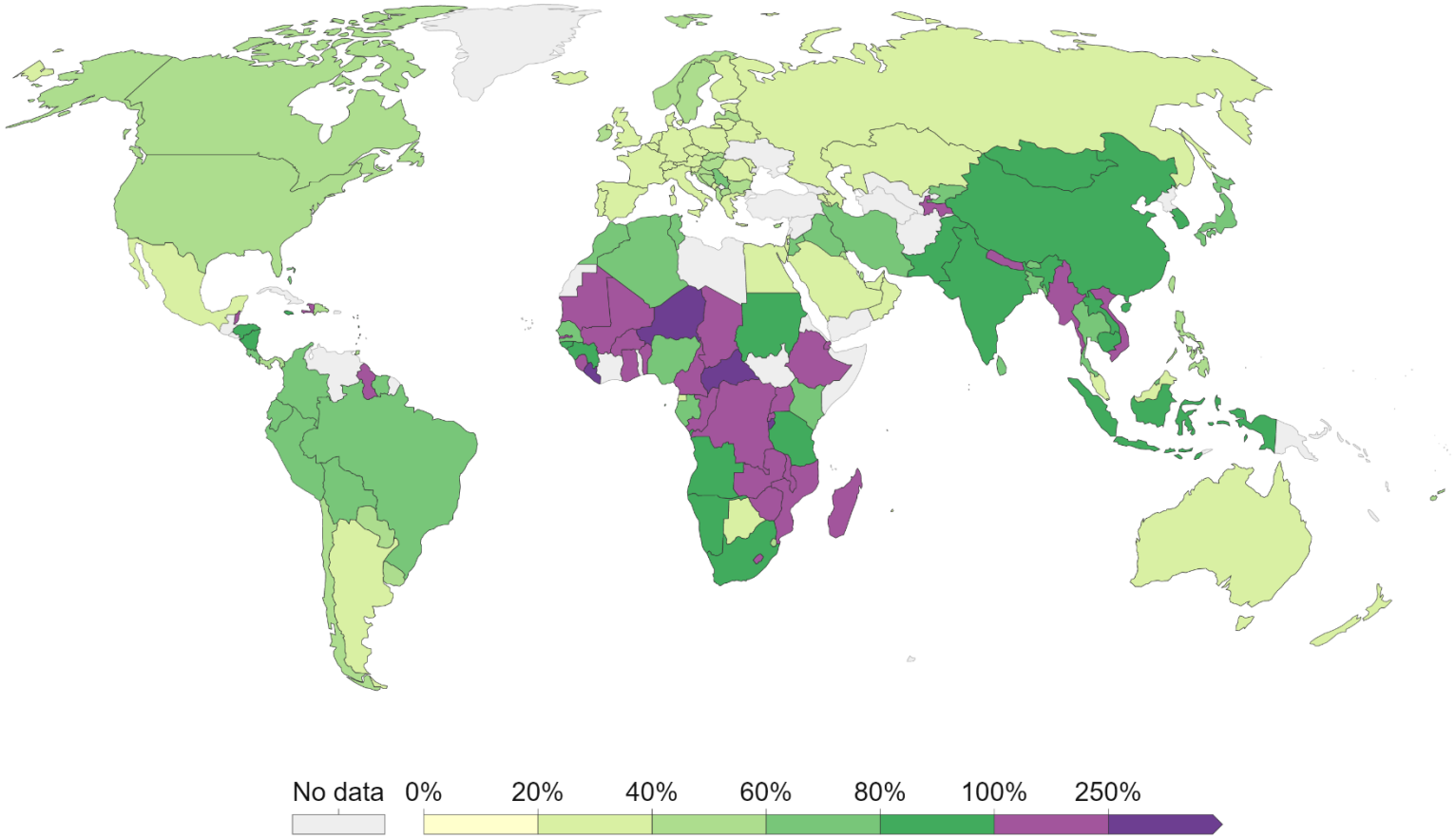
The cost of a nutrient adequate diet is defined as the lowest-cost set of items available at each time and place that would stay within the lower and upper bounds for dietary energy and all essential nutrients.



Source: Food Prices for Nutrition data at the World Bank, based on Herforth, Venkat, Bai, Costlow, Holleman & Masters (2022).
Note: Costs are given in 2017 international-$ per day.
OurWorldInData.org/food-prices • CC BY

Cost of a healthy diet as a share of average expenditure on food, 2017

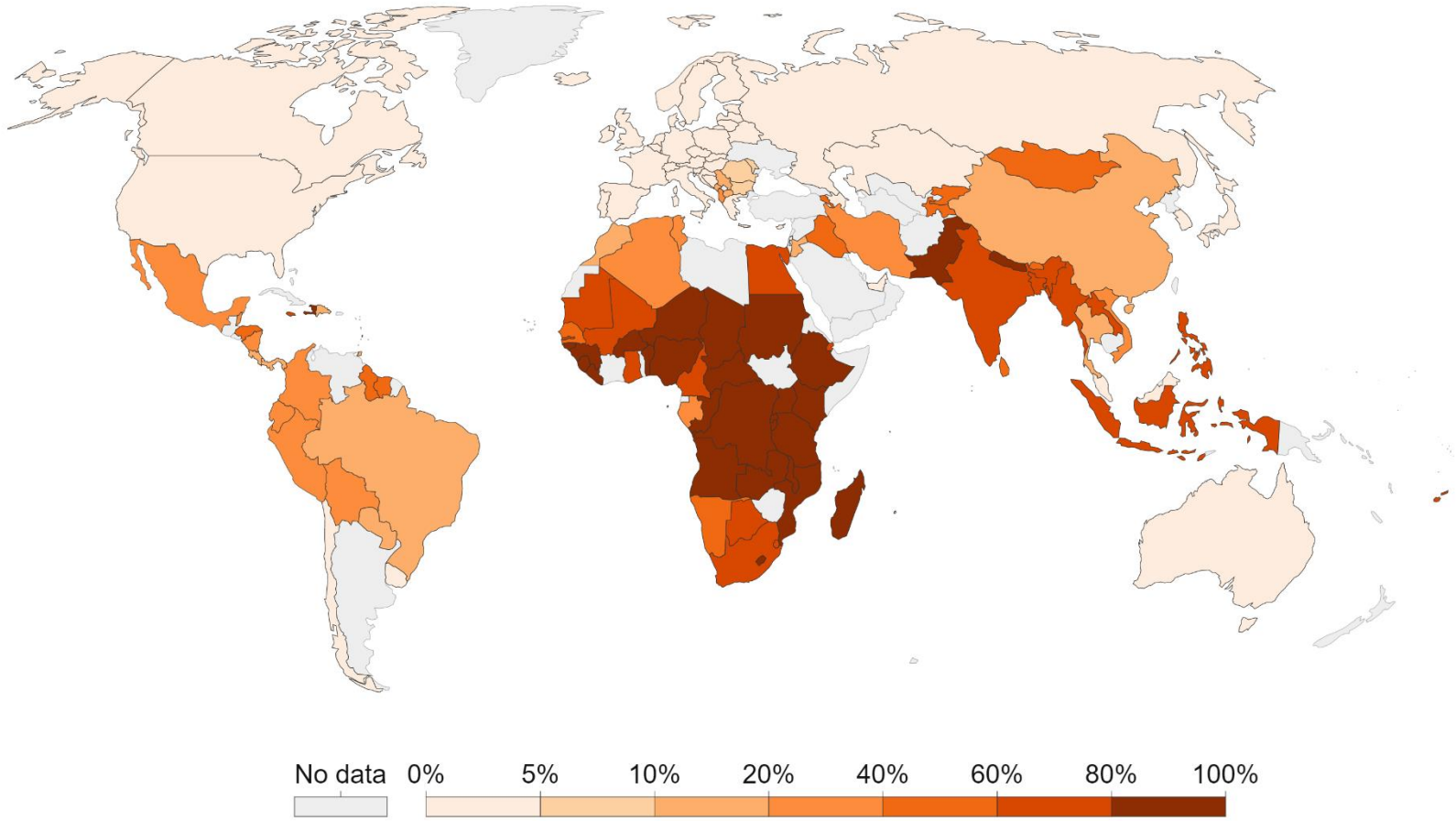
The cost of a healthy diet is the lowest-cost set of foods available that would meet requirements in dietary guidelines from governments and public health agencies.



Source: Food Prices for Nutrition data at the World Bank, based on Herforth, Venkat, Bai, Costlow, Holleman & Masters (2022).
OurWorldInData.org/food-prices • CC BY

Share of population that cannot afford a healthy diet, 2020

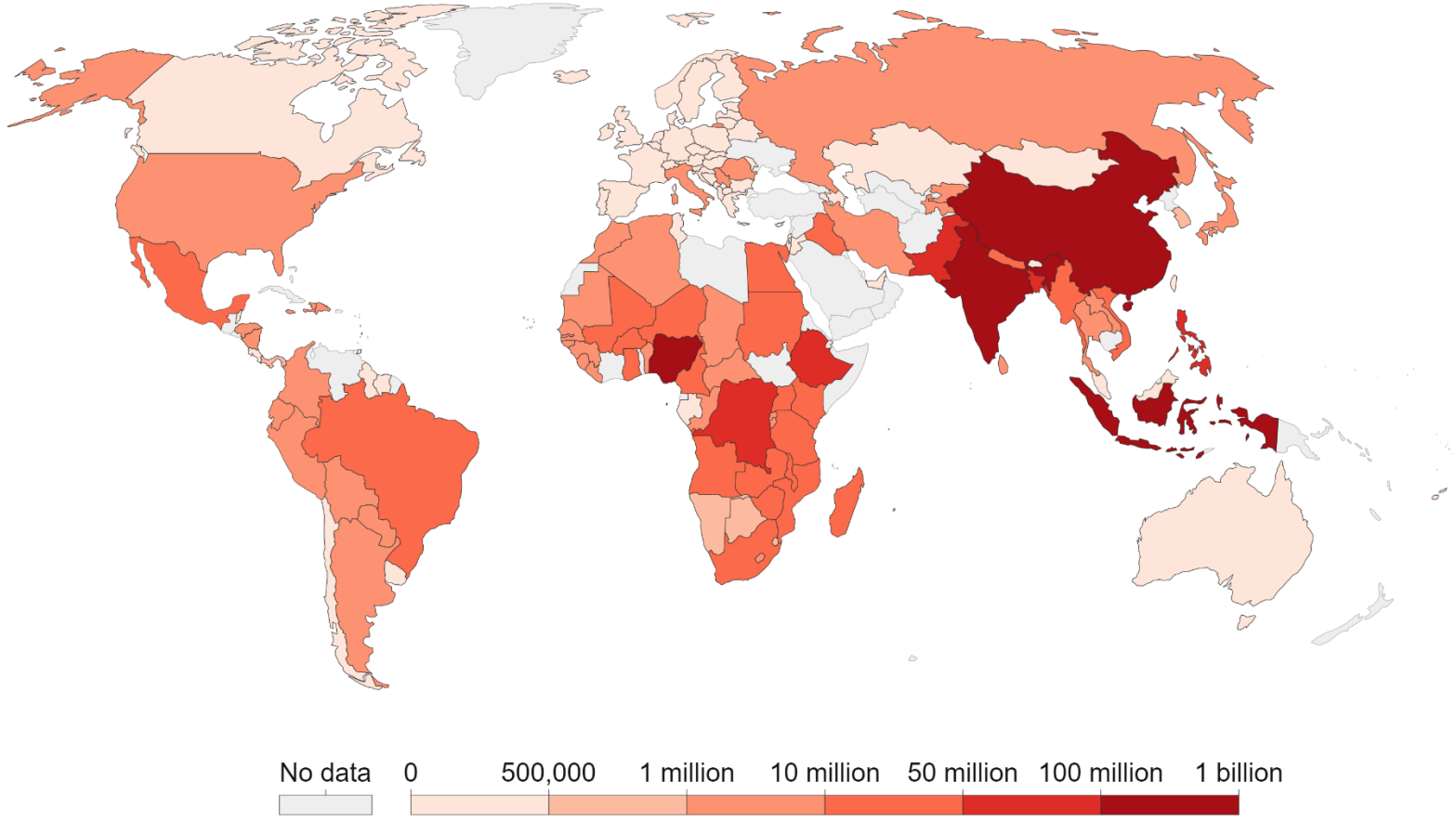
A diet is deemed unaffordable if it costs more than 52% of a household's income. The cost of a healthy diet is the lowest-cost set of foods available that would meet requirements in dietary guidelines from governments and public health agencies.



