UNIVERSITÀ DEGLI STUDI FIRENZE

DISEI
Dipartimento di scienze per l'economia e l'impresa

The economics of (mal)nutrition

Donato Romano

I Lincei per la Scuola- Firenze, 23 gennaio 2020

Contents

- Background: food and nutrition security
  - measures
  - data
- Conceptualization: FNS 4 dimensions
  - availability
  - access
  - utilization
  - stability
- Analysis: Sen's entitlement approach
- Policy implications

Why is human capital so important?

Human capital and development

- consequences of under/malnutrition:
  - health: vulnerability to disease/illness, anemia (iron), blindness (vitamin A)
  - low school attainment: role of school feeding
  - low labor productivity
  - high mortality rates: high fertility rates (insurance)
  - high discount rate: low investment and low growth, increased pressure on the environment (natural resource depletion)

Why food and nutrition security?

Human capital and development

- **short-run**: health/nutrition (and education) are development objectives in themselves, i.e. elements of welfare: **consumption goods**
- **long-run**: health/nutrition (and education) lead to increases in labor productivity, wages, and income (current for adults, future for children): **investments**

Measurement

Why FNS measurement matters?

- each measure captures and neglects different phenomena (i.e. **dimensions**) intrinsic to the concept of food security, thereby subtly influencing prioritization among food security interventions
- observational data necessarily report on the past, but policymakers are most interested in the likely **future effects** of prospective interventions → vulnerability, early warning, targeting
- national-level (i.e. aggregate/average) measures vs. intra-national (i.e. **disaggregated**) access and utilization concerns → households/individuals

What are we talking about?

Millennium Development Goals (UN Millennium Declaration)

Goal 1, Target 1.2
"Halve between 1990 and 2015 the *proportion* of people who are food insecure"

World Food Summit (FAO, 1996)

WFS Target
"Halve between 1990 and 2015 the *number* of people who are food insecure"

* WFS Target more restrictive than MDG Target 1.2

Measurement

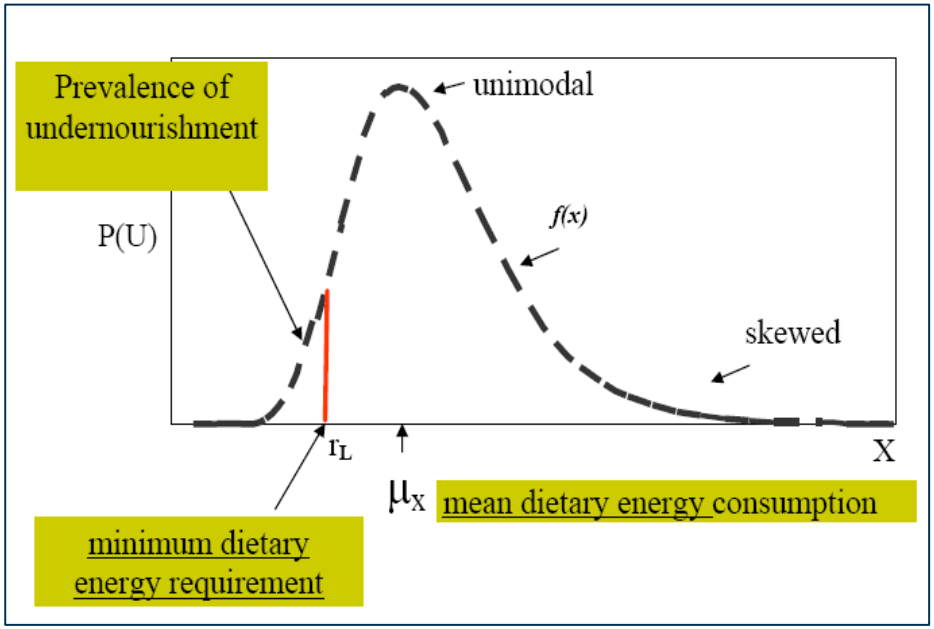
Measures of food consumption

- **Prevalence of undernourished** (PoU): (likely) proportion of people that are undernourished in the population
  - the methodology for estimating the PoU is based on the comparison of a probability distribution of *habitual* daily *dietary energy consumption*, *f(x)*, and a threshold level, the *minimum dietary energy requirement* (MDER)
  - both are based on the notion of an *average individual* in the reference population
- **Number of undernourished (NoU):** the product of the estimated PoU by the population size

Measurement

Measures of food consumption

- **Prevalence of undernourished** (PoU)

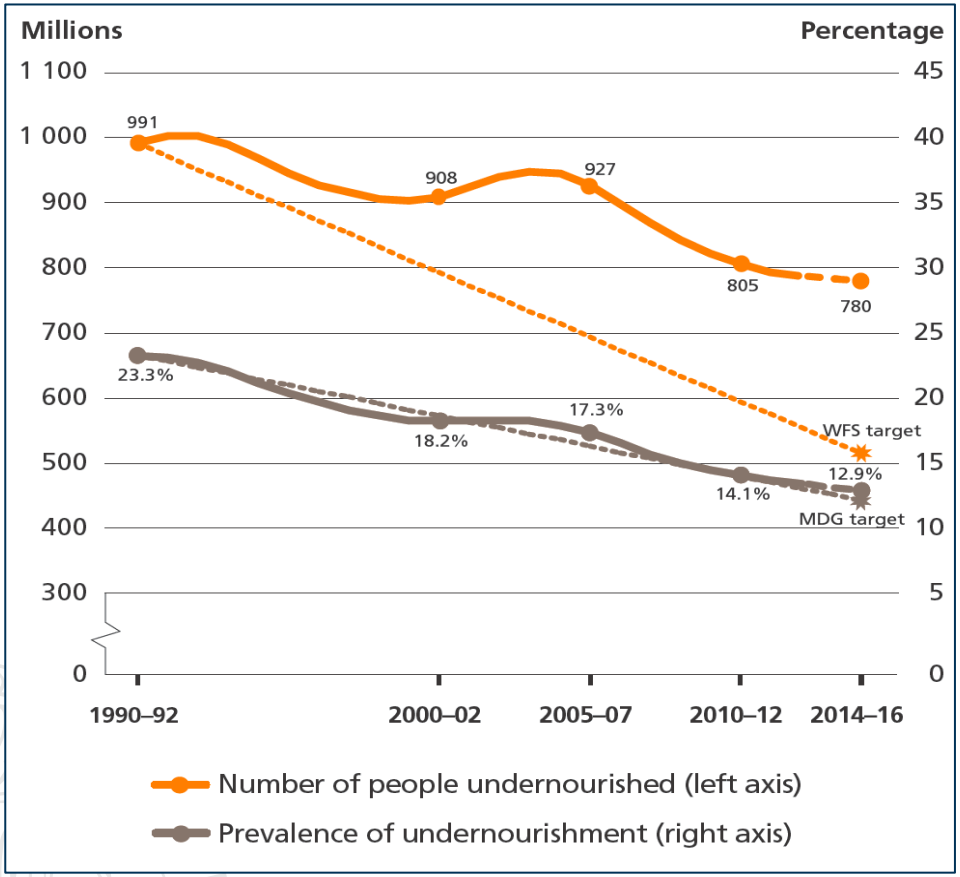


$$P(U) = P(x < r_L) = \int_{x<r_L} f(x)\,dx = F_x(r_L)$$

- $f(x)$: lognormal, skewed normal, skewed lognormal
- μ_x: per capita dietary energy supply (DES) from FAO's Country Food Balance Sheets
- r_L: minimum dietary energy requirement (MDER) = BMR*PAL
- variability and skewness:
  - until 2010: $CV = [(CV_y)^2 + (CV_r)^2]^{0.5}$
  - from 2011-12 on: based on regression analysis that decomposes the total variation of food consumption into two components (the variability of habitual food consumption and the variability of observed consumption around its mean)

What are we talking about?

- MDG target 1.2 achieved
- WFS target far from being achieved



(FAO-WFP-IFAD, 2015)

What are we talking about?

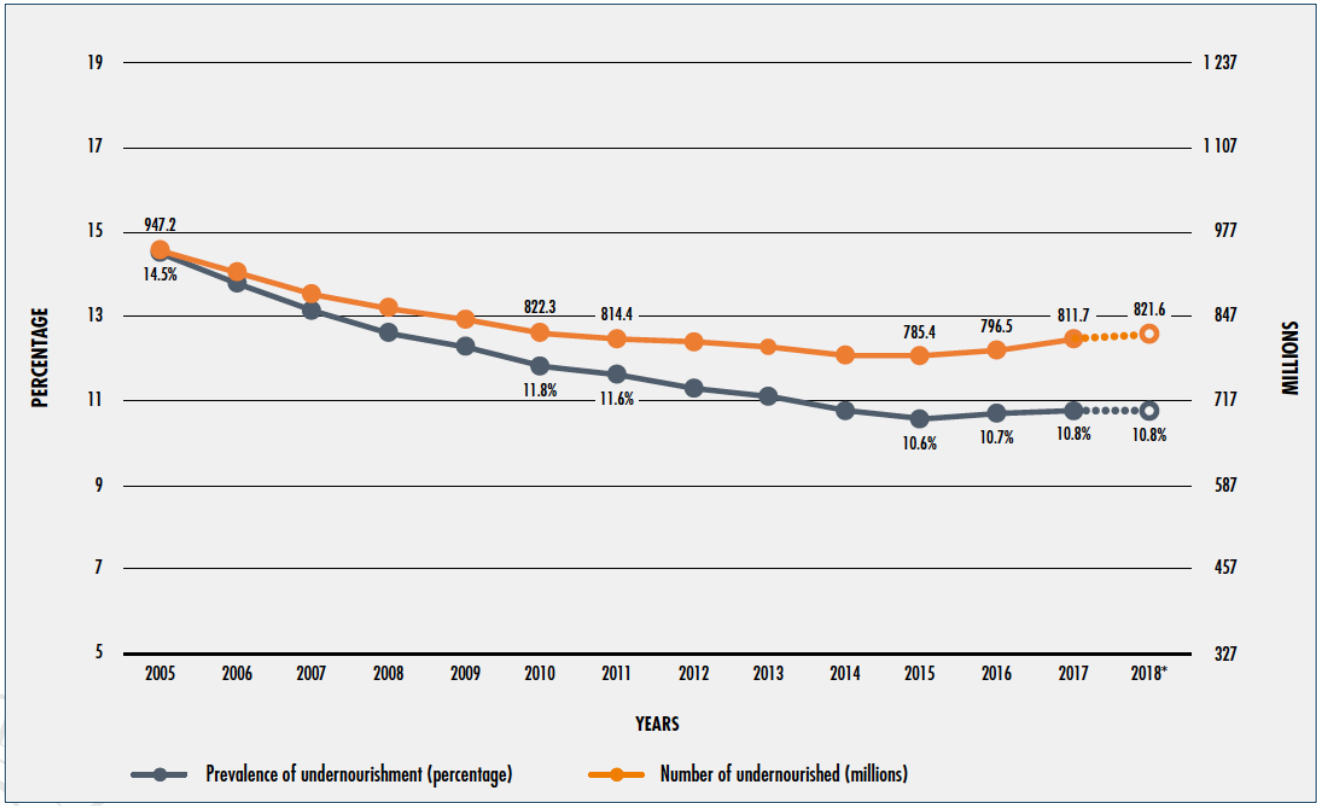
Sustainable Development Goals (UN Agenda 2030)

Goal 2, Target 2.2

"By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under five years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons"

What are we talking about? (FAO-WFP-IFAD, 2019)

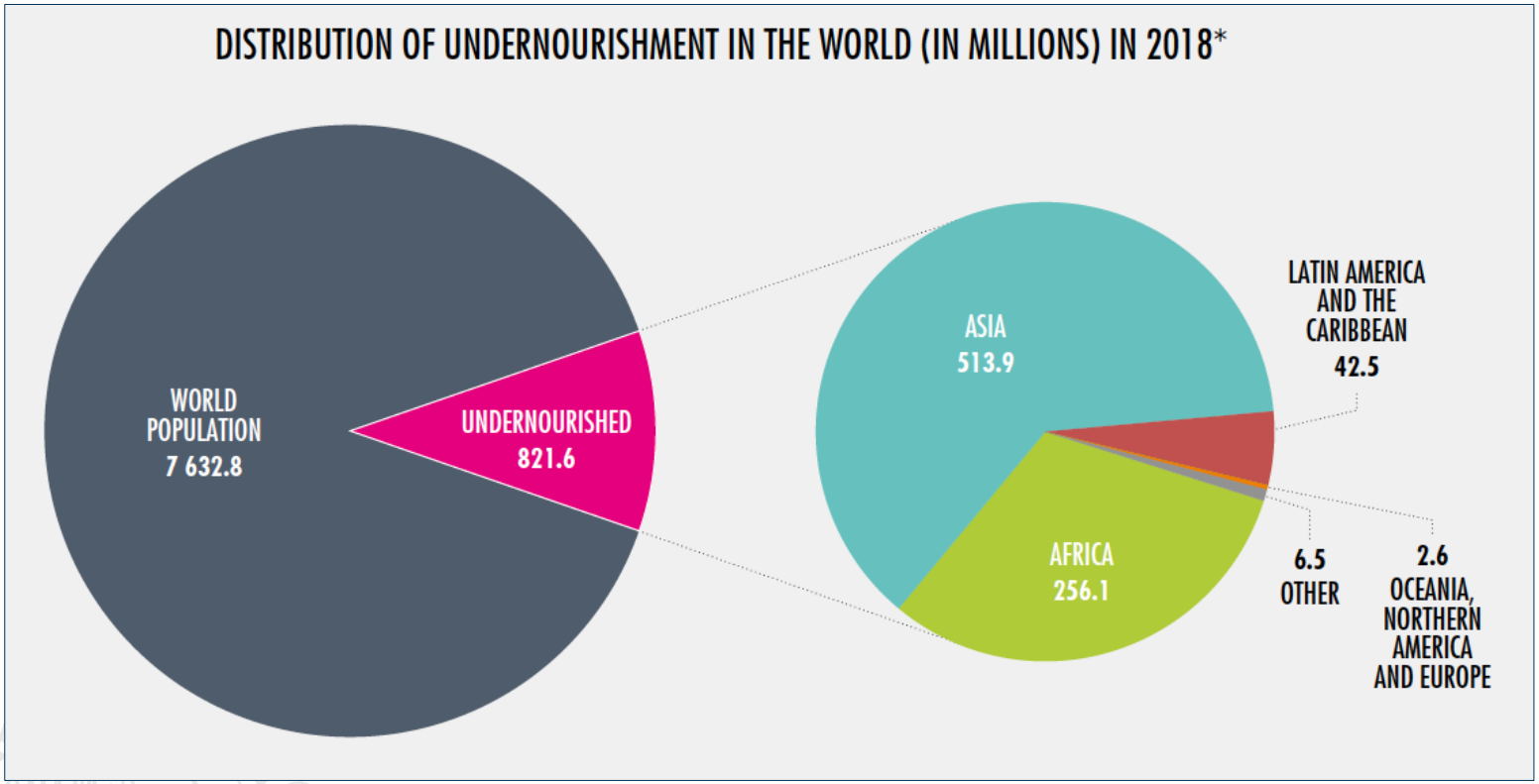
- Undernourished people are on the rise: 822 mln in 2018 (11% ca. of world population)



Source: FAO-WFP-IFAD-UNICEF-WHO, 2019

What are we talking about?

- Prevalence: largest in Africa (19.9%)
- Abs number: largest in Asia (513.9 mln)



Source: FAO-WFP-IFAD- UNICEF-WHO, 2019

Measurement

Measures of food insecurity Food Insecurity experience Scale (FIES)

Voices of the Hungry Project (FAO, 2013)

Website: http://www.fao.org/in-action/voices-of-the-hungry/en/

Video: https://youtu.be/znf5AiiVIjM

Since SOFI 2019, it is the second indicator to monitor SDG Target 2.1

Measurement

Measures of food insecurity

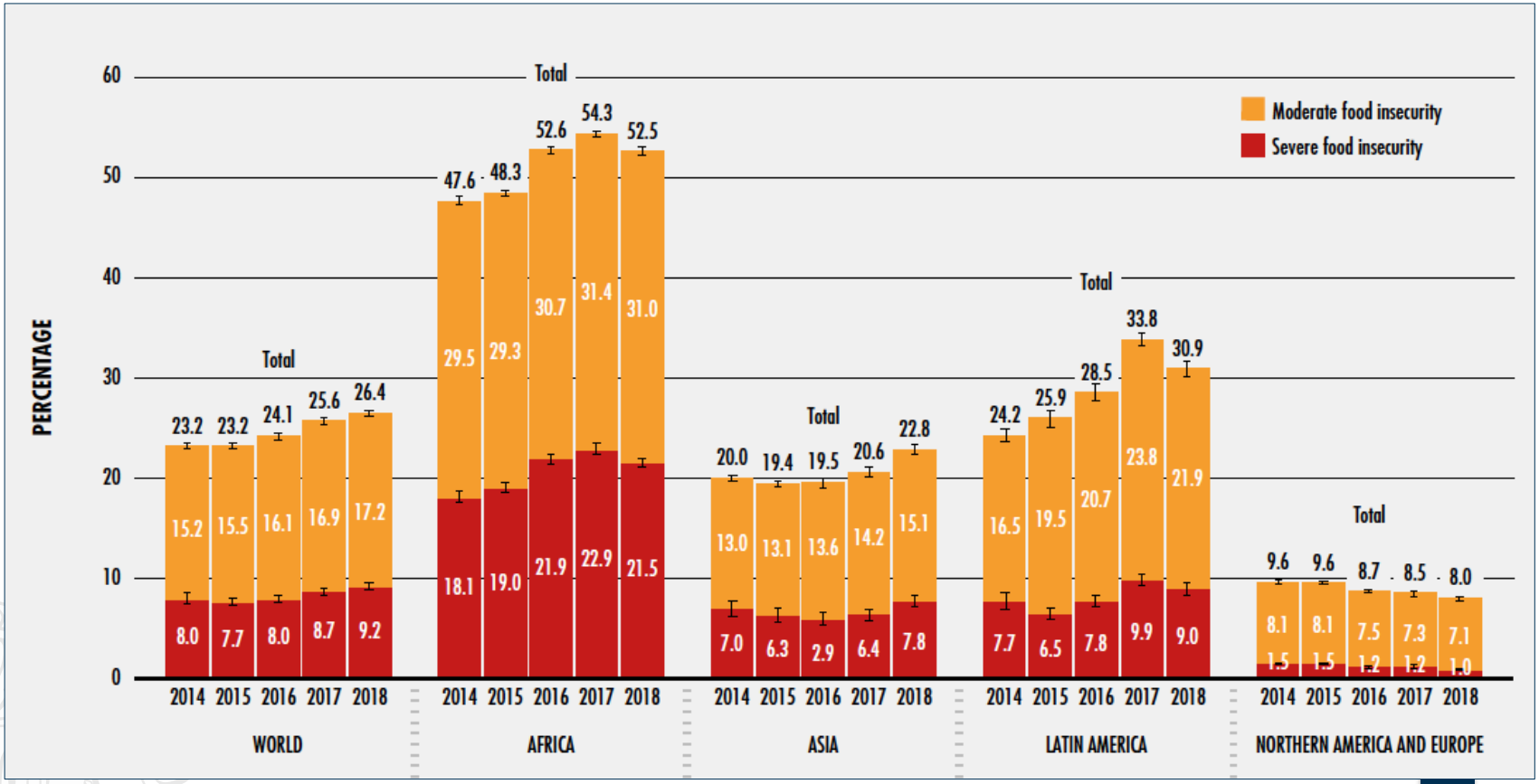
- **Food Insecurity experience Scale** (FIES)

During the last 12 months, was there a time when, because of lack of money or other resources:

1. You were worried you would not have enough food to eat?
2. You were unable to eat healthy and nutritious food?
3. You ate only a few kinds of foods?
4. You had to skip a meal?
5. You ate less than you thought you should?
6. Your household ran out of food?
7. You were hungry but did not eat?
8. You went without eating for a whole day?

What are we talking about? (FAO-WFP-IFAD, 2019)

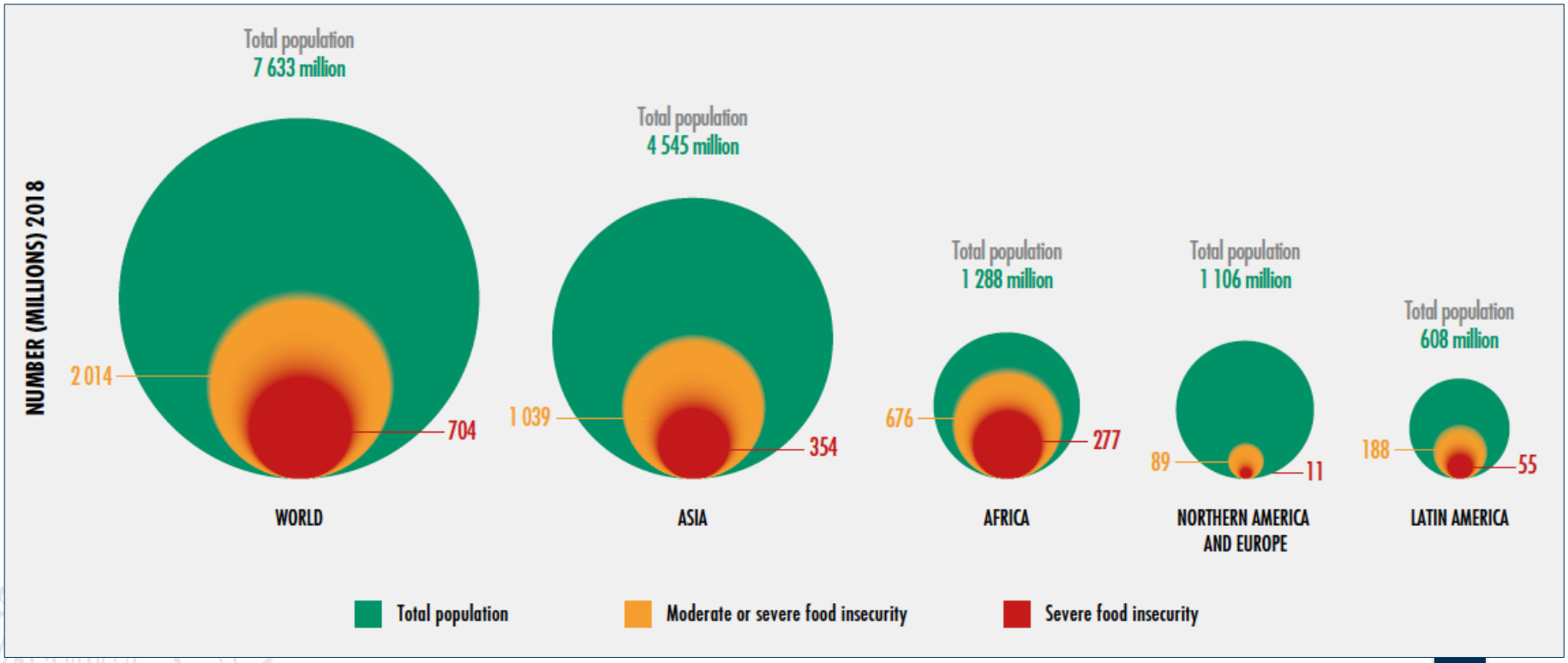
- FIES on the rise, mainly due to Asia and Latin America



Source: FAO-WFP-IFAD- UNICEF-WHO, 2019

What are we talking about? (FAO-WFP-IFAD, 2019)

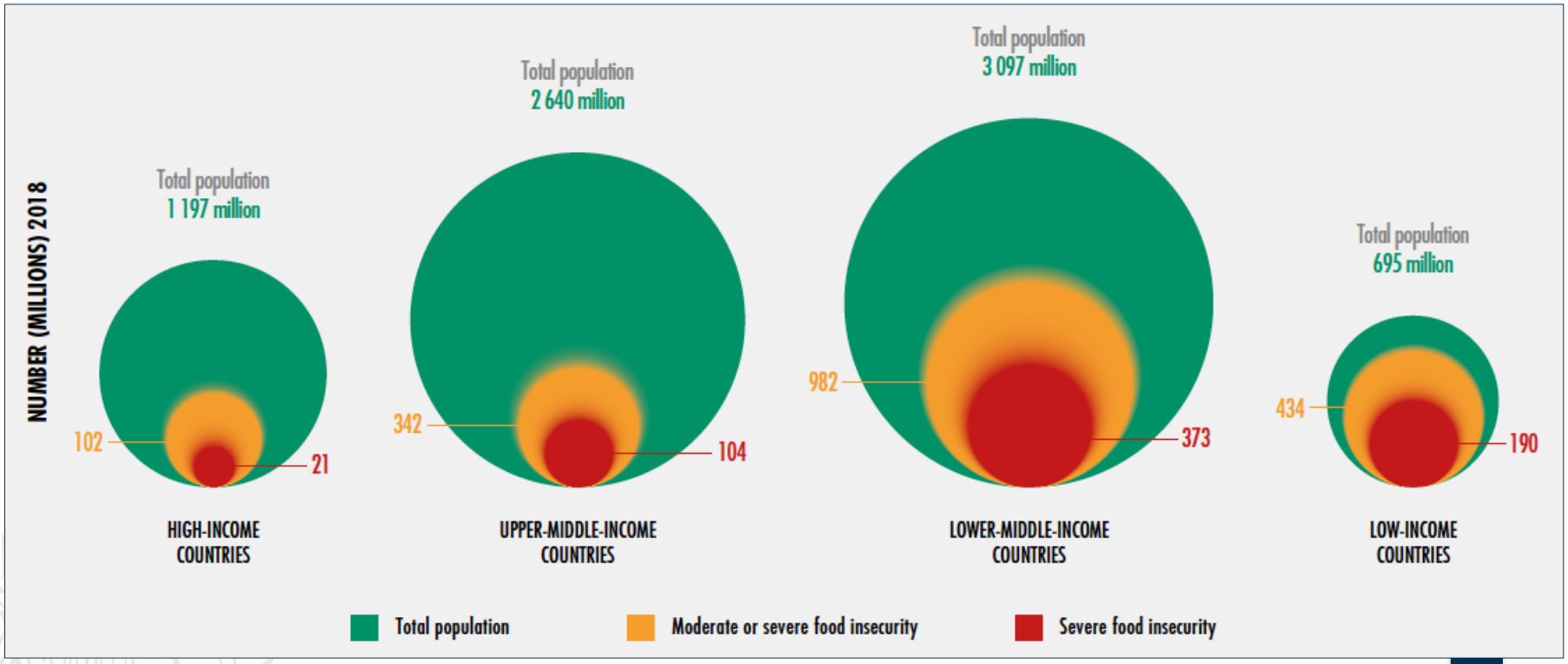
- FIES: the concentration and distribution of food insecurity by severity differs greatly across regions of the world