Source: Food Prices for Nutrition data at the World Bank, based on Herforth, Venkat, Bai, Costlow, Holleman & Masters (2022).
OurWorldInData.org/food-prices • CC BY

Number of people that cannot afford a nutrient adequate diet, 2017

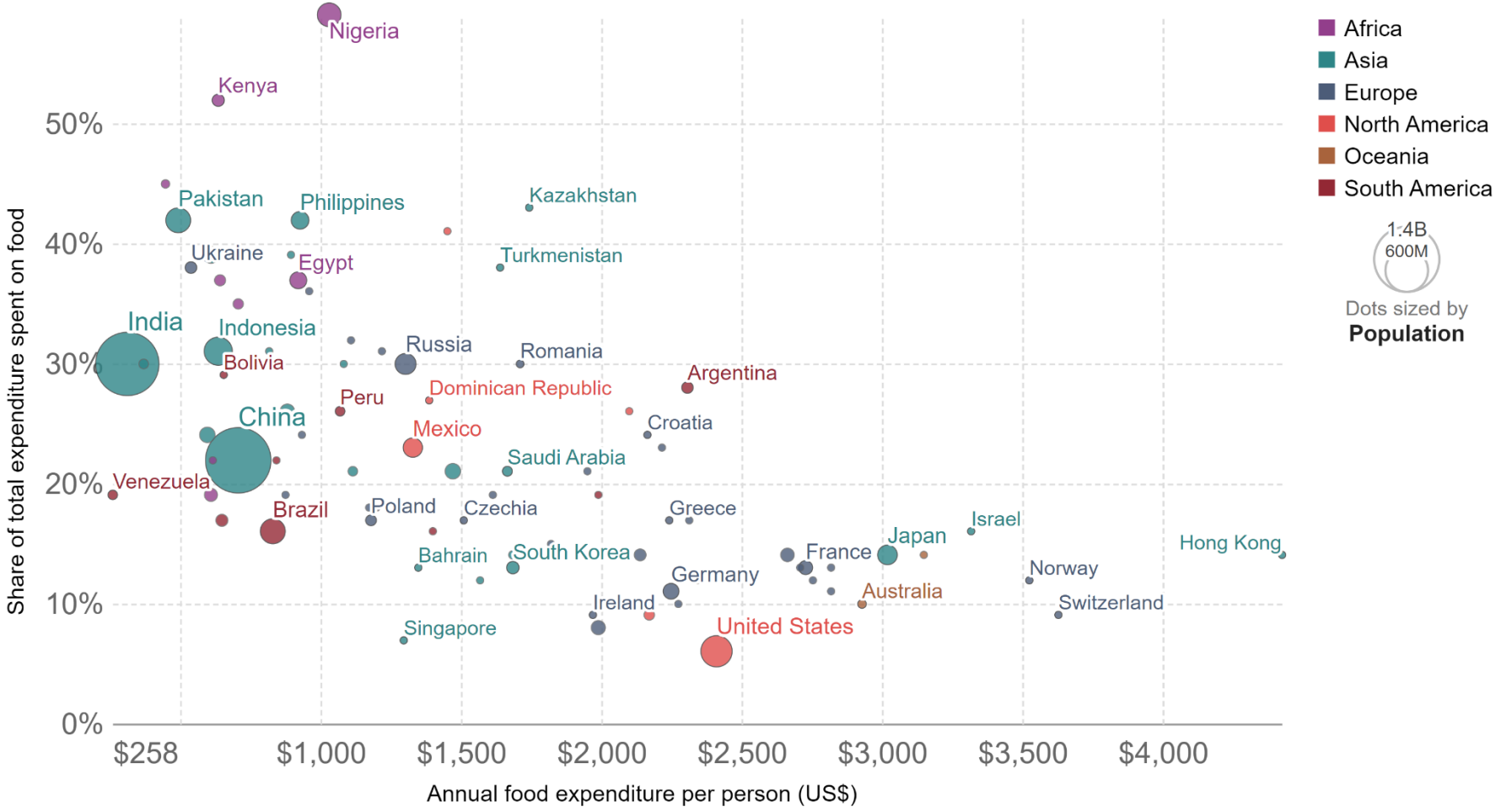
A diet is deemed unaffordable if it costs more than 52% of a household's income. The cost of a nutrient adequate diet is defined as the lowest-cost set of items available at each time and place that would stay within the lower and upper bounds for dietary energy and all essential nutrients.



Source: Food Prices for Nutrition data at the World Bank, based on Herforth, Venkat, Bai, Costlow, Holleman & Masters (2022).
OurWorldInData.org/food-prices • CC BY

Share of total expenditure spent on food vs. food expenditure per person, 2016

The share of total consumer expenditure per person spent on food versus the annual per capita spend on food, measured in US$.



Source: United States Department for Agriculture (USDA)

OurWorldInData.org/food-prices/ • CC BY

Food availability and food access

- The availability and accessibility of food significantly influences the quality of diets.
  - **Food availability** involves having a sufficient amount of high-quality food to satisfy a person's dietary needs. This food should be free of adverse substances and culturally acceptable.
  - **Food access** involves having the financial means to acquire food in a way that does not threaten or compromise other basic needs.
    - Access means that adequate food is obtainable by all people, including vulnerable individuals and groups.
  - Food access includes both physical and economic access. Physical access to food depends on the built environment

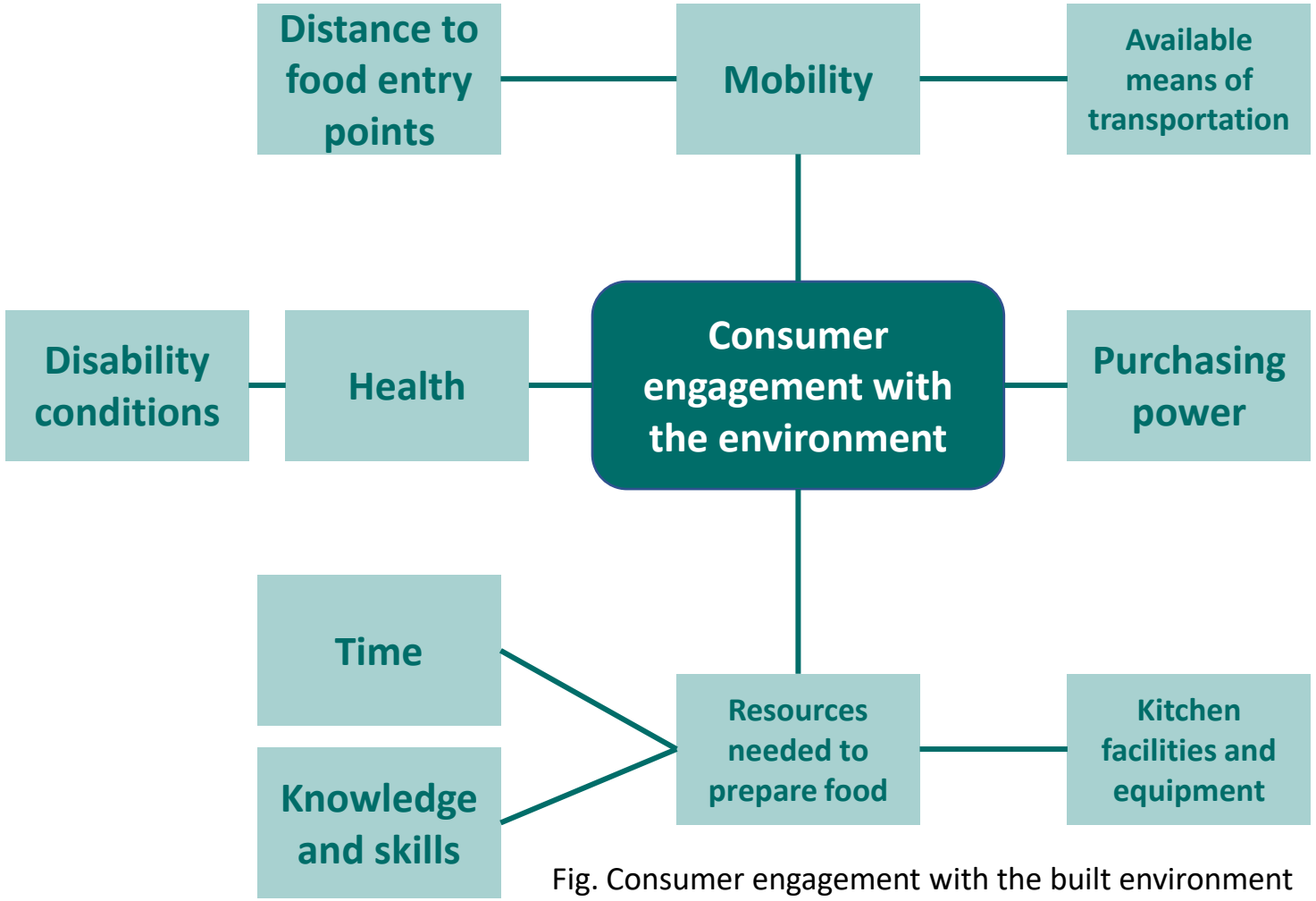
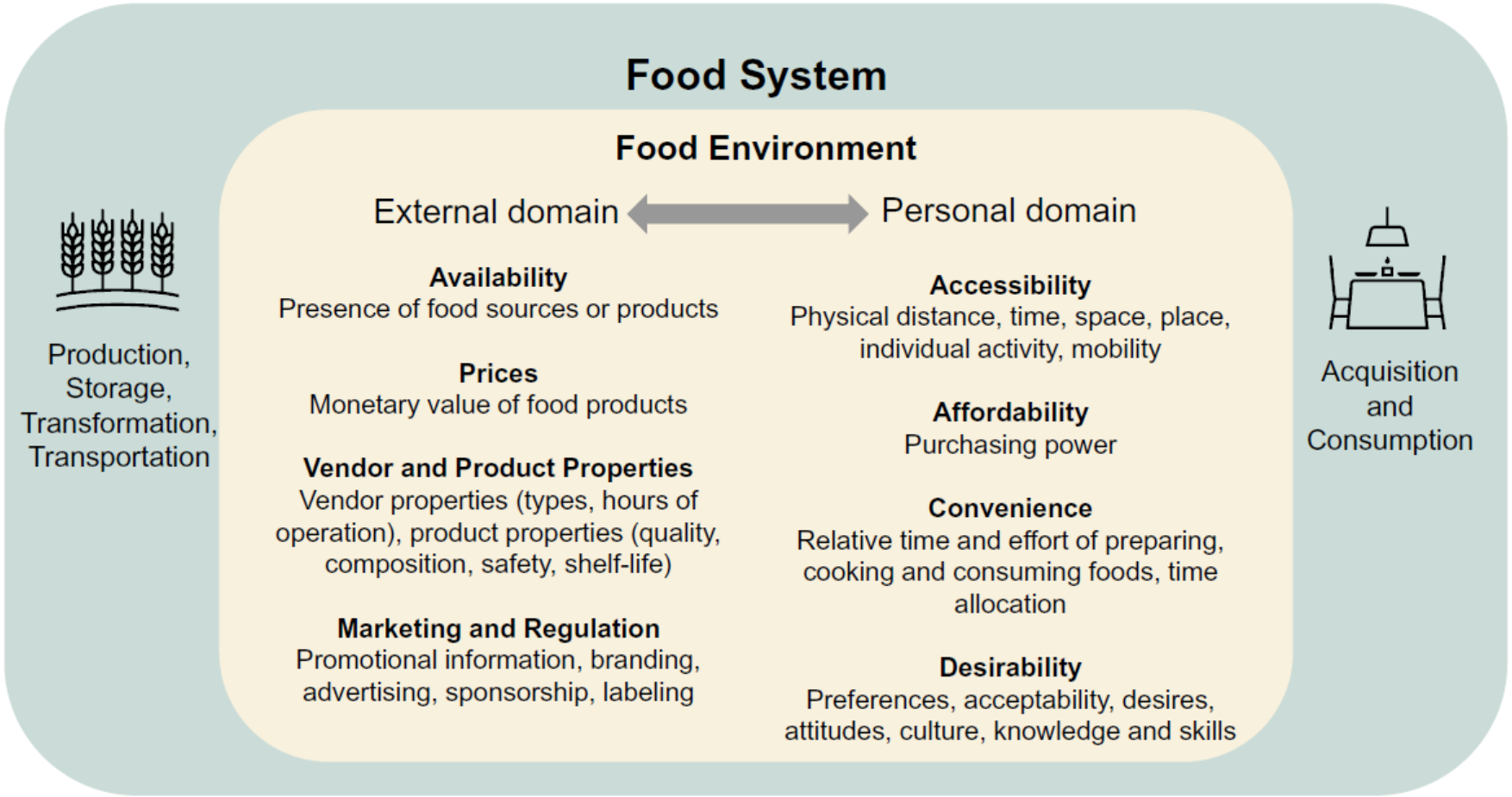


Fig. Consumer engagement with the built environment

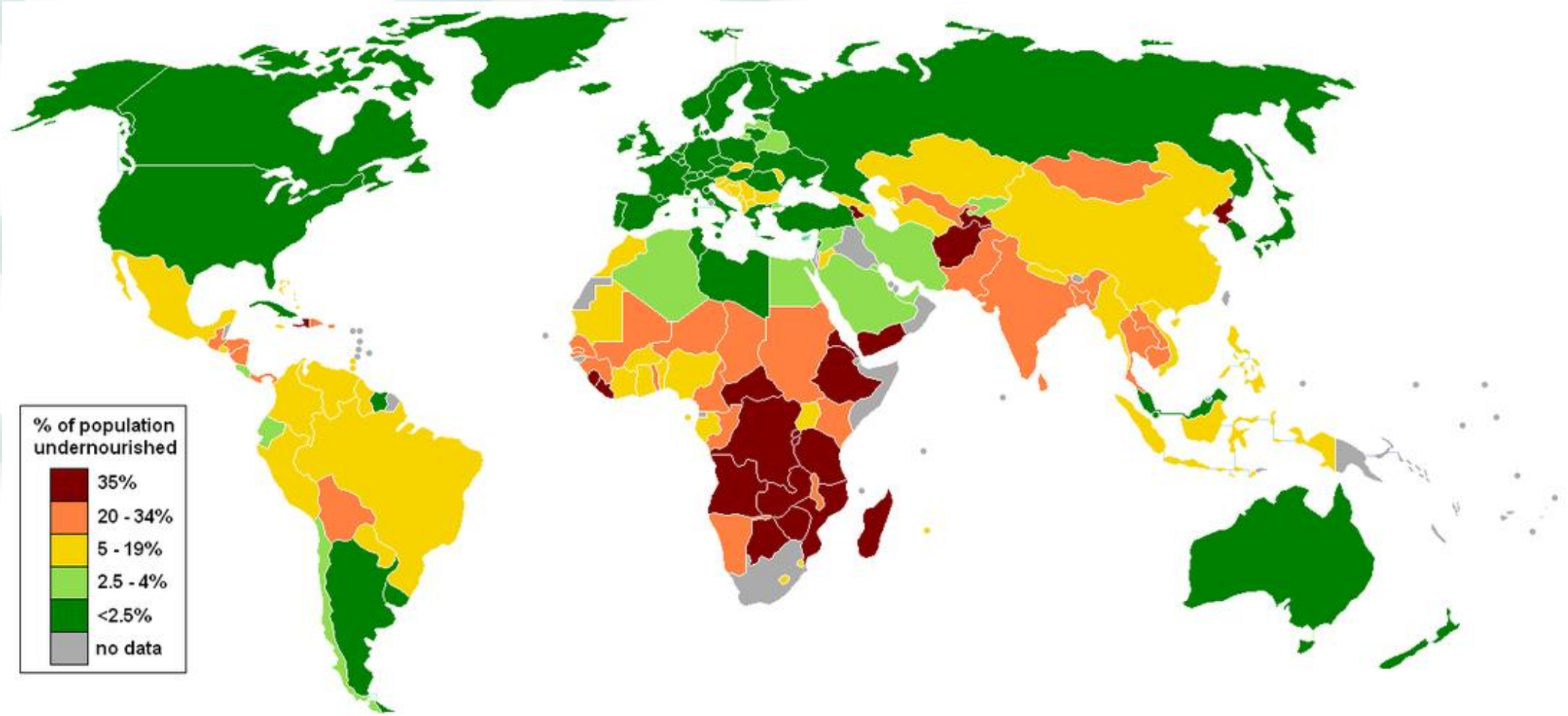
Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p19). https://doi.org/10.1007/978-3-030-72763-5

Food environment

Food environments are the places where people engage with food. These environments are where consumers make decisions about what to order, buy, or consume. These environments include the physical, economic, political, and sociocultural contexts that affect people's food choices. In addition, food environments include opportunities and conditions, all of which can influence dietary preferences, food choices, and nutritional status



- Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p20). https://doi.org/10.1007/978-3-030-72763-5.
- Turner C, Aggarwal A, Walls H, Herforth A, Drewnowski A, Coates J, et al. Concepts and critical perspectives for food environment research: A global framework with implications for action in low- and middle-income countries. Global Food Security. 2018 Sep 1;18:93–101.



"The Environmental Food Crisis." *Impacts on Biodiversity and Ecosystems from Conventional Expansion of Food Production*. GRID-Arendal. Web. 13 May 2015.
Sadik, N. "Population Growth and the Food Crisis." *Corporate Document Repository*. FAO. Web. 13 May 2015.

Classification by degree of processing of food and beverage products

- In a food value chain, a product's value increases as it moves through each stage of the chain. This value can be achieved by improving the food product's functionality, safety, or nutritional value through processing. This change is then often reflected in the price of the product.

Category	Definition	Examples
Unprocessed or minimally processed	Single foods, no or very slight modifications	Fresh or frozen fruits and vegetables, milk, eggs, fresh fish, fresh meat
Basically processed	Single foods, processed as isolated food components or modified by preservation methods	Sugar, oil, unsweetened canned fruit, unsalted canned vegetables, white rice, flour, pasta
Moderately processed	Single foods with the addition of flavour additives	Sweetened canned fruit, salted canned vegetables, salted nuts, whole-grain bread, cereals with no added sugar
Highly processed	Multi-ingredient, industrially formulated mixtures	Sugar-sweetened beverages, salty snacks such as chips and crackers, cookies, cakes, candy, refined-grain bread, ready-to-eat cereals with added sugar, pre-prepared meals, margarine, ketchup, mayonnaise

Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p18). https://doi.org/10.1007/978-3-030-72763-5.

Nutritional labeling

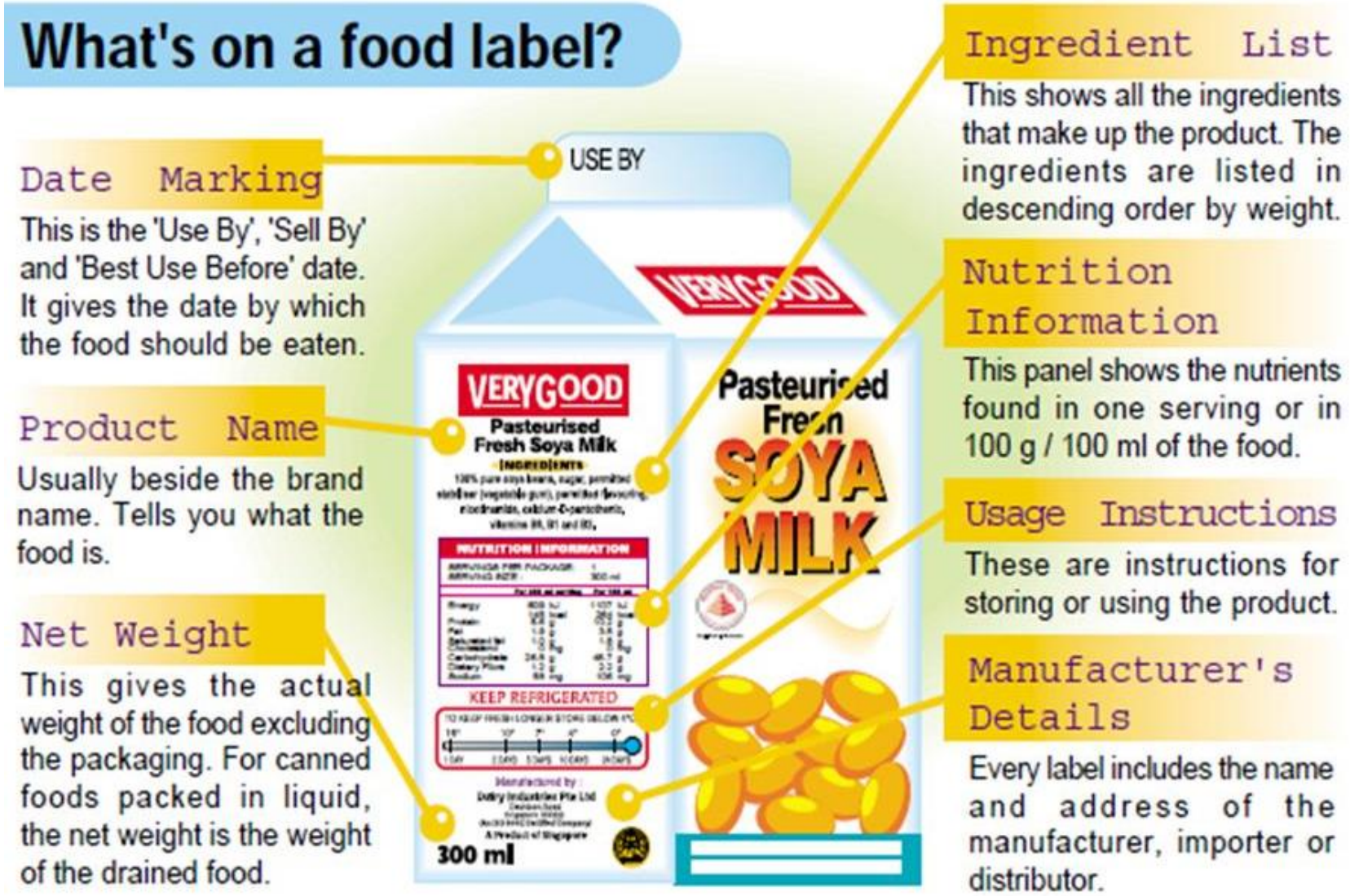
Nutritional labeling

An important policy objective of front-of-pack (FOP) nutrition labelling is to help consumers to make healthier food choices (Kanter et al., 2018). Most consumers declare indeed that they find FOP labelling helpful (e.g. 71% of respondents in a Dutch consumer survey28 and 78% in a German consumer survey29). Evidence seems to suggest that FOP labels fill an informational gap or an unmet consumer need, with older and overweight/obese people more likely to report a need for a FOP label (Joint Research Centre, 2020).

However, whether people really change their purchasing behaviour in response to the presence of FOP labels depends on a range of factors. To be effective, a FOP label needs to attract attention and then be accepted and understood by the consumers before it can potentially influence their food choices (Grunert & Wills, 2007) and consequently their diet and health.

Source: European Commission, 2020. Report from the Commission to The European Parliament and The Council: regarding the use of additional forms of expression and presentation of the nutrition declaration. Brussels, 20.5.2020 COM(2020) 207 final: p11.

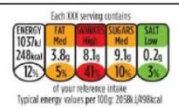
Food label



https://www.girlsallaround.com/clean-food/food-label-components/

Typologies and formats of FOP nutrition labelling schemes

Table 1 – Typologies and formats of FOP nutrition labelling schemes implemented/proposed/announced at Member States' and UK level

Taxonomies put forward in the literature				*Examples of FOP schemes*		*Developer*	*EU Member State*
Nutrient-specific labels	**Numerical**	Non-directive	Reductive (non-interpretative)	*Reference Intakes label*		*Private*	*Across the EU*
				NutrInform Battery		*Public*	*IT*
	Colour-coded	Semi-directive	Evaluative (interpretative)	*UK FOP label*		*Public*	*UK*
				Other 'traffic light' labels		*Private (retailers)*	*PT, ES*
Summary labels	**Positive (endor-sement) logos**	Directive	Evaluative (interpretative)	*Keyhole*		*Public*	*SE, DK, LT*
				Heart/Health logos		*NGO* *Public*	*FI SI* *HR*
				Healthy Choice		*Private*	*CZ, PL* *Phased out in NL*
	Graded indicators			*Nutri-Score*		*Public*	*FR, BE* *ES, DE, NL, LU*

https://food.ec.europa.eu/system/files/2020-05/labelling-nutrition_fop-report-2020-207_en.pdf

New Label

Nutrition Facts

8 servings per container

Serving size **2/3 cup (55g)**

Amount per serving

Calories **230**

	% Daily Value*
Total Fat 8g	**10%**
Saturated Fat 1g	**5%**
Trans Fat 0g	
Cholesterol 0mg	**0%**
Sodium 160mg	**7%**
Total Carbohydrate 37g	**13%**
Dietary Fiber 4g	**14%**
Total Sugars 12g	
Includes 10g Added Sugars	**20%**
Protein 3g	
Vitamin D 2mcg	10%
Calcium 260mg	20%
Iron 8mg	45%
Potassium 240mg	6%

* The % Daily Value (DV) tells you how much a nutrient in a serving of food contributes to a daily diet. 2,000 calories a day is used for general nutrition advice.

1. The serving size now appears in larger, bold font and some serving sizes have been updated.
2. Calories are now displayed in larger, bolder font.
3. Daily Values have been updated.
4. Added sugars, vitamin D, and potassium are now listed. Manufacturers must declare the amount in addition to percent Daily Value for vitamins and minerals.

https://www.fda.gov/food/new-nutrition-facts-label/whats-new-nutrition-facts-label

U.S. Food and Drug Administration
125K subscribers

GDA labelling

Example labels:

Shepherd's Pie (per pack)

Energy	Fat	Saturates	Sugars	Salt
1931kJ 461 kcal	19g	10g	2.1g	2.3g
23%	27%	50%	2%	38%

of an adult's Reference Intake.

Typical values (as sold) per 100g: Energy 455kJ/109kcal

Lasagne (per pack)

Energy	Fat	Saturates	Sugars	Salt
2549kJ 609 kcal	32g	16g	9.7g	1.6g
30%	46%	80%	11%	27%

of an adult's Reference Intake.

Typical values (as sold) per 100g: Energy 655kJ/157kcal

Example labels:

Pepperoni pizza 1 (per ½ pizza)

Energy	Fat	Saturates	Sugars	Salt
1601kJ 383 kcal	22g	8.7g	2.7g	2.6g
19%	31%	43%	3%	43%

of an adult's Reference Intake.

Typical values (as sold) per 100g: Energy 1322kJ/316kcal

Pepperoni pizza 2 (per ½ pizza)

Energy	Fat	Saturates	Sugars	Salt
2174kJ 519 kcal	30g	11g	4.4g	1.9g
26%	43%	55%	5%	32%

of an adult's Reference Intake.

Typical values (as sold) per 100g: Energy 1229kJ/294kcal

https://www.gdalabel.org.uk/gda/front-of-pack-labelling.html

Healthier choice labelling

Singapore

Malaysia

Thailand

Information and preferences

Sources of information

1. The Private Sector
   - All business entities
   - Aim to increase sales and profits
   - Advertising is the most common form of private sector information.

2. The Public Sector
   - All government entities and nonprofit organizations
     To improve public health and nutrition
   - The nutrition facts label is an example.

3. Social Networks
   - All personal and professional connections through various social connections, e.g., family, friends,
   - colleagues, etc.
   - Various channels (e.g., print, TV, online, face-to-face), purpose (e.g., education, promotion, advocacy), and quality (accurate vs inaccurate).