Source: FAO-WFP-IFAD- UNICEF-WHO, 2019

What are we talking about? (FAO-WFP-IFAD, 2019)

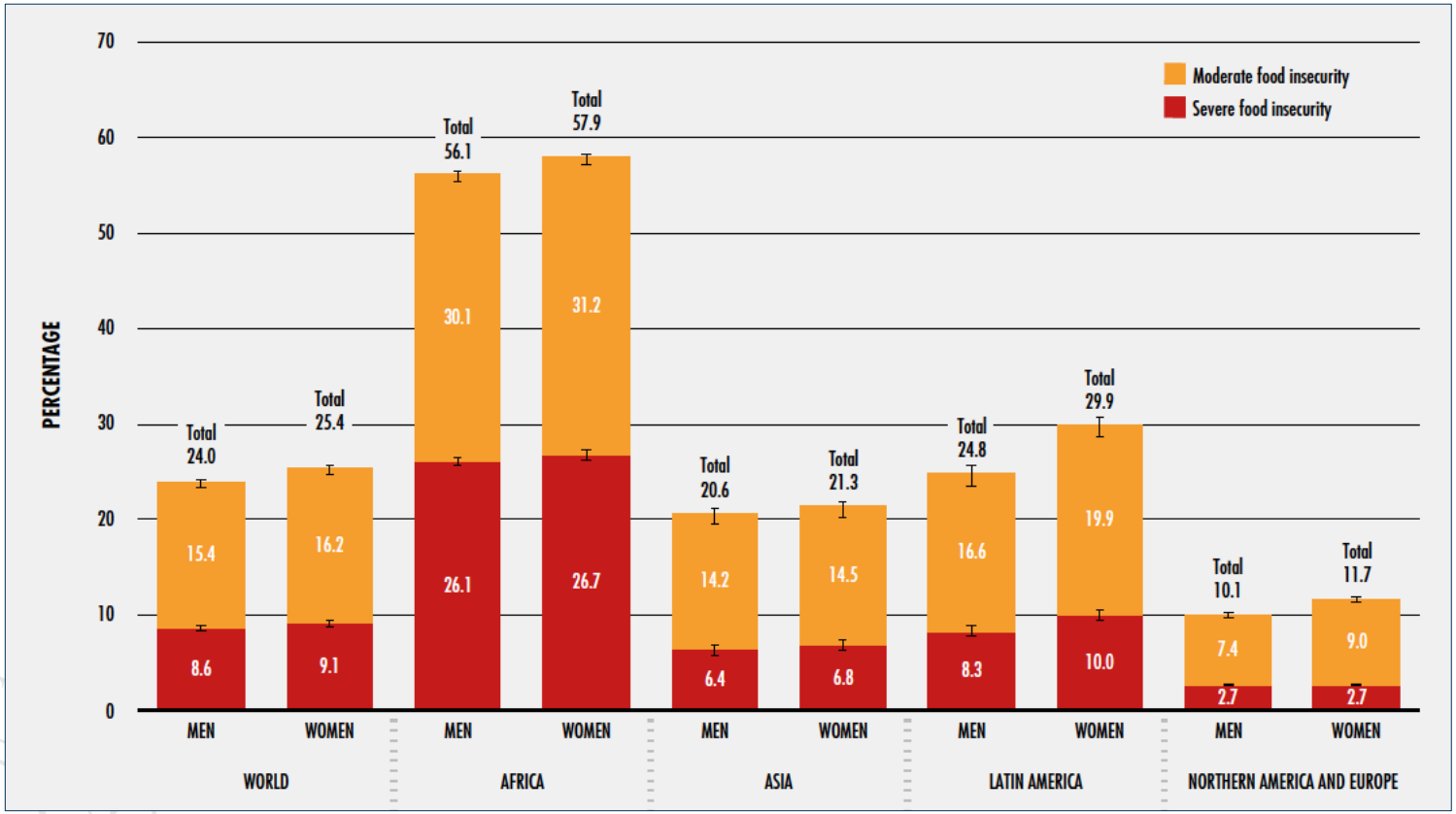
- FIES: as the country level of income falls, the prevalence of food insecurity increases and so does the proportion of severe food insecurity



Source: FAO-WFP-IFAD- UNICEF-WHO, 2019

What are we talking about? (FAO-WFP-IFAD, 2019)

- FIES: women slightly more likely to be food insecure (2016-2018 three-year averages)



Source: FAO-WFP-IFAD- UNICEF-WHO, 2019

Indicators of health status

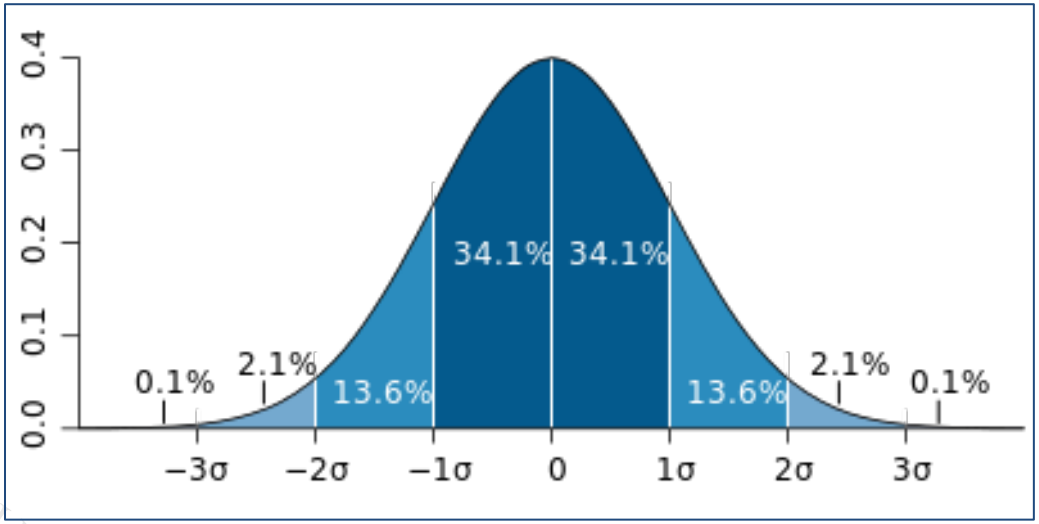
Nutrition-based indicators: anthropometrics

- **nutritional status** is the outcome of individual food consumption at level, health status and labor demand: it is **the outcome of individual's nutritional history**
- **anthropometric indicators**, based on estimates of the total mass of body tissues, such as weight or arm circumference, are accepted measures of the nutritional well-being of an individual. These measurements are most commonly taken on young children

Indicators of health status

Nutrition-based indicators: anthropometrics

- outcome of food intakes (*z*-scores) $z = (x_i - \mu)/\sigma$
  - comparison between the *i*-th individual and the population mean (μ), using standard deviation as a scaling factor (σ): how many SD is the the *i*-th individual far from the mean?



For normal distribution:

- $\mu \pm \sigma$ = 68.27%
- $\mu \pm 2\sigma$ = 95.45%
- $\mu \pm 3\sigma$ = 99.73%

Indicators of health status

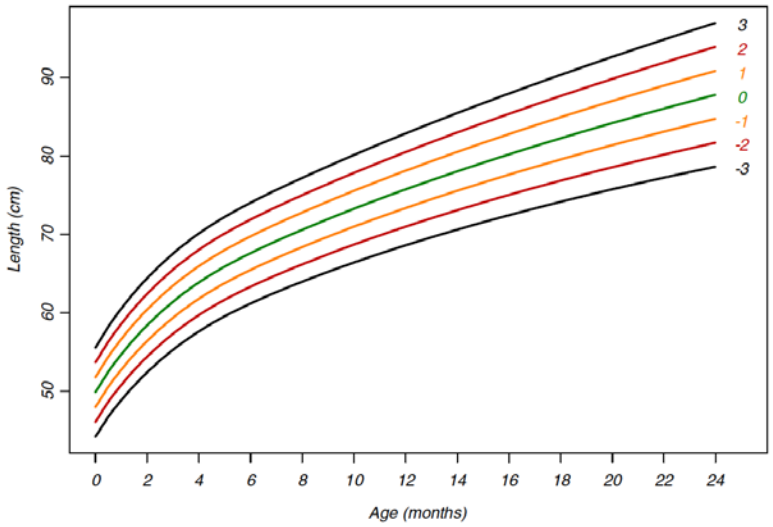
Nutrition-based indicators: anthropometrics

- outcome of food intakes (*z*-scores) $z = (x_i - \mu)/\sigma$
  - *z*-scores may be positive or negative
    - **wasting**: < - 2SD from *weight for height* (WHZ) median, short run factors (e.g. starvation, severe disease e.g. diarrhea)
    - **stunting**: < - 2SD from *height for age* (HAZ) median, long run factors (e.g. early malnutrition, chronic illness)
    - **underweight**: < -2SD *weight for age* (WAZ) = HAZ × WHZ median
- **mid-upper arm circumference**
- **blood test** for micronutrients deficiencies (e.g. iron, zinc, vitamin A)

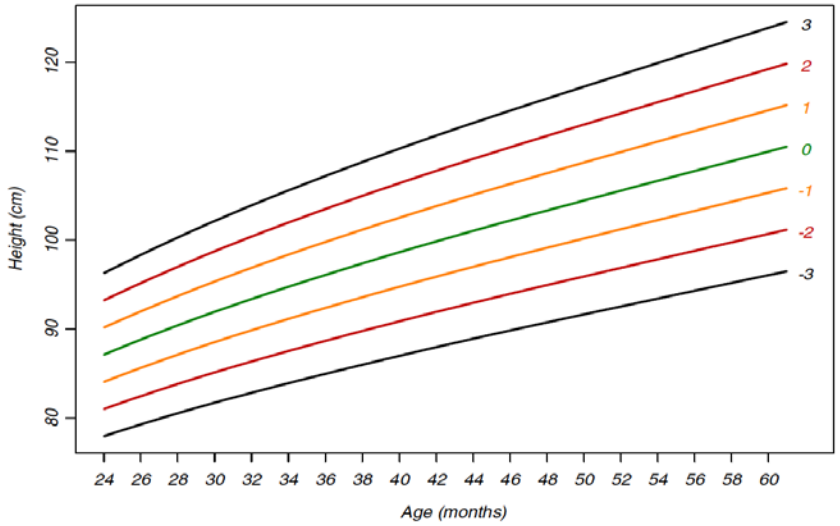
Indicators of health status

Nutrition-based indicators: anthropometrics

- height-for-age: WHO 2006 new standards for 0-5 years based on the Multi-Centre Growth Reference Study