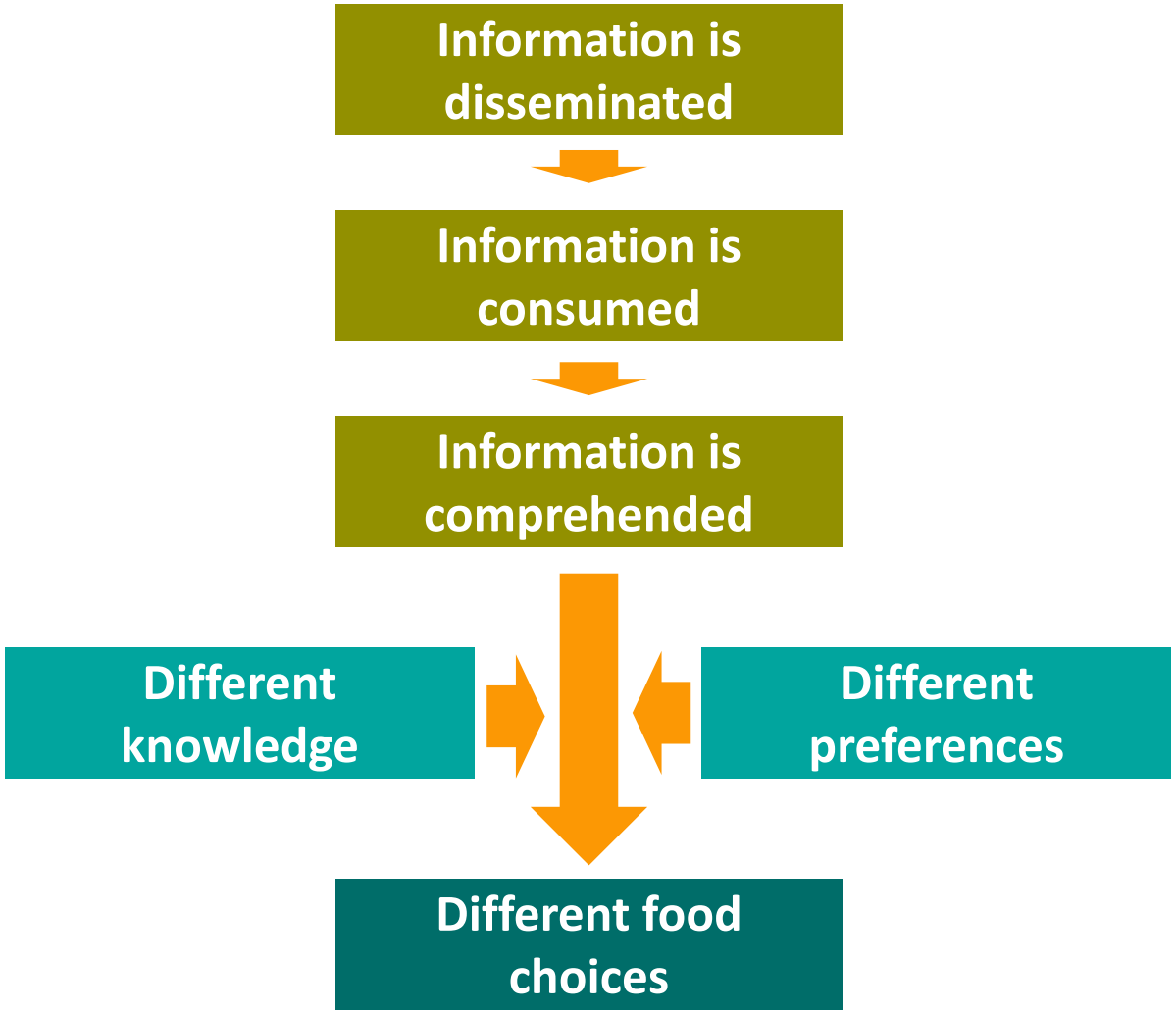


Fig. The Effect of Information on Choices

The Food–Preference Relationship

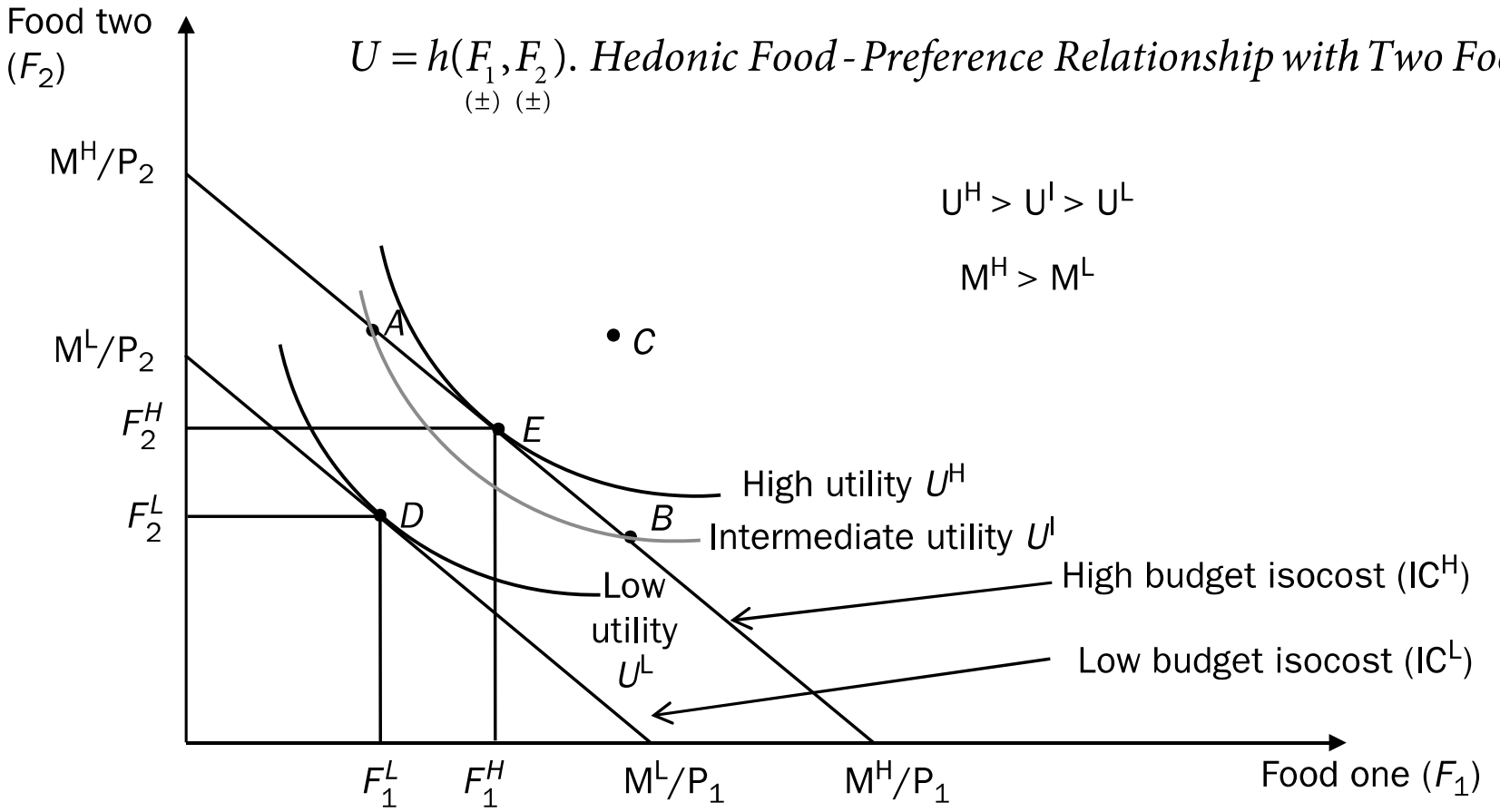


FIGURE 4.3. Budget-Constrained Utility Maximization with Two Foods and Two Income Levels. [The IAPS]As the budget increases, consumption of at least one food increases.

Davis, G. C. & Serrano, E. L. 2016. Food and nutrition economics : fundamentals for health sciences. New York: Oxford University Press.

The Food–Income Relationship: Engel Curve

The food consumption that maximizes total satisfaction

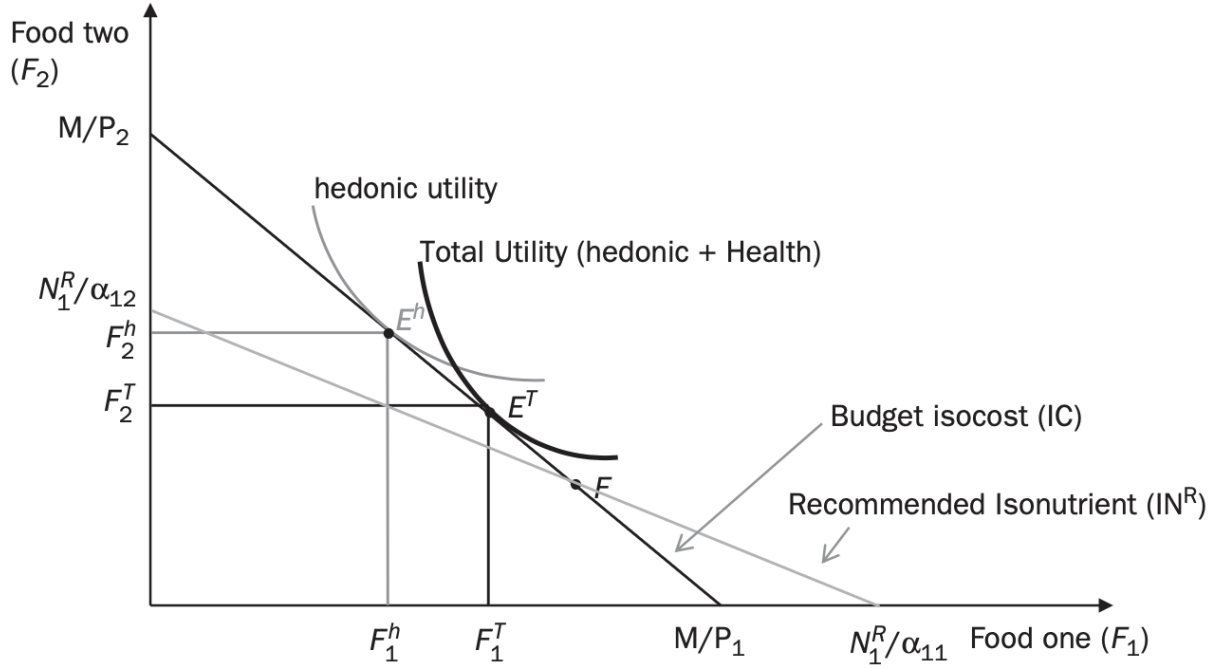


FIGURE 4.5. Budget-Constrained Total Utility (hedonic + Health) and hedonic-Only Maximization with Two Foods and Recommended Nutrient Intake.

[The IAPS]The food consumption that maximizes total satisfaction (hedonic + Health) and meets recommended intake does not necessarily maximize hedonic satisfaction alone.

1. What happens to this graph if income increases?
2. What happens to this graph if the nutrient level increases?
3. What does the graph look like if the isocost and isonutrient lines do not intersect? (There are two possible cases). What are the implications of these two cases?

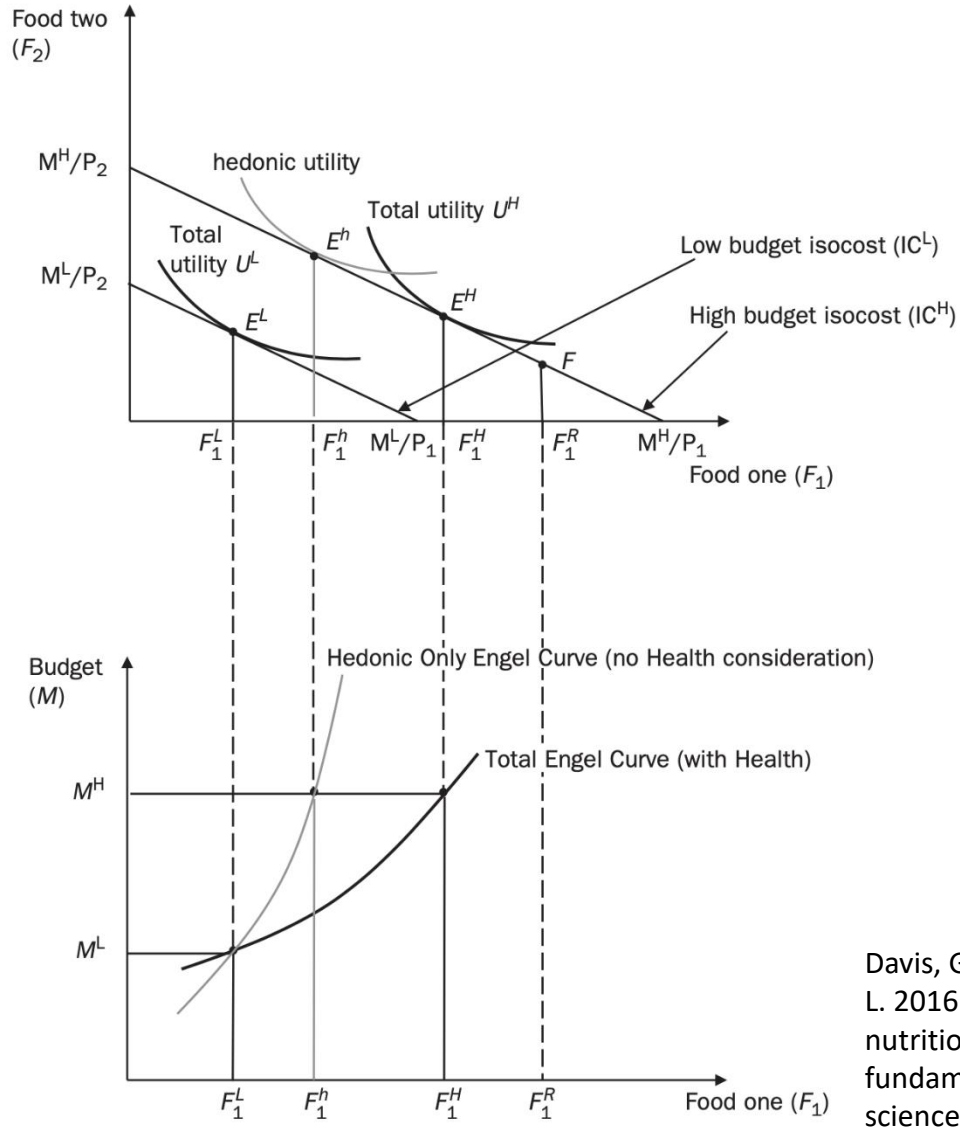


FIGURE 4.6. Utility Maximization and the Engel Curve with and Without Health-Effect Considerations for a Healthy Food.

[The IAPS]The relationship between income and food consumption (i.e., the Engel curve) varies with preferences.

Davis, G. C. & Serrano, E. L. 2016. Food and nutrition economics : fundamentals for health sciences. New York: Oxford University Press.

Economics of Price Changes

The demand curve

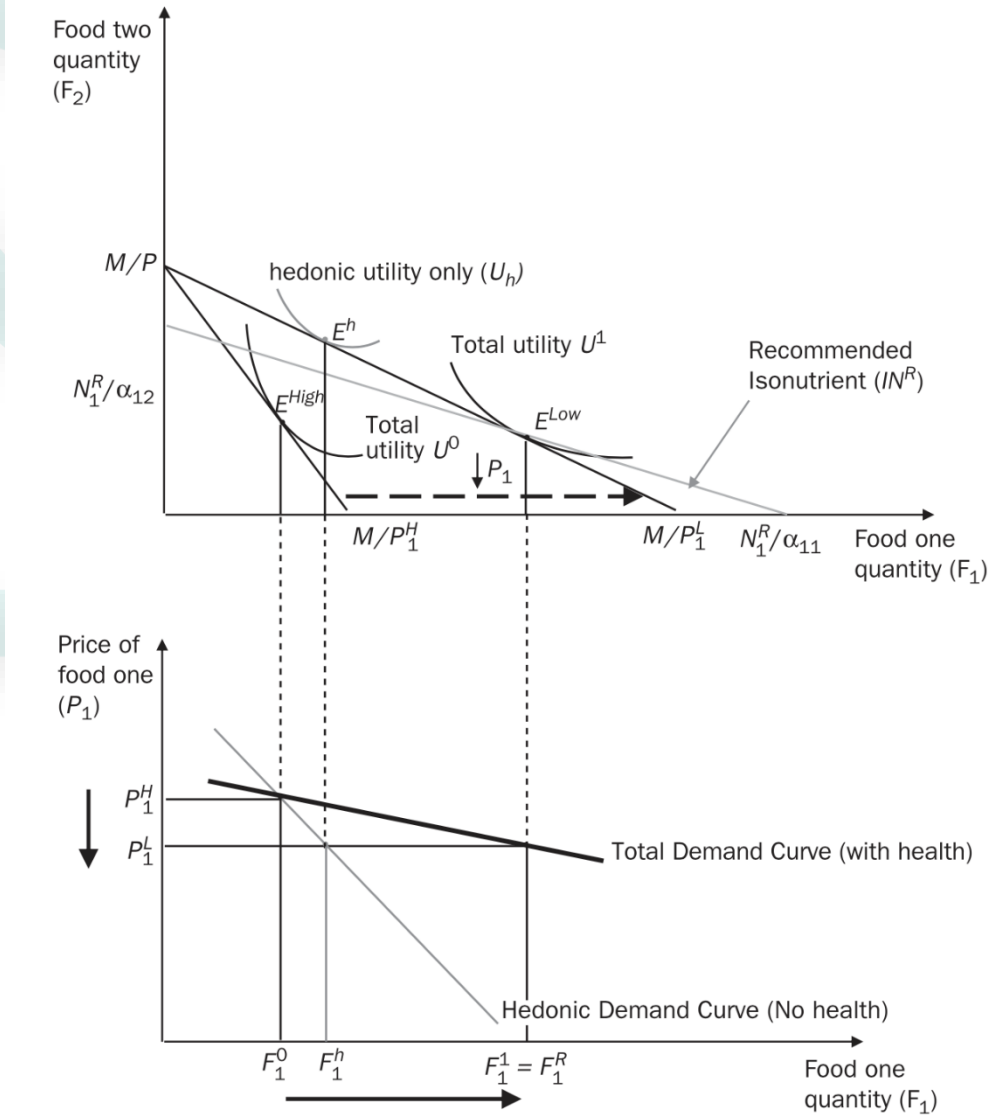


FIGURE 5.2 The Demand for a Food with and Without Health Considerations.

[IAPS]The Law of Demand: As price decreases, consumption increases, *ceteris paribus*—a movement *along* the demand curve.

Shifts in the demand curve

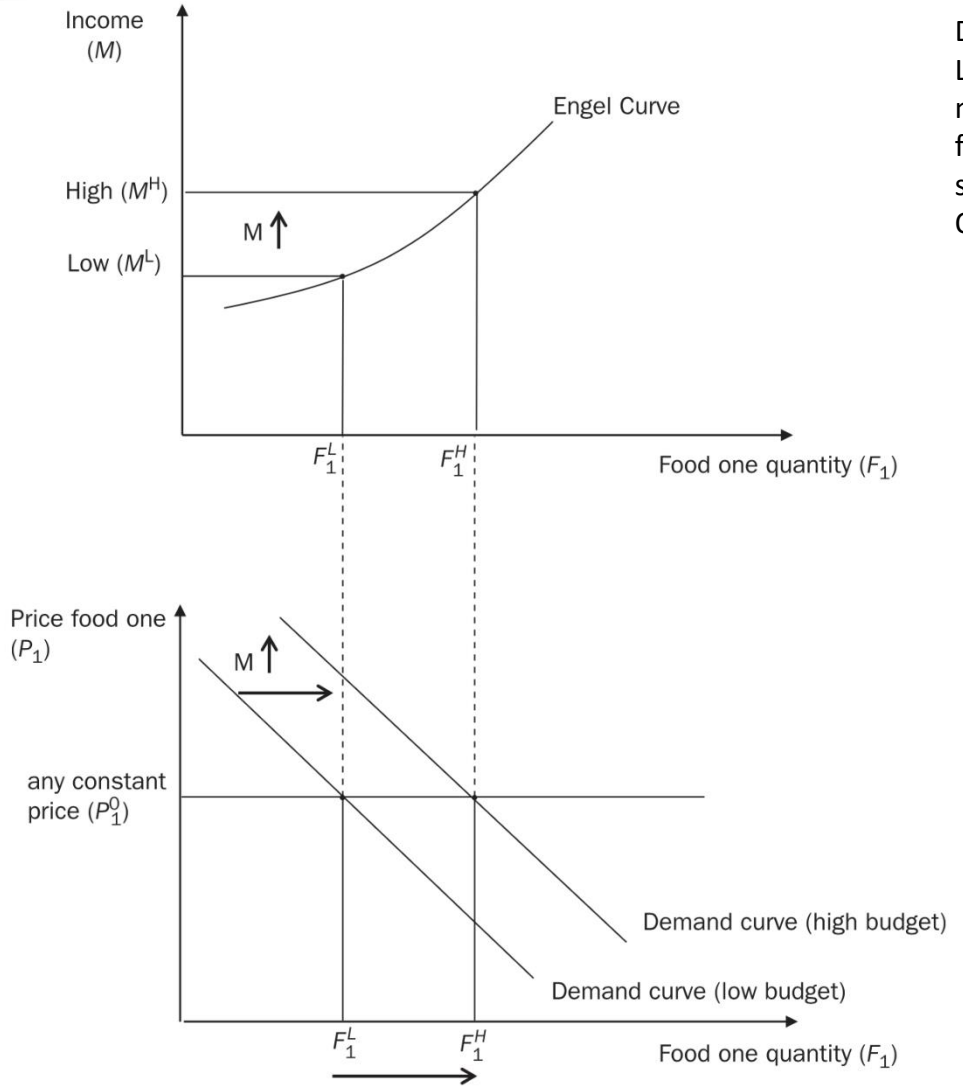


FIGURE 5.3 How Income Affects the Demand Curve for a Normal Good.

[IAPS] As income increases, demand for Food 1 increases—a *shift* to the right in the demand curve, for a normal good.

Davis, G. C. & Serrano, E. L. 2016. Food and nutrition economics : fundamentals for health sciences. New York: Oxford University Press.

The Food-Preference Relationship with Information

Food – Budget Relationship: $M = P_U F_U + P_H F_H$

Iso–cost line for two foods: health (F_H) and unhealthy (F_U)

$$F_H = \frac{M}{P_H} + \frac{P_U}{P_H} F_U$$

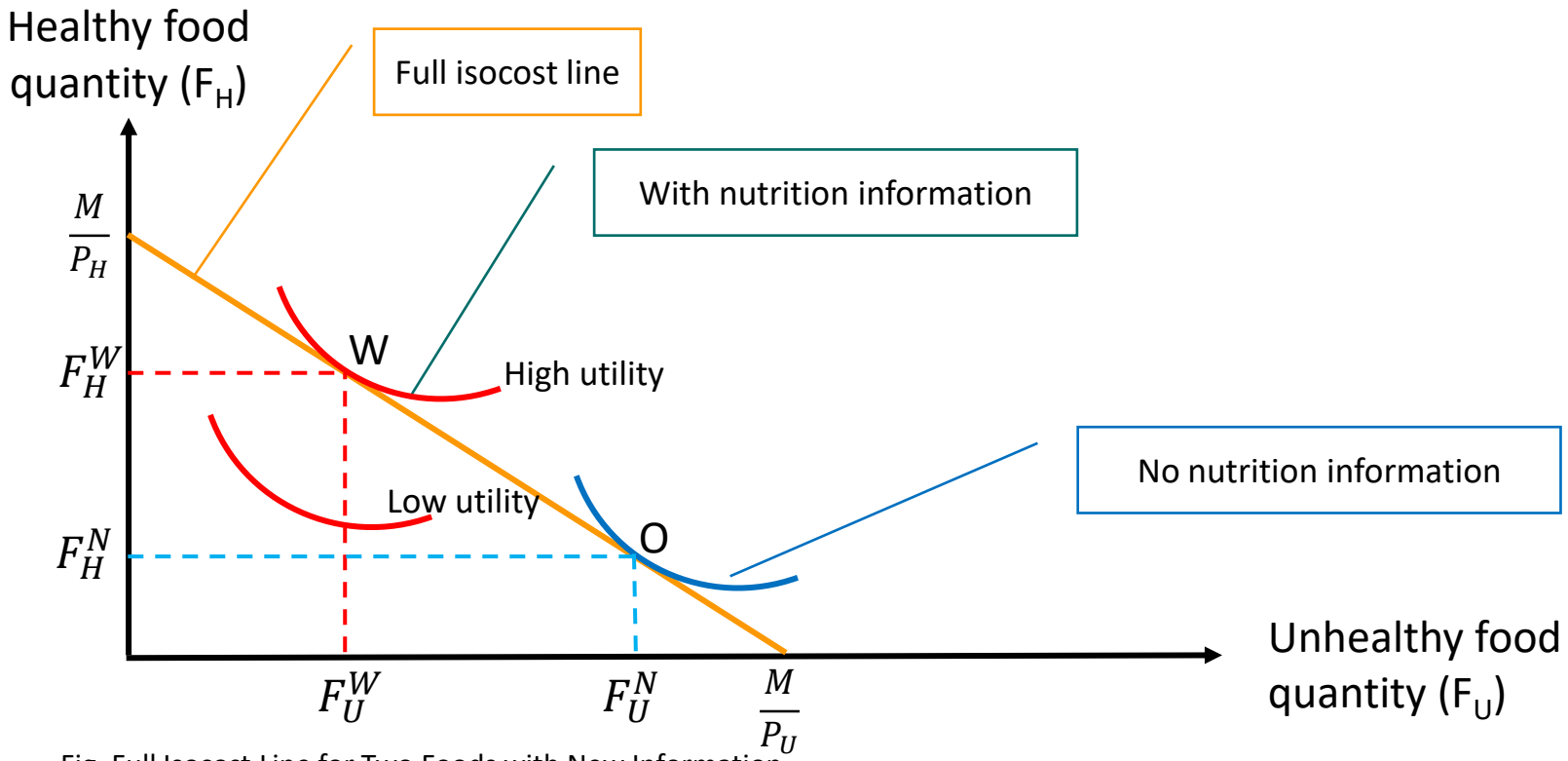
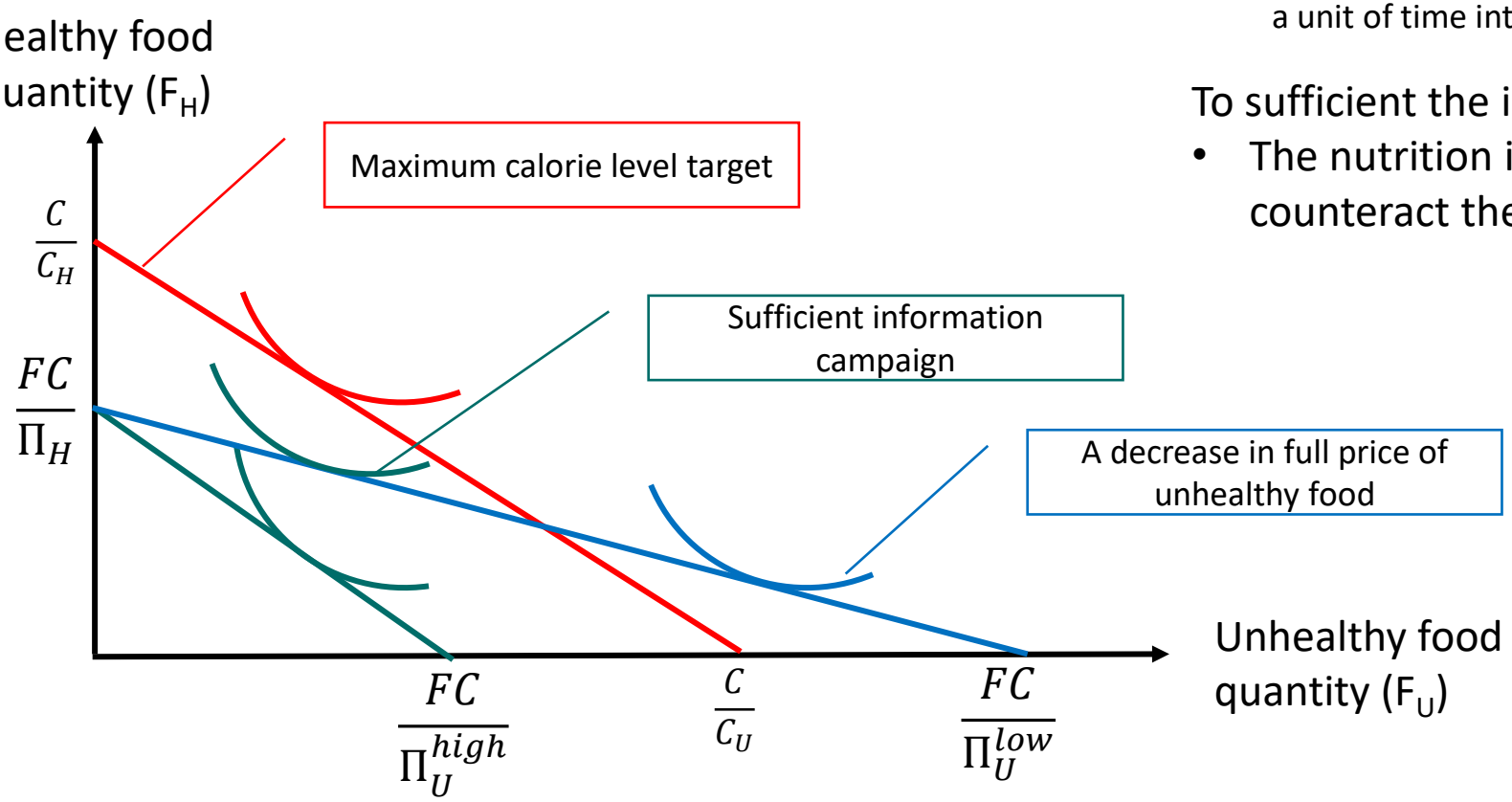