Length-for-age z-scores for boys from birth to 24 months



Height-for-age z-scores for boys from 24 to 60 months

Source: WHO, 2006

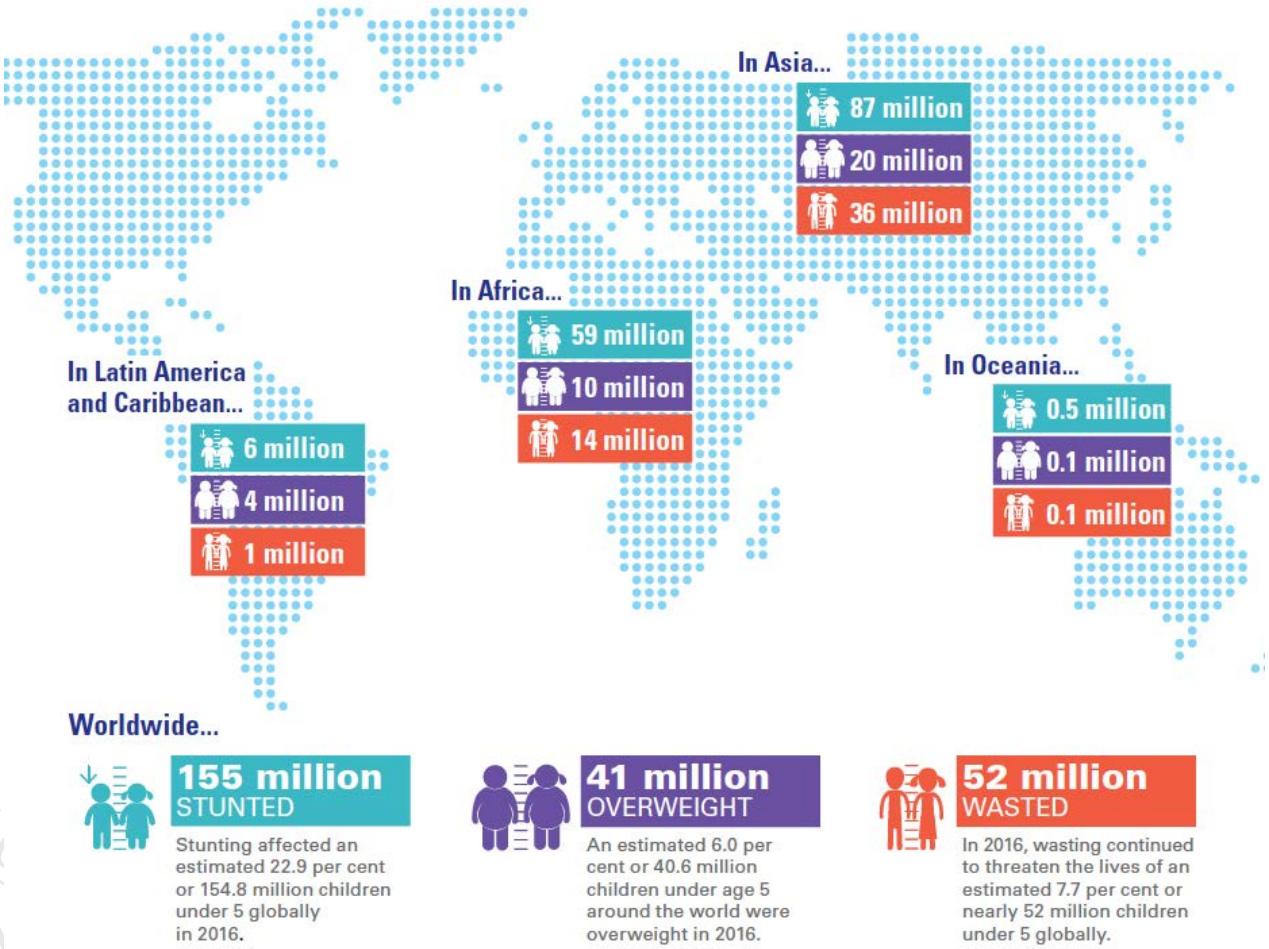
Indicators of health status

Nutrition-based indicators: anthropometrics

- **Body Mass Index** (BMI) is becoming more accepted as the best way of identifying changes in the wellbeing of <u>adults</u>
  - it is given as weight (W), in kilos, divided by height (H) squared, in meters: $BMI = W/H^2$
  - the BMI can take values between 15 and 40, with the following cutoff for adults above 20 y old (WHO):
    - < 16: severe chronic malnutrition
    - 16-17.5: chronic malnutrition with wasting
    - 18.5-25: normal
    - 25-30: overweight
    - > 30: obese