Fig. Full Isocost Line for Two Foods with New Information

Information and preferences

Calorie from two foods equation: $C = C_H F_H + C_U F_U$

Iso-calorie line: $F_H = \frac{C}{C_H} - \frac{C_U}{C_H} F_U$



Full cost (FC) = Money Food Cost + Money Time Cost

Reduce Time Cost
- High Time Cost: $\prod^{highU} = P_U + w_U T^{highU}$
- Low Time Cost: $\prod^{lowU} = P_U + w_U T^{lowU}$

- T = units of Time
- w = the time cost conversion factor that converts a unit of time into its dollar equivalent

To sufficient the information campaign
- The nutrition information program is sufficient to counteract the reduce full price of unhealthy food.

Davis, G. C. & Serrano, E. L. 2016. Food and nutrition economics : fundamentals for health sciences. New York: Oxford University Press.

Changing Palates, Changing Demands

Consumer engagement and the foodie generation

- Consumer engagement and the Foodie generation
  - Consumers are increasingly demanding more from their foods—more alignment with their priorities and values, more creativity, and more options.
  - The novelty and entertainment value of food has grown as people have become less concerned with eating healthy and spending quality time on preparing food.
  - The "**Foodie Generation**" of young adults aged 18 to 35 pursue information about their food choices through social media and the internet. This new type of consumerism has forced food suppliers to rethink everything from ingredients to promotional marketing.
  - They want more transparency from the food industry and are willing to pay more for higher-quality food

Alexander Spatar / Getty

Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p76). https://doi.org/10.1007/978-3-030-72763-5.

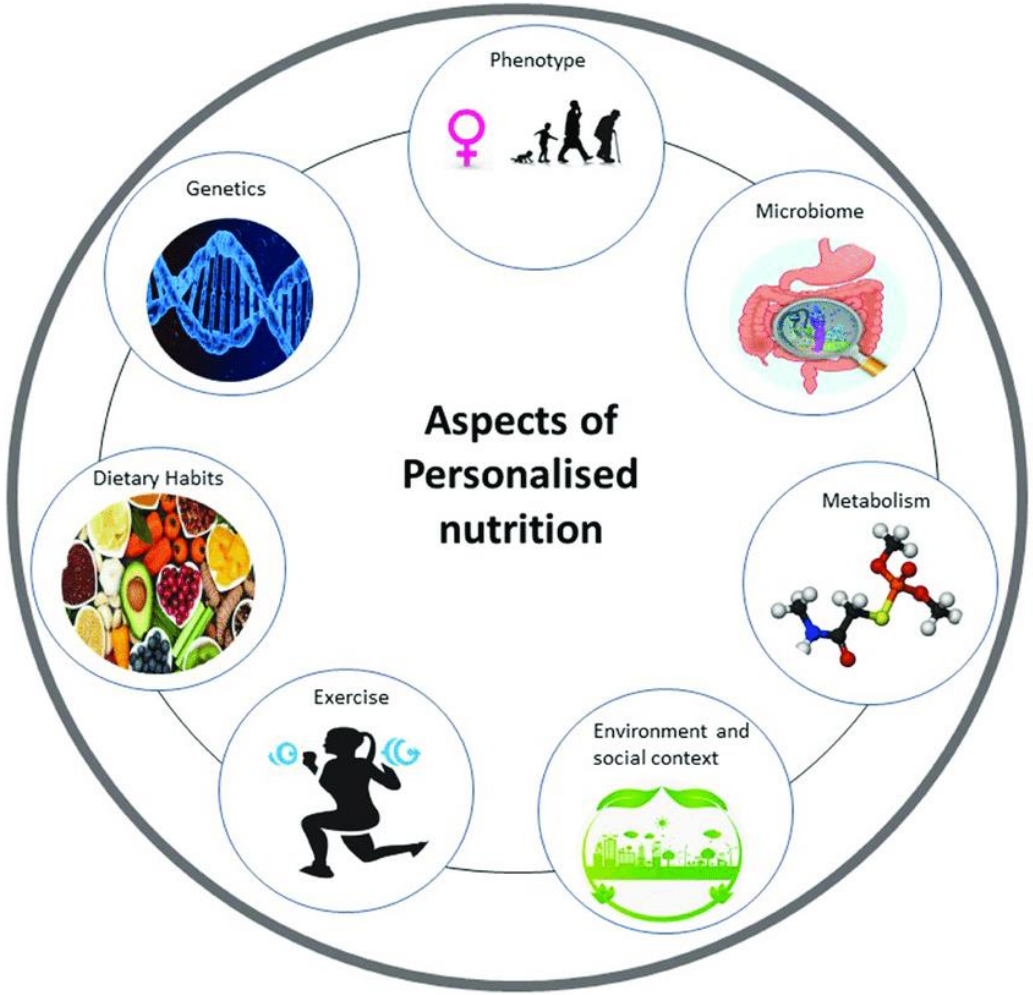
Personalized Nutrition

- Precision nutrition relies on a wide range of tools, including high-throughput analytical chemistry techniques, longitudinal tracking, data science, and behavioural interventions, to provide highly personalized and targeted dietary guidance.

Weak points:

- The collection and analysis of personal health information presents concerns about genetic profiling and privacy.
- The individual-centric approach of these technologies does not address the underlying determinants of poor nutrition outcomes, such as socioeconomic inequities or unhealthy food environments

Different aspects of personalized nutrition.



Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p177-178). https://doi.org/10.1007/978-3-030-72763-5.

Kapoor, N., Sahay, R., Kalra, S., Bajaj, S., Dasgupta, A., Shrestha, D., ... & Das, A. K. (2021). Consensus on Medical Nutrition Therapy for Diabesity (CoMeND) in Adults: A South Asian Perspective. Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 14, 1703.

Food technology

Food technologies

- Mechanical Operations
- Heating
- Refrigeration and Freezing
- Dehydration
- Acidification
- Water Activity
- Smoking
- Irradiation
- Extrusion
- Additives
- Modified/Controlled Atmosphere
- Packaging

The pros and cons of emerging technology in our food system

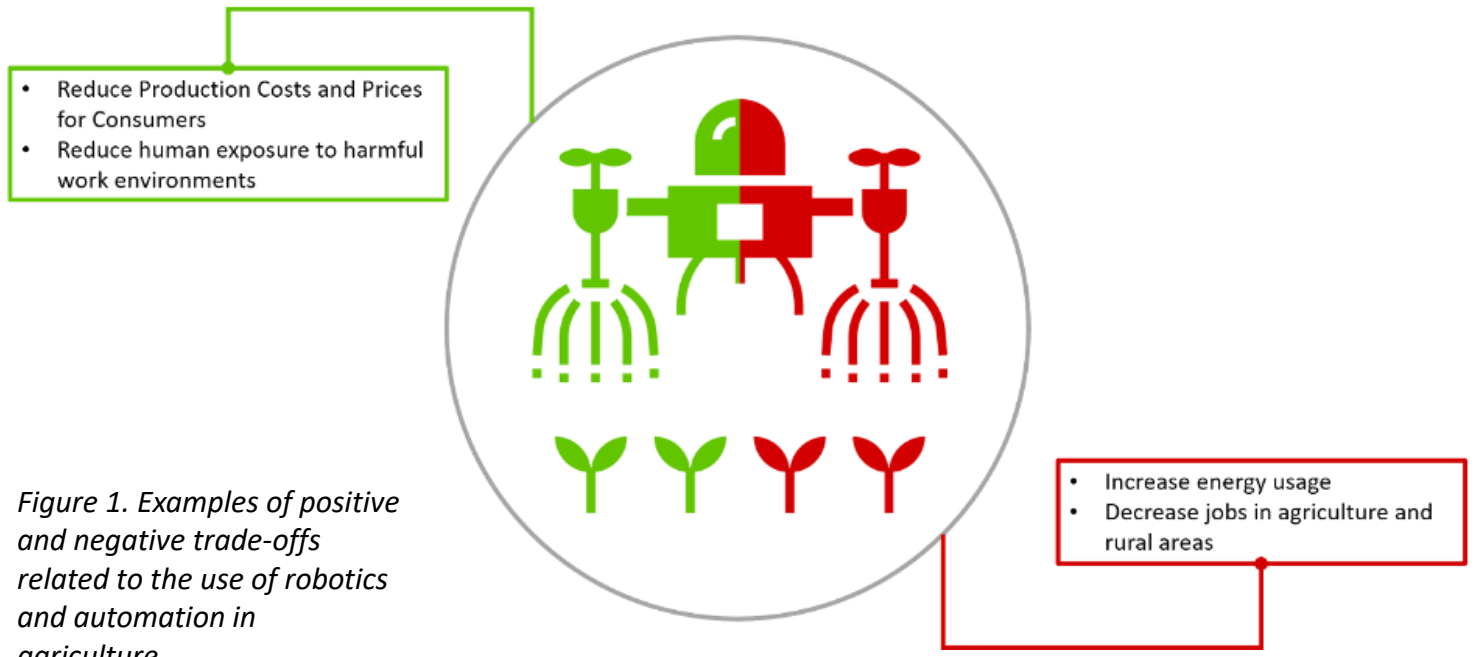


Figure 1. Examples of positive and negative trade-offs related to the use of robotics and automation in agriculture.

Source: https://ccafs.cgiar.org/news/pros-and-cons-emerging-technology-our-food-system

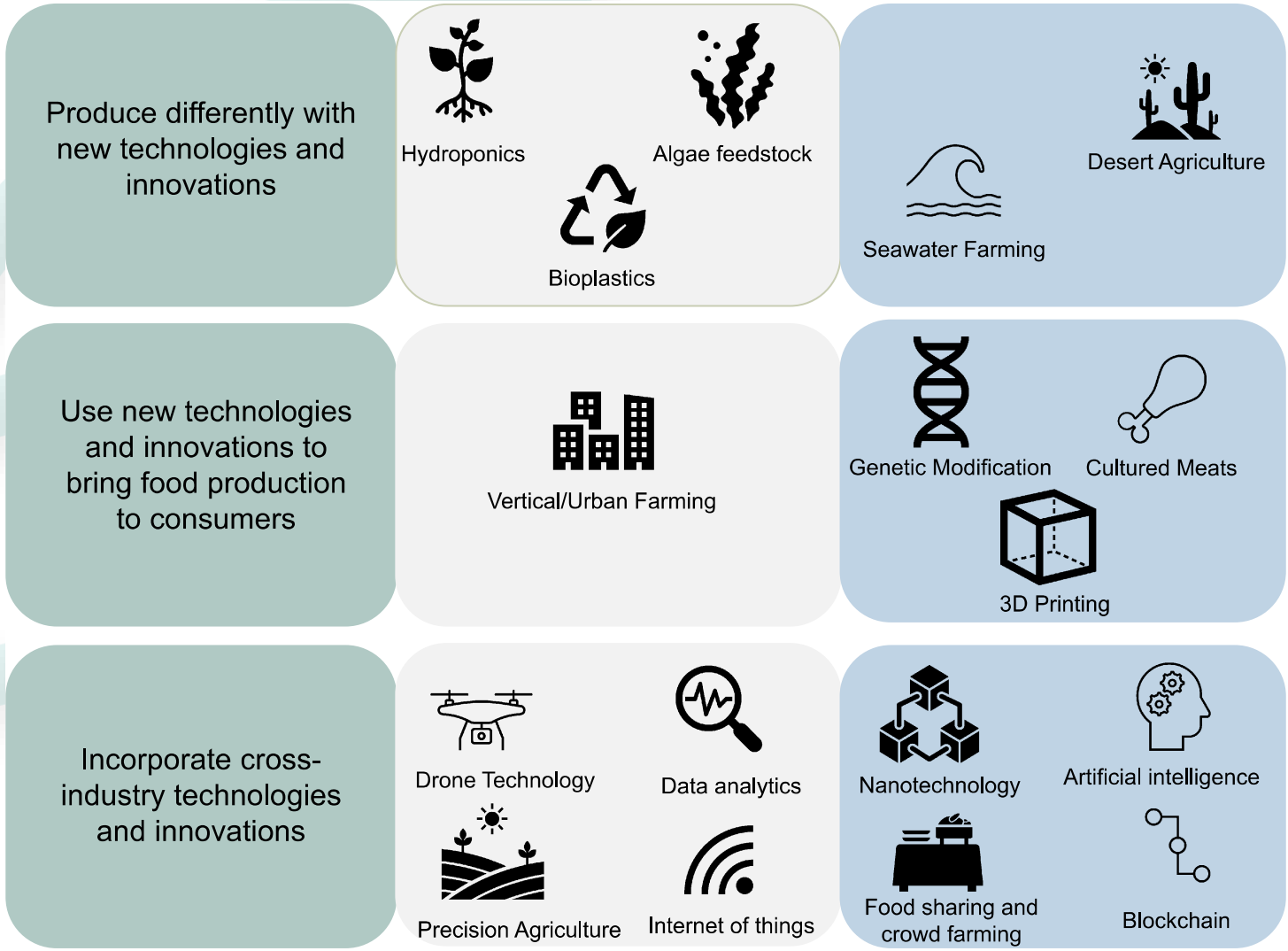


Fig. 11.1 Technologies and their readiness for markets [6]

DeClercqM,VatsA,BielA.Agriculture4.0:Thefutureoffarmingtechnology.Proceedings of the World Government Summit, Dubai, UAE. 2018;11–3.

Technological innovations across the food system

- Cellular agriculture
- On-farm technology
- Replacement of food and feed
- Food processing and safety
- Food supply innovations
- Health

Technology	Production	Processing	Distribution	Packaging	Consumption	Waste
Artificial meat/fish	■	■			■	
Artificial products	■	■			■	
Novel nitrogen-fixing crops	■					■
Novel perennials	■					
Biofortified crops	■				■	
Vertical agriculture	■		■			
Macrobials	■					■
Botanicals	■					■
Microbials	■					■
Holobiomics	■					■
Microalgae & cyanobacteria for food	■	■			■	■
Seaweed for food	■	■			■	■
Insects for food	■	■			■	■
Microbial protein	■	■			■	■
Livestock/seafood substitutes	■	■			■	■
Innovative aquaculture feed	■	■				■
Omega-3 products for aquaculture	■					
Dietary additives for livestock	■					■
Biodegradable coatings			■	■		■
Microorganisms coating			■	■		■
Nanocomposites			■	■		■
Sustainable processing technologies		■	■	■		■
Food safety tech		■		■		■
Intelligent food packaging		■	■	■		■
Traceability technologies		■	■	■	■	
Farm-to-fork virtual marketplace		■	■	■	■	■
Smartphone food diagnostics		■	■		■	
Personalised food		■	■	■	■	■
3D printing	■	■	■	■	■	■

Fig. Technological innovations across the food system

Source: Herrero M, Thornton PK, Mason-D'Croz D, Palmer J, Benton TG, Bodirsky BL, et al. Inno- vation can accelerate the transition towards a sustainable food system. Nature Food. 2020 May 1;1(5):266–72.

Key Messages

Technology holds the potential to transform the food system. With emerging innovations, the grand challenge of feeding the world a sufficient, healthy diet while staying within planetary boundaries may be attainable. Technological advances encompass the entire food supply chain, from the agricultural level to the processing and retail stages in the middle and finally on to the consumer side. While technologies can shape food environments and consumer preferences, demand for certain foods also influences how new ideas take hold and thrive within society.

Despite the promise of new technologies, the future of food systems remains uncertain. Many emerging innovations only exist in the early stages of development and implementation. Some advances are scalable, while others will likely be too costly to be widely applied. Without consumer acceptance for novel technologies, these advances will never come to fruition. Some innovations pose ethical issues and threaten to worsen existing inequities. While the world's changing food culture has inspired some consumers to learn more about their food, others prioritize convenient, inexpensive options, often at the expense of health and nutrition. Achieving the goal of a sustainable food system will require that cultural and technological advances prioritize the fair distribution of healthy, nutritious, responsibly produced food in tandem with knowledge and resources.

Essential elements for accelerating the systemic transformation of food systems. These accelerators help achieve healthy and sustainable diets, productive agri-food systems and improved waste management— three outcomes necessary to attain sustainable food systems. Figure from Herrero et al. (2020) Innovation can accelerate the transition towards a sustainable food system. Nature Food.

- Fanzo, J. & Davis, C. 2021. Global food systems, diets, and nutrition: Linking science, economics, and policy. Cham: Palgrave macmillan (p178). https://doi.org/10.1007/978-3-030-72763-5.
- Herrero, M., Thornton, P.K., Mason-D'Croz, D. et al. Innovation can accelerate the transition towards a sustainable food system. Nat Food 1, 266–272 (2020). https://doi.org/10.1038/s43016-020-0074-1

Food fortification

Fortified foods: Too much of a good thing?

Food Fortification in Southeast Asia

Table 1. Mandatory nutrient fortification in ASEAN [19].

Nutrient	Food Vehicle	Country
Iodine	Salt	All 10 countries, except Brunei, Singapore and some parts of Malaysia
Iron	Wheat flour	Indonesia
	Wheat flour and rice	Philippines
Vitamin A	Condensed, evaporated and filled milk; margarine	Malaysia
	Wheat flour, refined sugar, cooking oil	Philippines
	Condensed milk, margarine	Thailand
	Unbranded cooking oil	Indonesia (commencing 2015)
Vitamin D	Margarine	Malaysia
Folic acid and B vitamins	Wheat flour	Indonesia
	Rice	Thailand
Zinc	Wheat flour	Indonesia

Gayer J, Smith G. Micronutrient Fortification of Food in Southeast Asia: Recommendations from an Expert Workshop. *Nutrients*. 2015; 7(1):646-658. https://doi.org/10.3390/nu7010646

Fortification in Thailand

Implication rules was revised in 2006

http://food.fda.moph.go.th/Rules/dataRules/4-4-1RuleNutrification_Edit1fab49.pdf

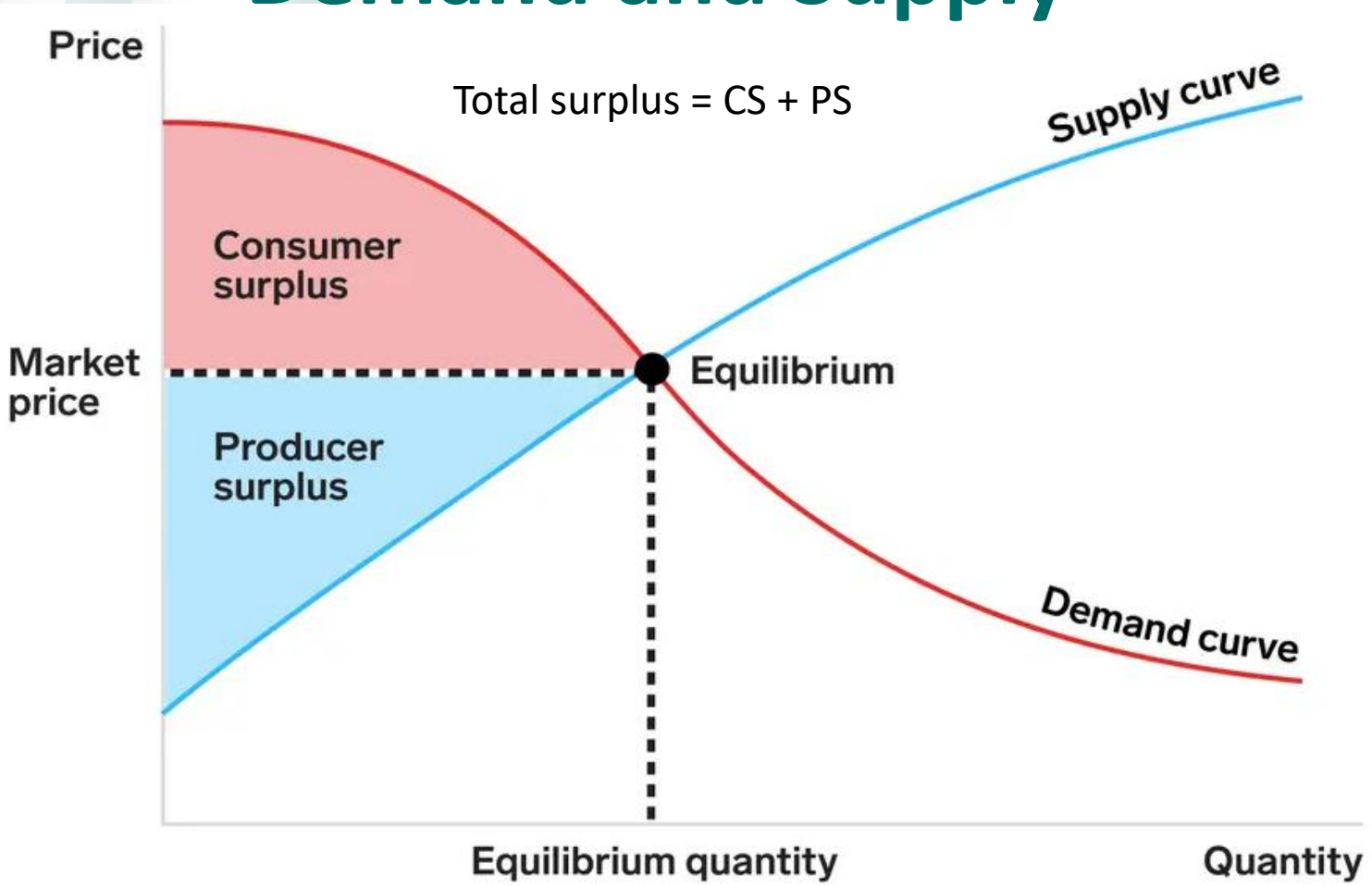

SALLY FALLON MORELL
"Nature doesn't make mistakes, but scientists do."
WISE TRADITIONS PODCAST 381
westonaprice.org

Willingness to Pay

Demand and Supply

A consumer surplus refers to the monetary benefit that a consumer receives when purchasing a good for a lower price than the top amount they'd be **willing to pay** in that scenario. The consumer surplus refers to the marginal benefit — or the highest price they'd pay — minus what they actually paid.

Producer surplus refers to the monetary gain that producers get by selling a particular good above the lowest price that they'd be **willing to sell** at. The marginal cost refers to the incremental costs that a producer has when producing more of a particular good.