Indicators of health status

Nutrition-based indicators: anthropometrics



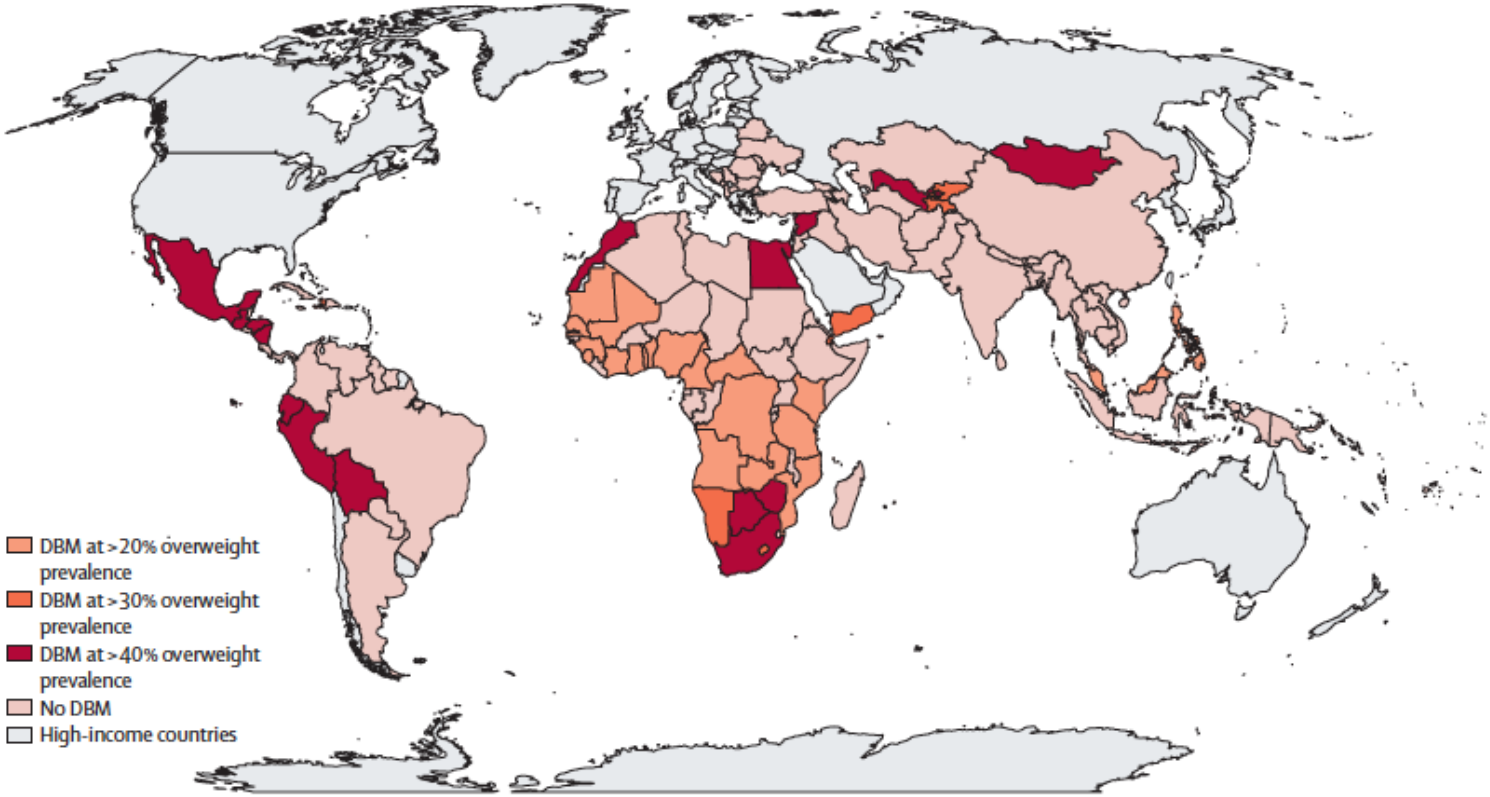
Double burden of malnutrition

Source: UNICEF/WHO/WB, 2017

Indicators of health status

Nutrition-based indicators: anthropometrics

Double burden of malnutrition, 1990

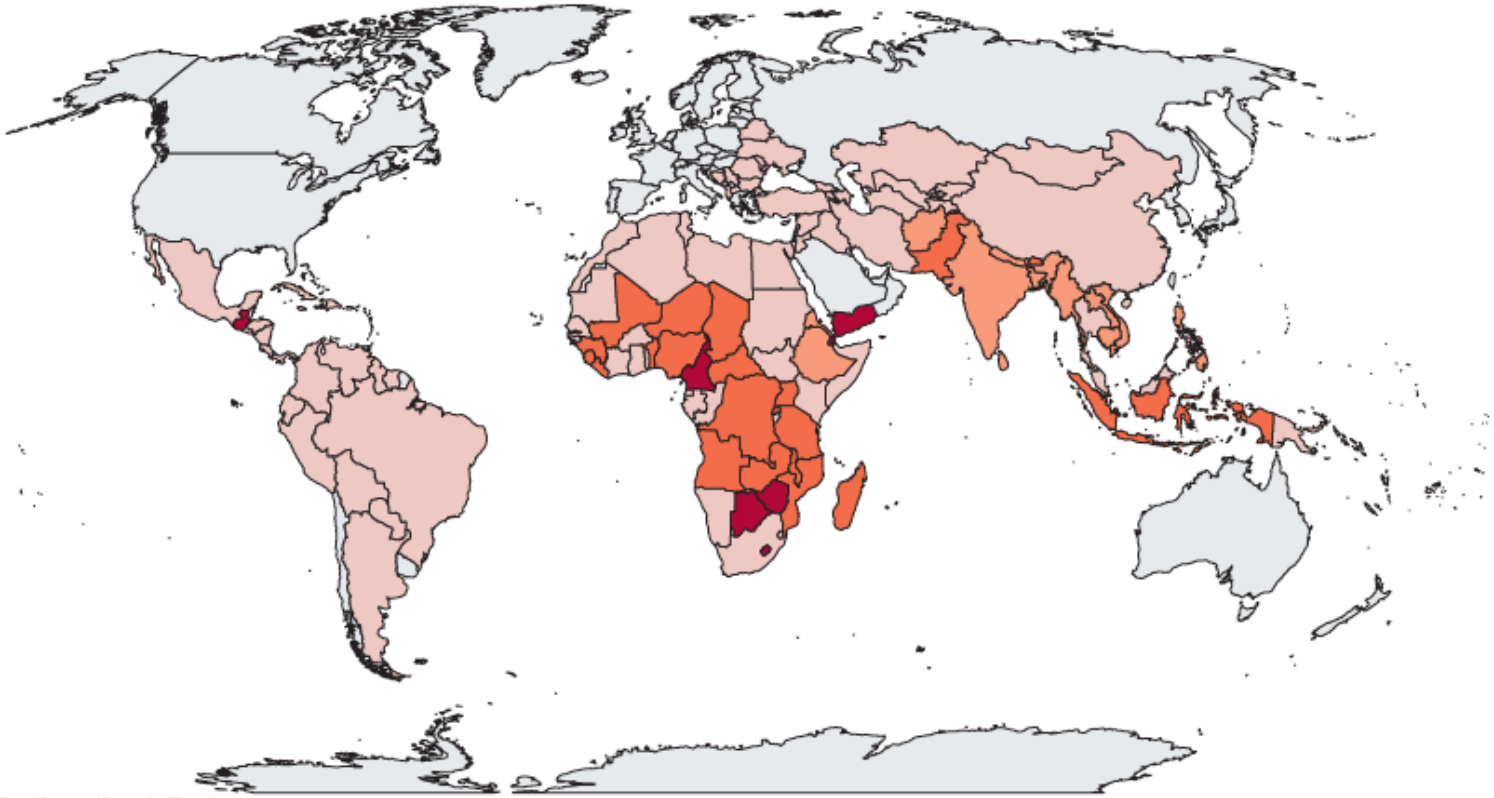


Source: Popkin & Corvalan, 2019

Indicators of health status

Nutrition-based indicators: anthropometrics

Double burden of malnutrition, 2010

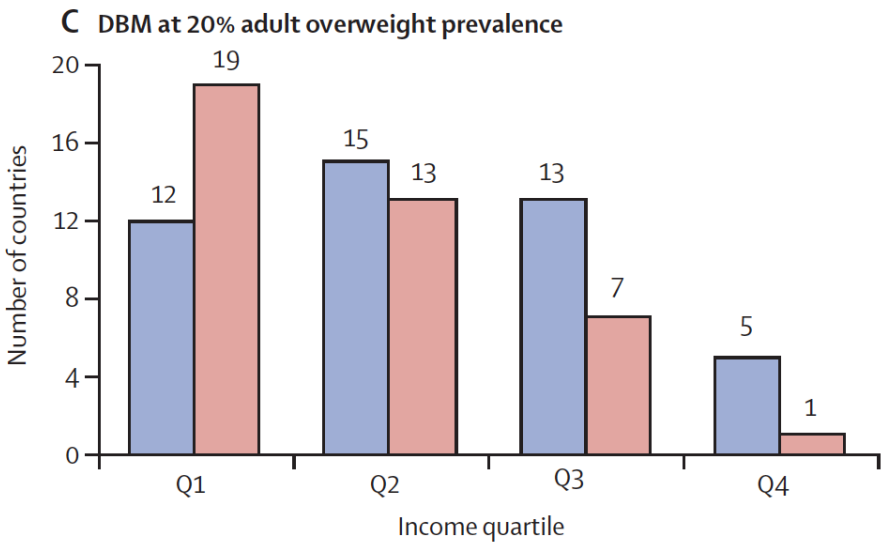


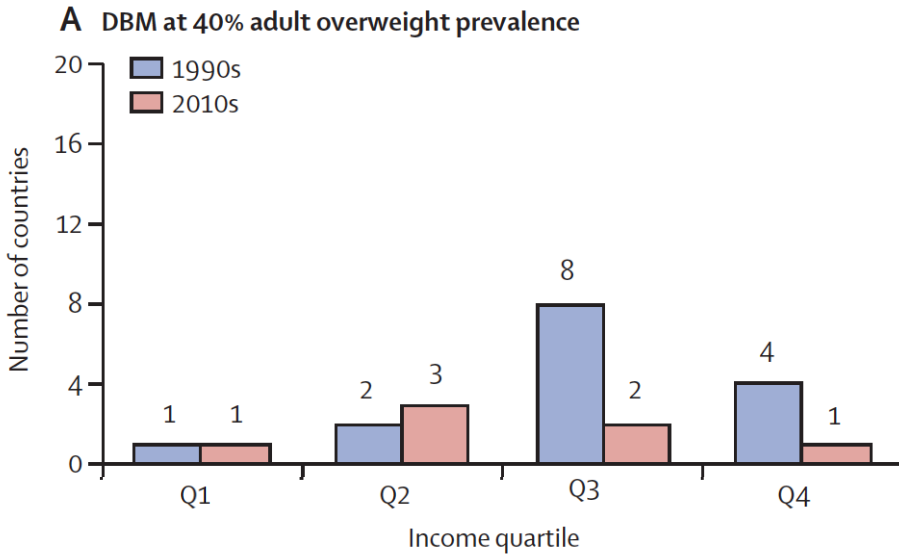
Source: Popkin & Corvalan, 2019

Indicators of health status

Nutrition-based indicators: anthropometrics

Double burden of malnutrition, 1990-2010



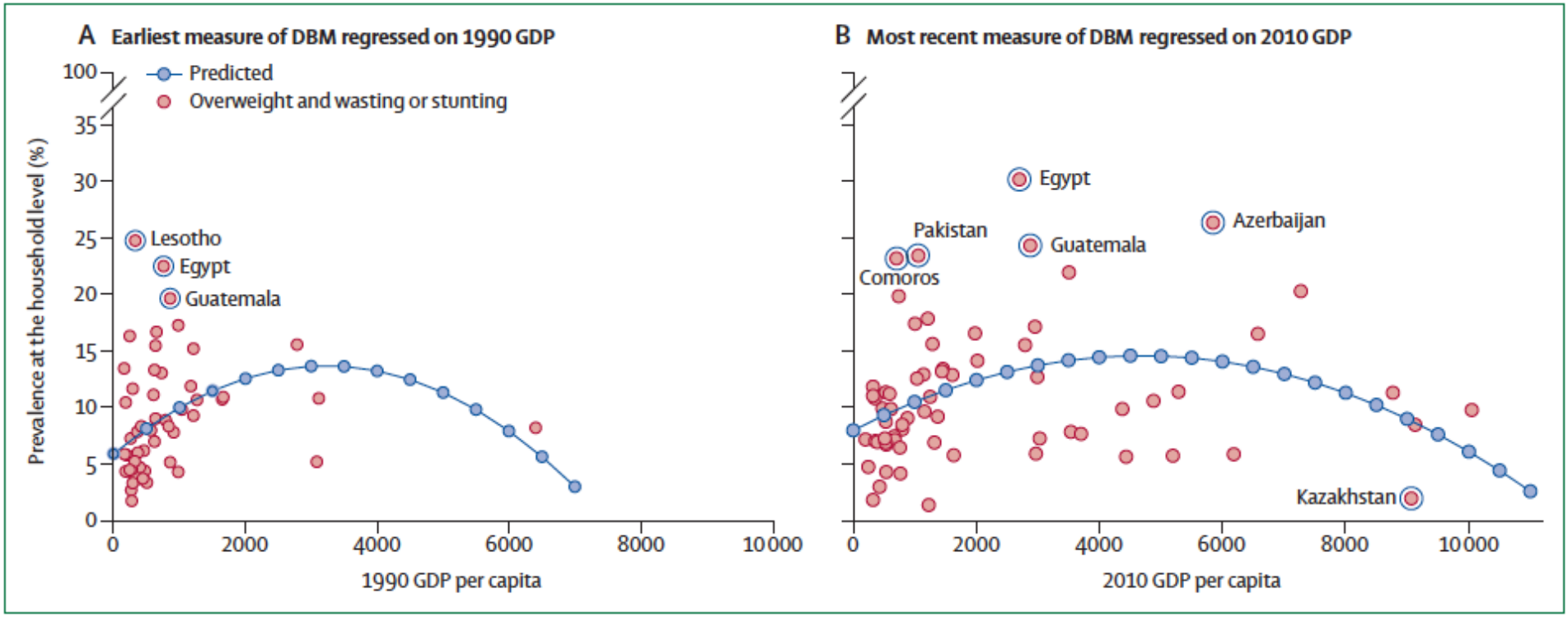


Source: Popkin & Corvalan, 2019

Indicators of health status

Nutrition-based indicators: anthropometrics

Double burden of malnutrition, 1990-2010

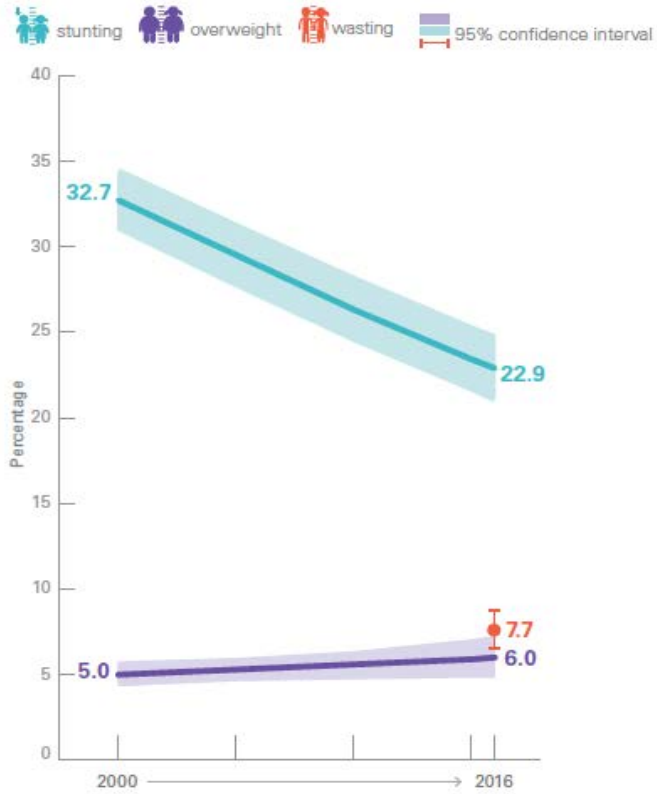


Source: Popkin & Corvalan, 2019

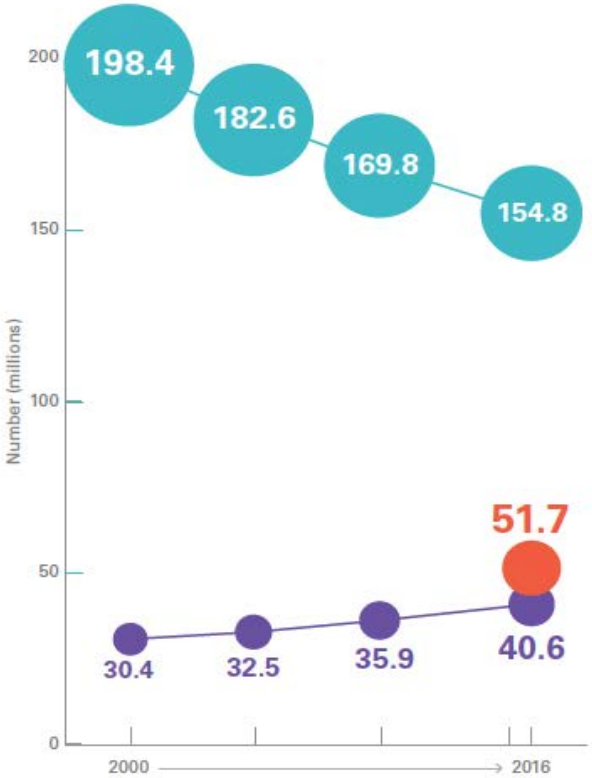
Indicators of health status

Nutrition-based indicators: anthropometrics

- stunting is declining too slowly while overweight continues to rise



Percentage of stunted, overweight and wasted children under 5, global, 2000–2016



Number (millions) of stunted, overweight and wasted children under 5, global, 2000–2016

Source: UNICEF/WHO/WB, 2017

What are we talking about

Summary

- stunting and wasting and thinness in women are slowly declining
- overweight overweight is increasing in most age groups
- severe levels of the DBM have shifted to LMI countries in the poorest income quartile
- increases in overweight are the result of
  - changes in the global food system that make less nutritious food cheaper and more accessible
  - the decrease in physical activity due to major technological shifts in the workplace, home, and transportation

Definitions

World Food Summit (FAO, 1996)

Food security is
"a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life"

Definitions

Related concepts

- **food security**: access to enough food
- **food safety**: access to safe food
- **food self-sufficiency**: domestically produced food
- **undernourishment**: caloric consumption (*daily energy consumption*, DEC) below a given threshold: $c < z$

undernourished people = outcome of undernourishment

Definitions

Related concepts

- **vulnerability to food insecurity**: likelihood to fall below the threshold: Pr ($c < z$) > 0
  - chronic: Pr ($c < z$) = 1
  - transitory: 0 < Pr($c < z$) < 1 (temporary, seasonal)

  Difference between:
  - **risk**: uncertain event (shock) that might have a negative impact on individual welfare
  - **risk exposure**: likelihood a certain shock will happen
  - **vulnerability to risk**: likelihood a certain shock will translate into a welfare decrease

Definitions

Related concepts

- **malnutrition**: abnormal physiological condition caused by inadequate, unbalanced or excessive consumption of macronutrients and/or micronutrients, i.e. nutritional mismatch in qualitative and/or quantitative terms vis-à-vis a "normal" diet
  - undernutrition
  - overnutrition
  - micronutrients deficiency: iodine, iron, zinc, vitamin A, etc.

Conceptualization

Dimensions

- three (four) pillars:
  - availability
  - access
  - utilization
  - (stability)

    - each of them necessary but not sufficient condition for food security
    - inherently hierarchical: AV → AC → UT, … but also UT → AC → AC

Conceptualization

Availability

- supply side: global, national, local
- **Food Balance Sheet** (FBS): average level of food supply in a country over a given period of time

	PROD	+ IMP	+ STCH	- EXP	- FEED	- SEED	- PROC	WASTE	- OTHER	= FOOD	DES CALORIES PER PERSON / DAY (*)
	1000 MT / YEAR										
Grand Total											**2414**
Cereals (excl. Beer)	19973.7	1116.5	-355.7	6673.9	5211.8	434.7	407.5	969.4	9.7	7027.8	1114.2
Starchy Roots	16956.2	133.8	-1053.9	13525.9	0.4	0.9	143.7	1350.1	3.7	1011.4	45.2
Sugar crops	53406.6		-1333.3	0.3			43698.3	2753.7		5621.0	73.0
Sugar & Sweeteners	5267.7	11.3	-136.6	3360.6					13.0	1776.6	283.2
Pulses	269.5	5.7		37.9		21.9		8.2		207.3	31.5
Treenuts	54.0	2.2		15.8						40.5	6.5
Oil crops	2337.2	873.5	-198.7	38.5	1.0	14.3	1735.2	135.9		1087.5	100.1
Vegetable Oils	819.9	66.3	-149.9	116.5					272.8	348.7	137.9
Vegetables	2753.0	25.3		372.1			0.0	245.7		2163.9	26.8
Fruits (excl. Wine)	7270.5	55.9	0.2	1173.2			14.5	566.7		5574.7	114.4
Stimulants	78.1	21.4	-6.7	64.6						28.5	0.9
Spices	67.1	7.2		20.9				1.9		51.6	6.9
Alcoholic Beverages	2114.9	28.4		78.9					24.0	2040.4	163.4
Honey	3.0	0.2		1.6						1.6	0.2
Meat	1902.5	3.3		271.6				20.7		1614.8	150.9
Offals	75.7	2.8		0.4						77.7	3.8
Animal Fats	31.8	19.1		0.7					5.6	44.6	15.6
Milk (excl. Butter)	409.4	1095.4		81.1				12.3	12.0	1400.1	32.1
Eggs	812.0	1.3		6.8		137.4		40.6		628.4	42.6
Fish, Seafood	3458.0	532.1	1.7	809.3	1185.9					1996.5	62.2
Aquatic Products	30.1	0.5		14.5						16.1	0.2
Miscellaneous											2.1

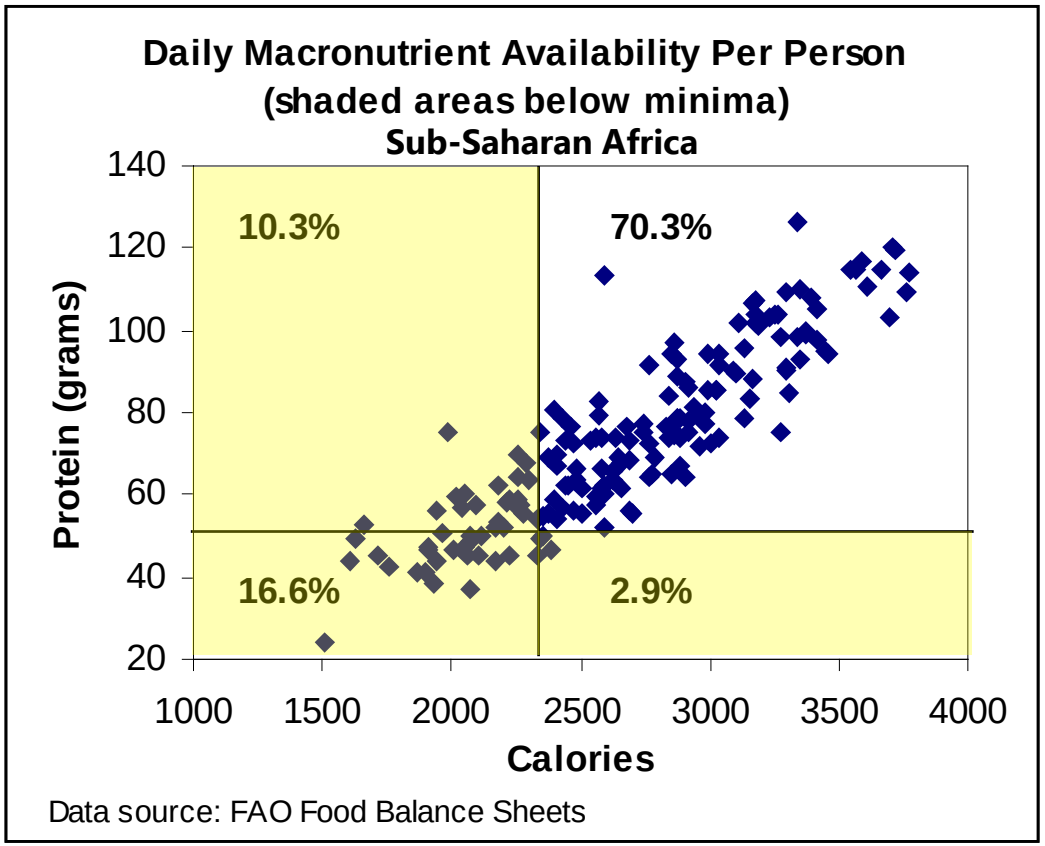
(*) Food quantities converted into energy values and divided by total population and by 365 days.