Cr. Rachel Mendelson/Insider

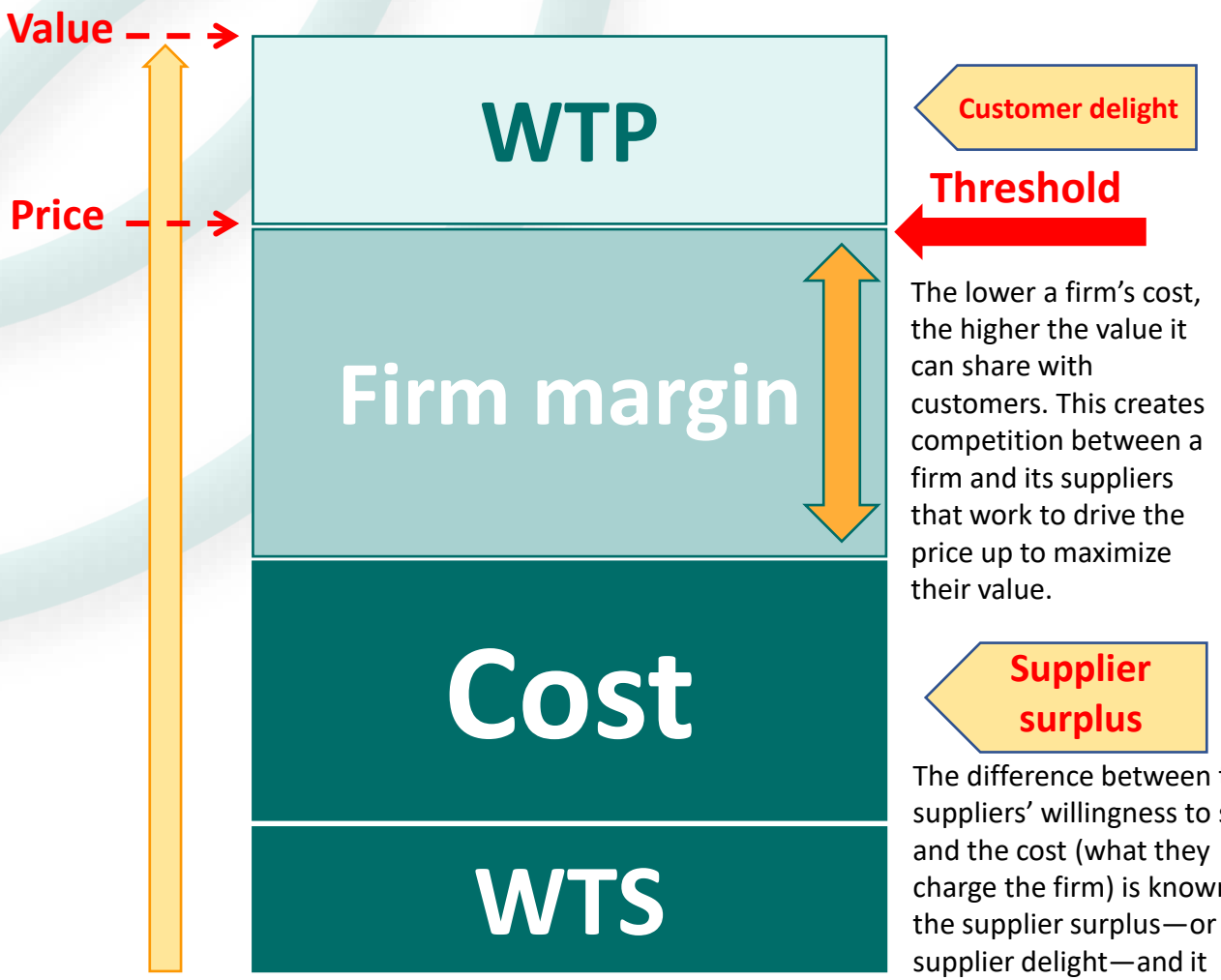
Business aspect on willingness to pay

"Willingness to pay (WTP) is the highest price a customer is willing to pay for your product or service. Customers are likely to make a purchase when companies charge any amount up to that threshold."

…Tim Stobierski (2020)

Price: the final price a company charges when it sells a product or service

Cost: how much money goes into producing a product or service, including all of its components both physical and non-physical costs, such as utilities and rental space.



Customer delight

Threshold

The lower a firm's cost, the higher the value it can share with customers. This creates competition between a firm and its suppliers that work to drive the price up to maximize their value.

Supplier surplus

The difference between the suppliers' willingness to sell and the cost (what they charge the firm) is known as the supplier surplus—or the supplier delight—and it represents the value they've captured from a sale at the firm's expense.

The difference between the customer's willingness to pay and the final price of the purchase is known as the customer's delight. This is the level of goodwill, loyalty, and brand enthusiasm that the customer feels after making a purchase, which is typically tied to the value they've claimed from the transaction.

Factors influence WTP

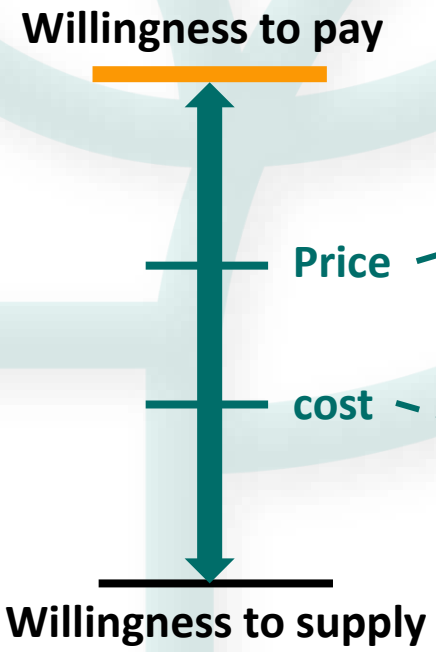
- The state of economy
- Trendy/in-season of a product
- Consumer's personal price reference point
- Circumstantial needs
- Scarcity of a product
- Quality of a product
- Value proposition
- Customer needs
- Brand awareness
- Social proof and influencer marketing (e.g. fear of missing out: FOMO)

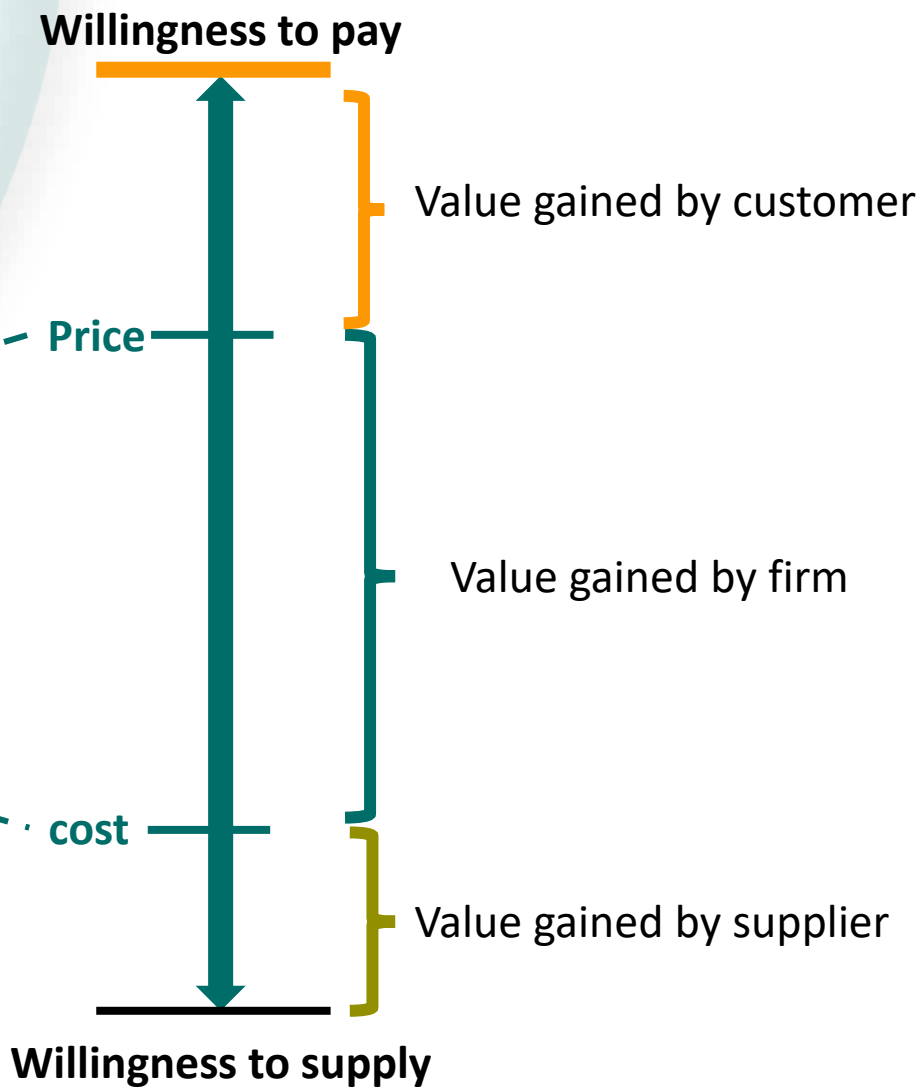
https://online.hbs.edu/blog/post/value-based-strategy

What is the difference between willingness to pay (WTP) and willingness to accept (WTA)?

Value creation (Expanding value)

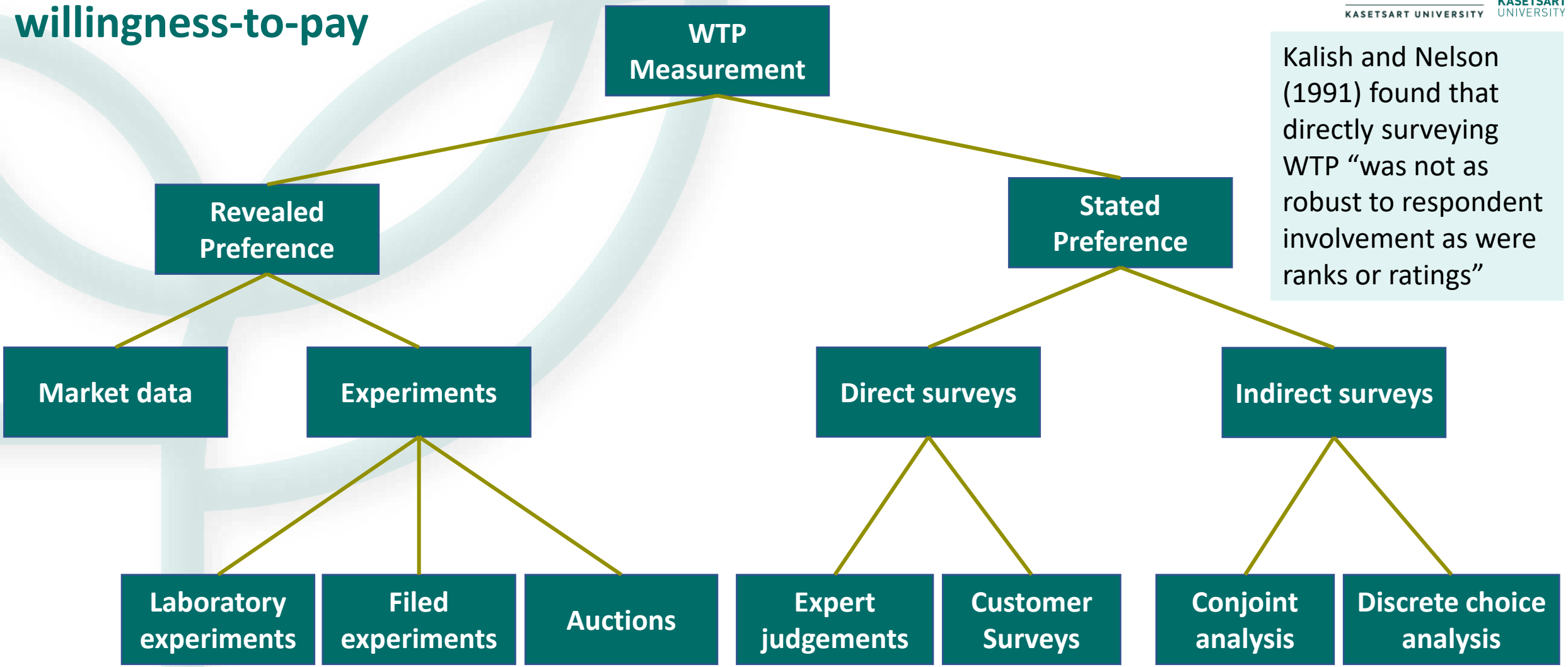
How food business strategize 'value creation'?





Methods for measuring willingness-to-pay

Methods to measure willingness-to-pay



Kalish and Nelson (1991) found that directly surveying WTP "was not as robust to respondent involvement as were ranks or ratings"

Fig. 1. Classification framework for methods to measure willingness-to-pay

Breidert, C., Hahsler, M., & Reutterer, T. (2006). A review of methods for measuring willingness-to-pay. Innovative marketing, 2(4).

Comparative evaluation of competing methods for measuring willingness-to-pay

	Market data	Experiments	Direct Surveys	Indirect Surveys	
				Conjoint Analysis	Discrete Choice Analysis (CBC)
Cost effective	+/-	--	++	+	+
Time efficient	+/-	--	++	+	+
Flexibility to include new price/product combinations	--	++	+/-	++	++
Validity of estimations	++	+/-	--	+	+
Real purchase behavior	++	+/-	--	--	--
Observed choice behavior	++	+	--	--	+
Individual level estimations	+/-	+/-	++	++	+

+ (++) = (strong) advantage
- (--) = (strong) disadvantage
+/- = no clear advantage or disadvantage (depending on data-collection and/or estimation method)

Breidert, C., Hahsler, M., & Reutterer, T. (2006). A review of methods for measuring willingness-to-pay. Innovative marketing, 2(4).

Example

Given the complexity of calculating WTP due to multiple factors, there is no one formula. Conjointly recommends three methodologies, each with their own advantages and limitations.

- **Direct surveys** require the respondents to (directly) state how much he or she is willing to pay for a specific product or bundle of attributes.
- Naturally, this approach has a number of possible biases. For example, it is often difficult to state a WTP for an unfamiliar product.
- WTP also tends to be sometimes overstated because of prestige effects or understated due to consumer collaborations effects to keep the prices low.

	Direct survey		Indirect survey
Methodologies	**Gabor-Granger**	**Van Westendorp**	**Conjoint Analysis**
When To Use	Determine price points for existing products (Yes / No)	Determine price range for existing or new products	Assess features other than prices of multiple products
Advantages	Straightforward approach of questioning	Relatively easy to program	Offers more insights into customers' decision-making process
Limitations	Does not consider competitive pricing	Respondents need to have some knowledge of market offerings	Requires high level of expertise

Breidert, C., Hahsler, M., & Reutterer, T. (2006). A review of methods for measuring willingness-to-pay. Innovative marketing, 2(4).

https://conjointly.com/blog/willingness-to-pay/