- food supply (*FQ*):
  $$FQ_i = P_i + M_i - X_i + SC_i - W_i - S_i - I_i - O_i$$
- conversion in energy value (*EV*):
  $$FQ_i \cdot CF_i = EV_i$$
- aggregation across all food items and division by population:
  $$\frac{\sum_i EV_i}{POP \cdot 365} = DES = \mu_x$$

Conceptualization

Availability

- supply side: global, national, local



Conceptualization

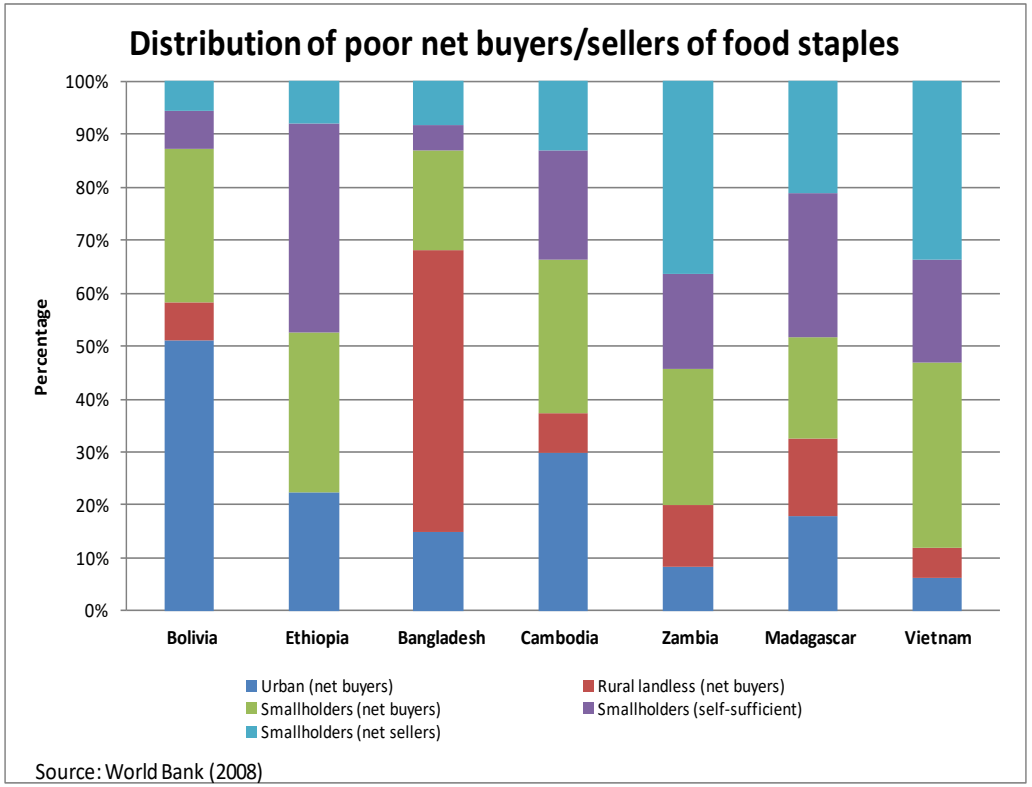
Access

- physical and economic access: well-being
- demand side, in relation to availability
  - range of food choices open to the person(s), given their income, prevailing prices, and formal or informal safety net arrangements through which they can access food
  - A. Sen's ***entitlements*** (*Poverty and famines*, 1981)

Conceptualization

Access

- higher food prices will benefit farmers?
  - net buyers vs. net sellers (no more than 1/3)



Conceptualization

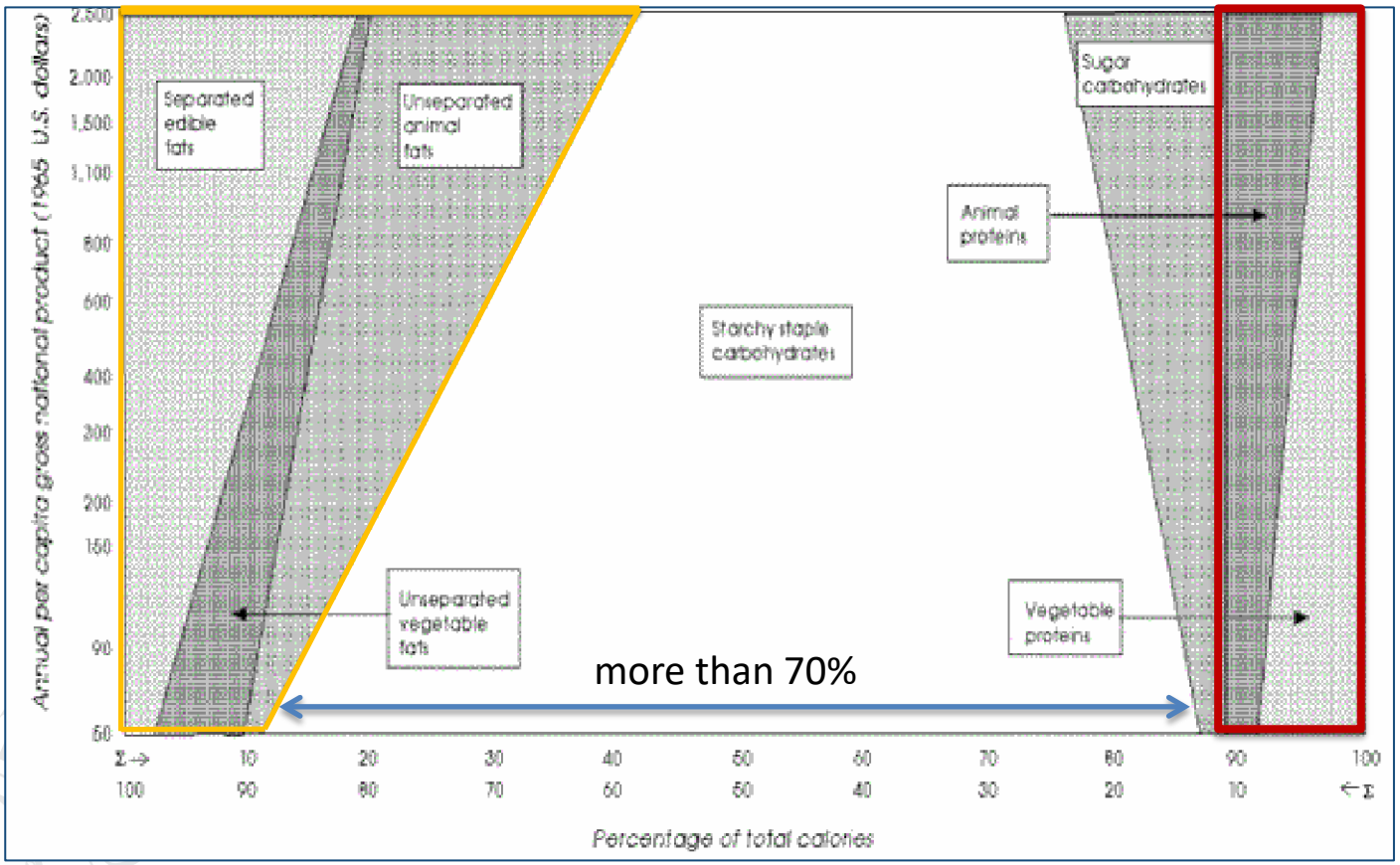
Utilization

- use of the food to which people have access
  - nutritional balanced diet, esp. micronutrients (minerals and vitamins)
  - preparation
  - safety

Conceptualization

Utilization

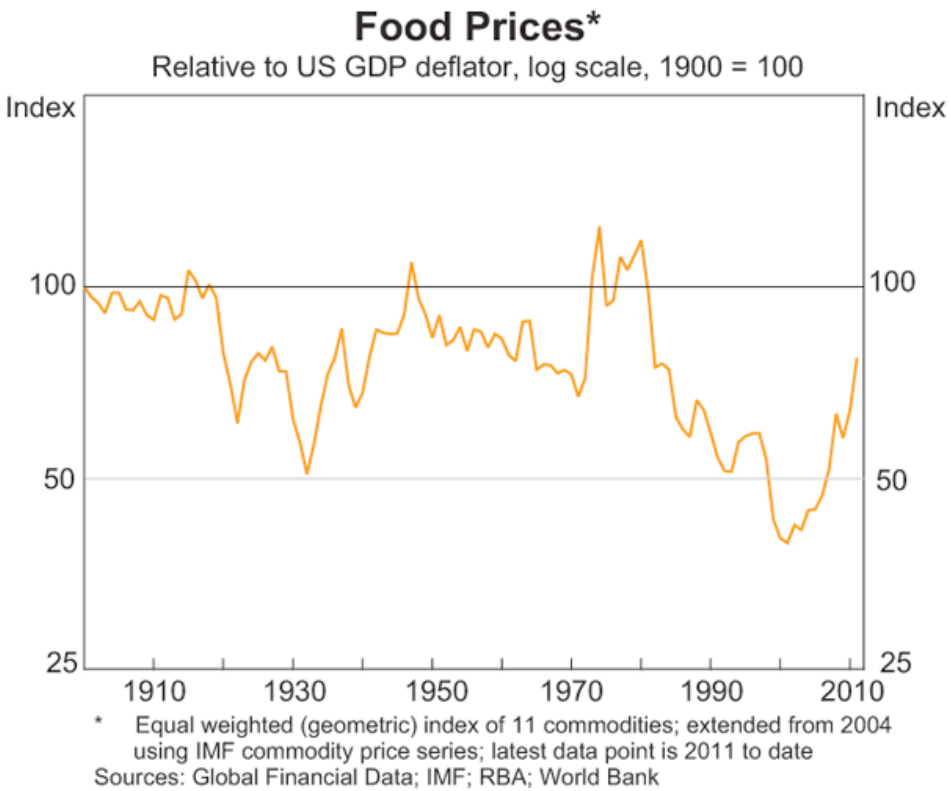
- food consumption pattern



Conceptualization

Stability (FAO)

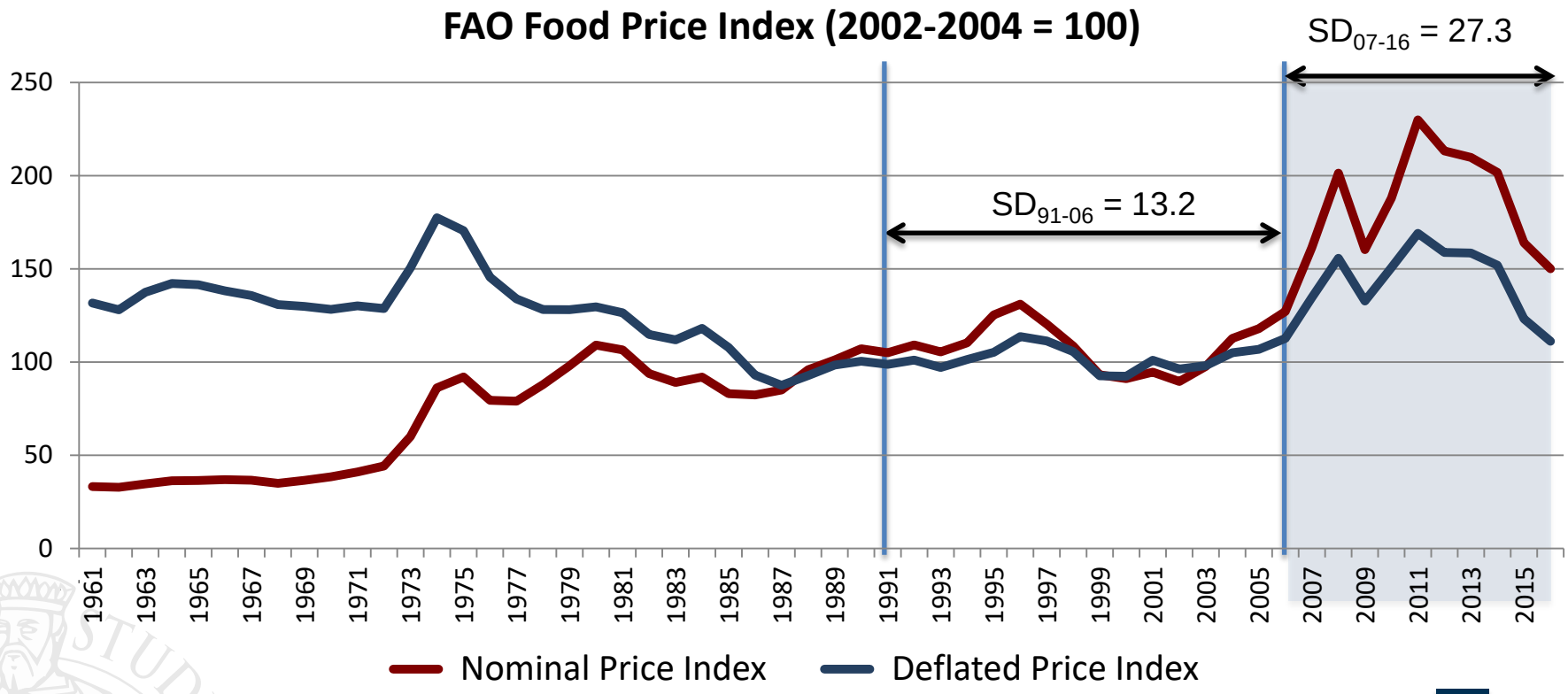
- secular decreasing trend
- … but quite volatile



Conceptualization

Stability (FAO)

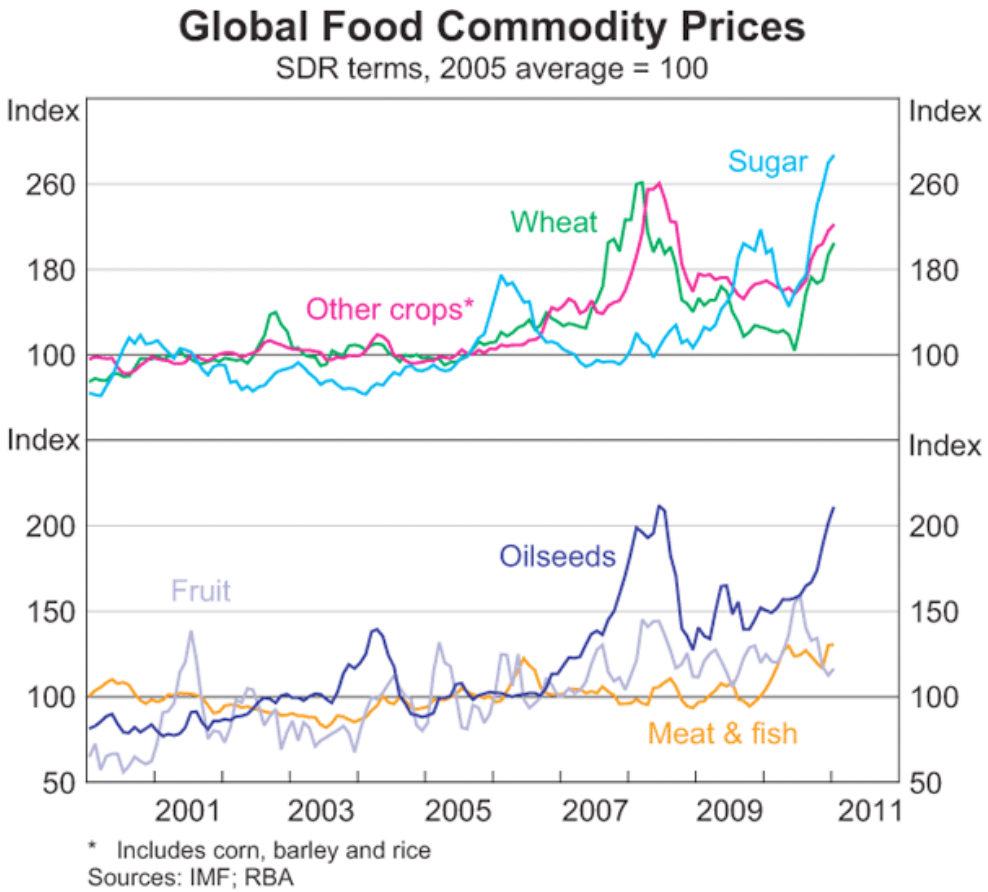
- volatility of food commodity prices



Conceptualization

Stability (FAO)

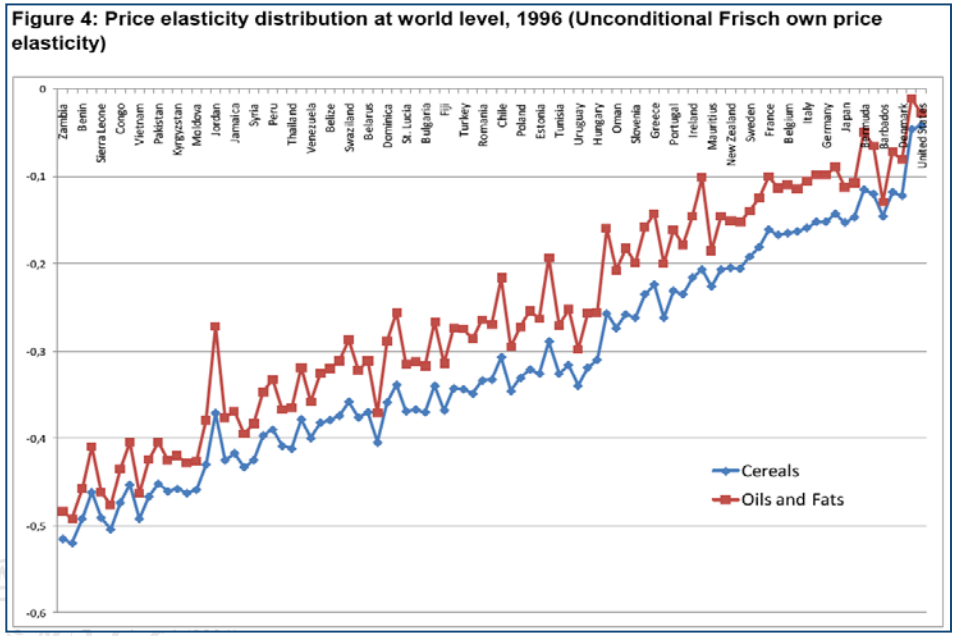
- volatility of food commodity prices

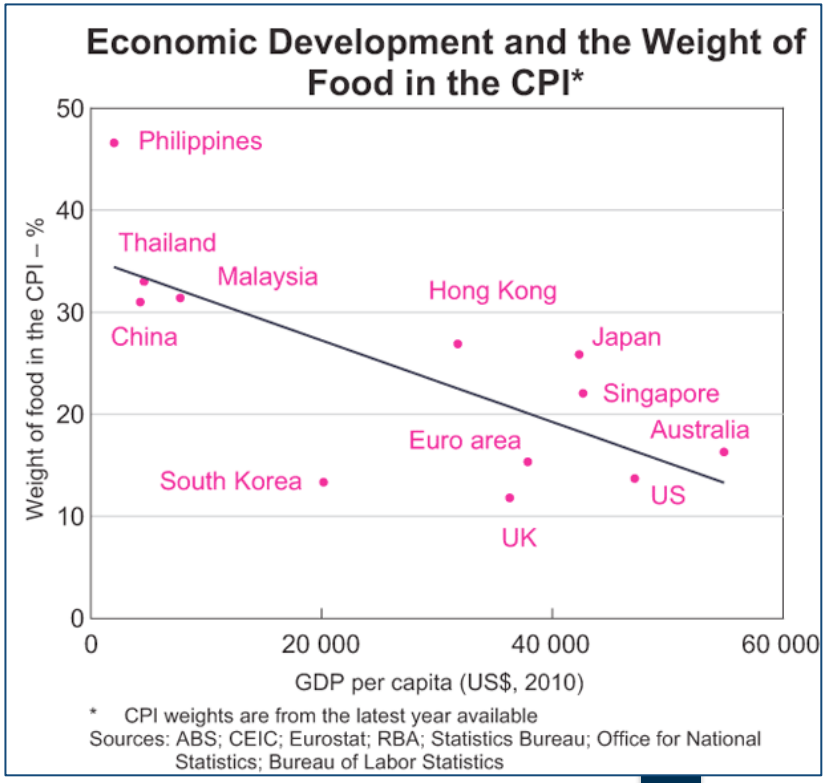


Conceptualization

Stability (FAO)

- susceptibility of individuals to food price volatility





Analysis

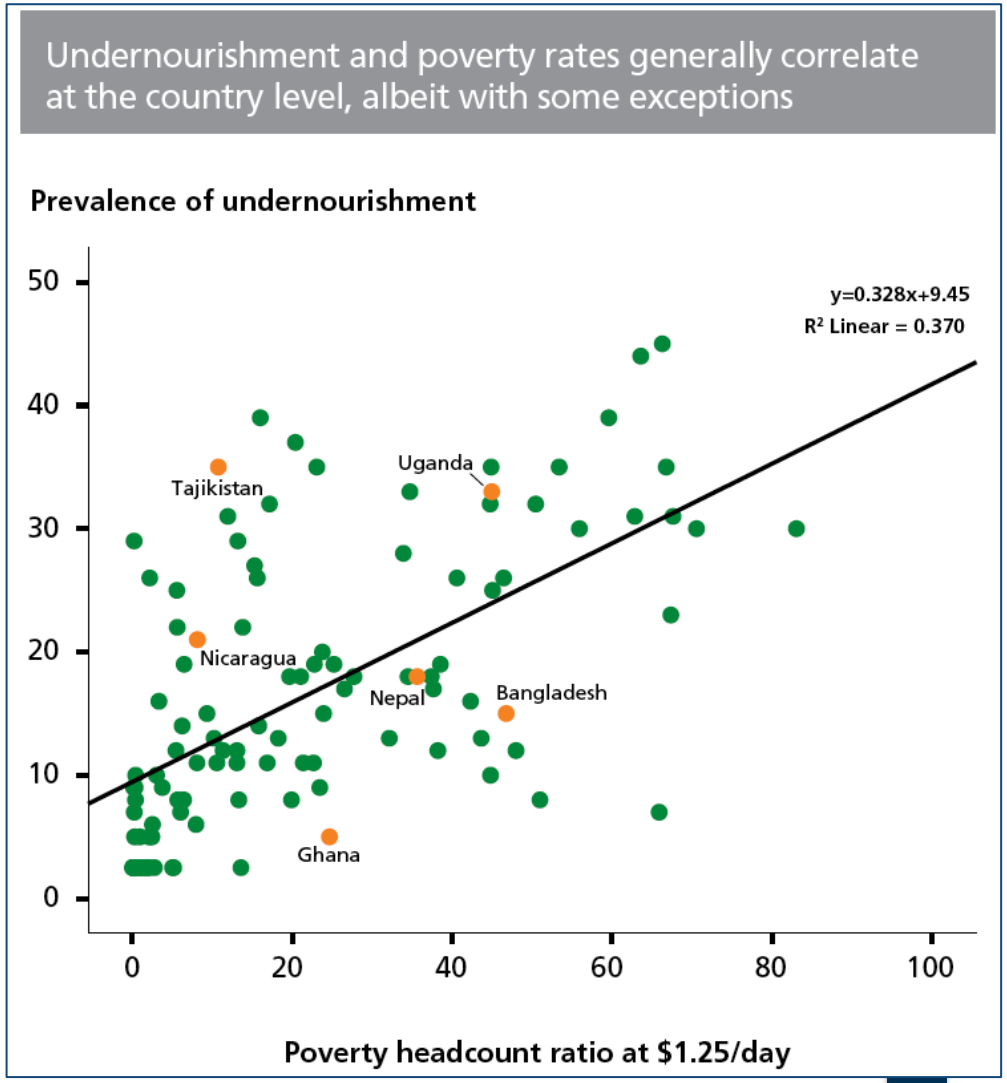
A paradigm shift

- from a more aggregate, higher level (global/country) to a more disaggregated, lower level (household/individual)
  - until 70s: focus on food supply, country self-sufficiency, food stocks, stabilization schemes
  - 80s-90s: focus on food access and entitlements, inter-household distribution
  - from 90s on: focus on food access by the individual within the household, intra-household distribution
  - today: back to 70s?

Analysis

Poverty vs. food insecurity

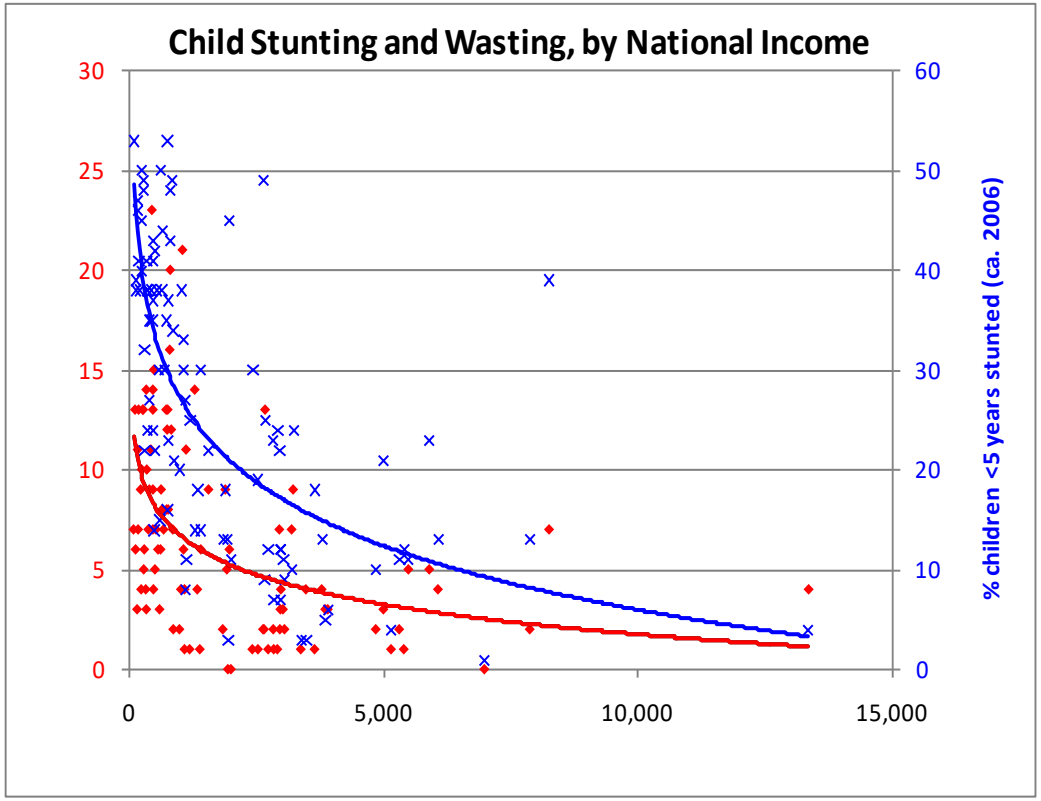
- food insecurity is a dimension of poverty (MDG #1)
- highly correlated: the poor are more vulnerable to food insecurity than the non-poor



Analysis

Poverty vs. food insecurity

- food insecurity is a dimension of poverty (MDG #1)
- highly correlated: the poor are more vulnerable to food insecurity than the non-poor



Analysis

From food availability to food entitlement

«Starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat. While the latter can be a cause of the former, it is but one of many *possible* causes. Whether and how starvation relates to food supply is a matter for factual investigation.» (Sen, 1981: 1, emphasis original)

- food availability → self-sufficiency
  - focus on domestic production, but supply includes also food import and food aid
  - focus on aggregate domestic production, but access (and stability) is key for food security (individuals)

Analysis

Entitlement approach (Sen, 1981)

«Starvation is the characteristic of some people not *having* enough food to eat. It is not the characteristic of there *being* not enough food to eat. While the latter can be a cause of the former, it is but one of many *possible* causes. Whether and how starvation relates to food supply is a matter for factual investigation.» (Sen, 1981: 1, emphasis original)

- Ireland (1846-47), China (1959-61), Wollo (1973): (*food availability decline*, FAD)
- Great Bengal famine (1943-44)
- Bangladesh (1974-75)

Analysis

Entitlement approach (Sen, 1981)

«Food supply statements say things about a commodity (or a group of commodities) considered on its own. Starvation statements are about the *relationship* of persons to the commodity (or that commodity group). Leaving out cases in which a person may deliberately starve, starvation statements translate readily into statements of ownership of food by persons. In order to understand starvation, it is, therefore, necessary to go into the structure of ownership.»

«Ownership relations are one kind of *entitlement* relations. It is necessary to understand the entitlement systems within which the problem of starvation is to be analysed. This applies *more generally* to poverty as such, and *more specifically* to famines as well. … An entitlement relation applied to ownership connects one set of ownerships to another through certain rules of legitimacy. It is a recursive relation and the process of connecting can be repeated.» (Sen, 1981: 1, emphasis original)

Analysis

Entitlement approach (Sen, 1981)

- Four entitlements
  - **own-labour** entitlement
  - **production-based** entitlement
  - **trade-based** entitlement
  - **inheritance and transfer** entitlement

Analysis

Entitlement approach (Sen, 1981)

- Two important concepts
  - **initial endowments**, representing the individual starting position
  - **exchange entitlement mapping**, i.e. the transformation modalities (Stiglitz's "architecture" of the economic system):
    - the price system
    - legal structure
    - institutions (formal and informal)

Analysis

Addressing food and nutrition issues is complex

«Life is better now than at almost any time in history. More people are richer and fewer people live in dire poverty. Lives are longer and parents no longer routinely watch a quarter of their children die. Yet millions still experience the horrors of destitution and of premature death. *The world is hugely unequal*.» (Deaton, 2013: 1, emphasis added)

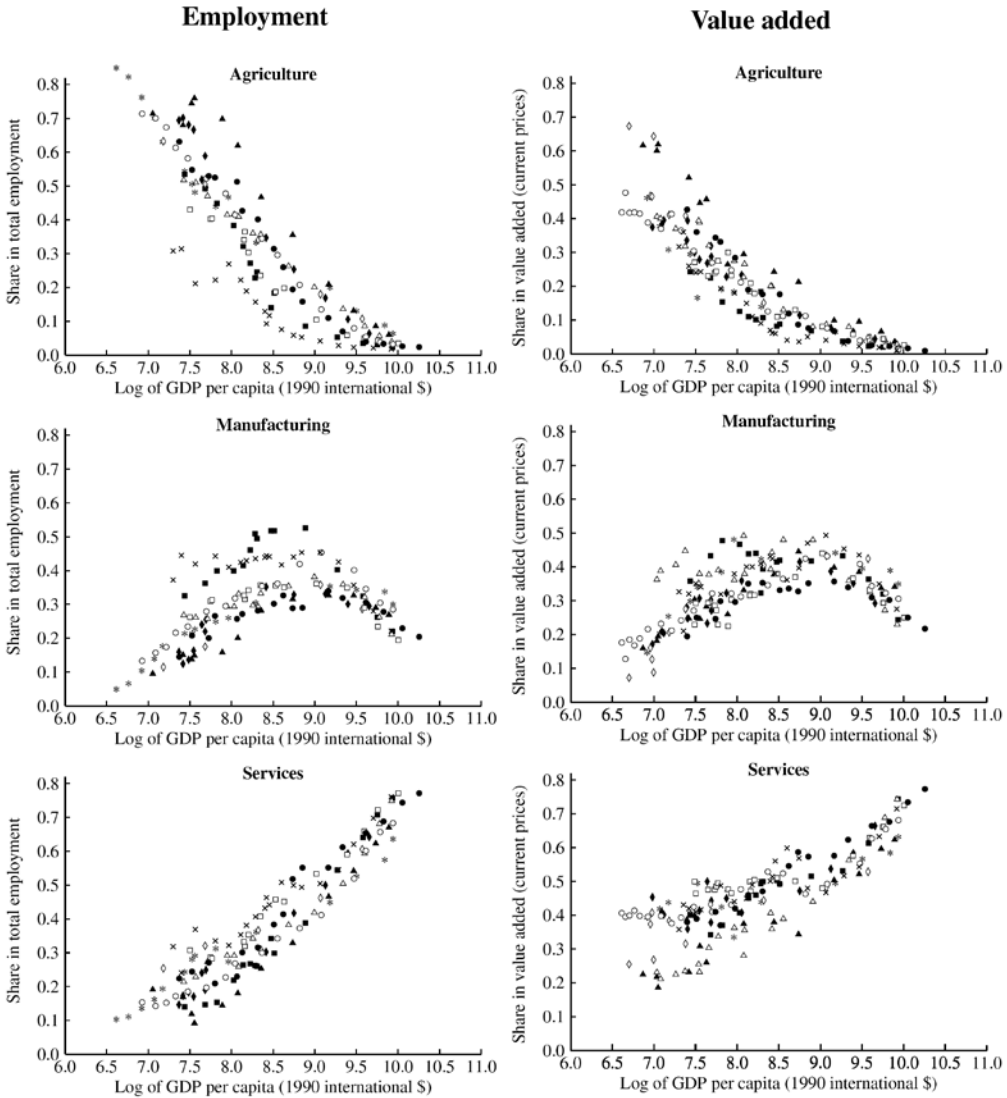
- Malnutrition remains the world's leading cause of death and disability
- It is hard to eradicate, partly because it has different causes in different people (AV, AC, UT and NEEDS)

Changing patterns in economic growth

Structural change

Herrendorf *et al*., (2013)
Handbook of Growth Economics

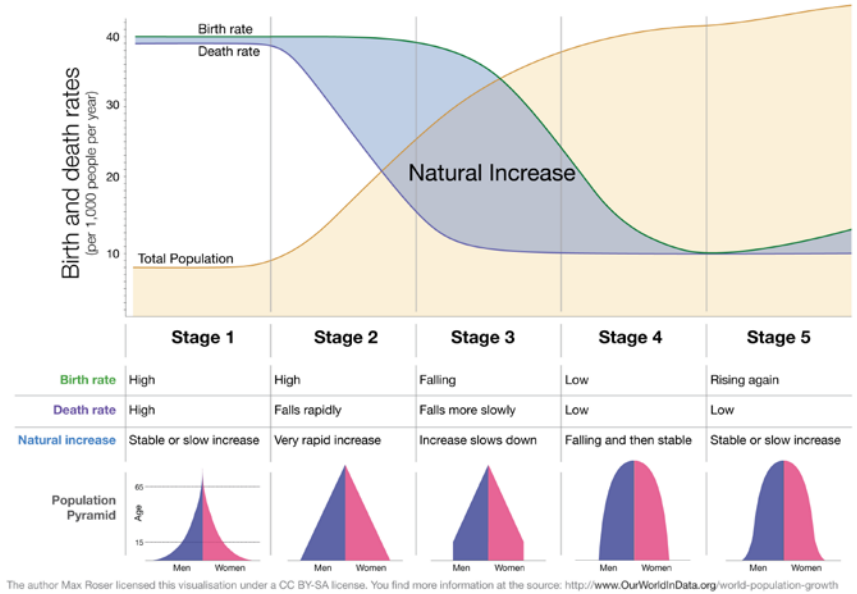
Selected DCs,
long time series
1800-2000



■■■ Belgium ♦♦♦ Spain ▲▲▲ Finland
◊◊◊ Korea □□□ Netherland ○○○ Sweden
△△△ France ∗∗∗ Japan
×××United Kingdom ●●● United States

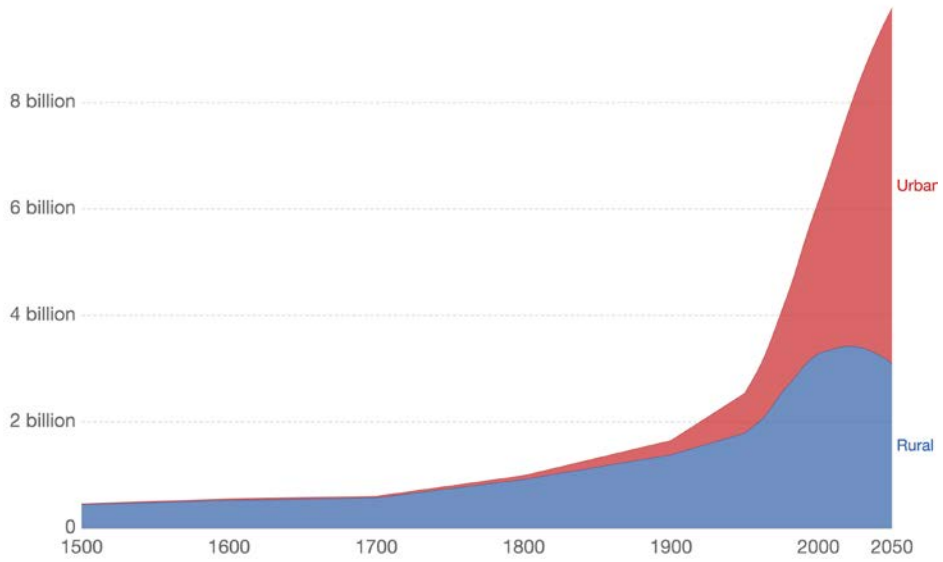
Changing patterns in economic growth

Demographic transition



Changing world pop composition, e.g. dependency ratio

Urbanization

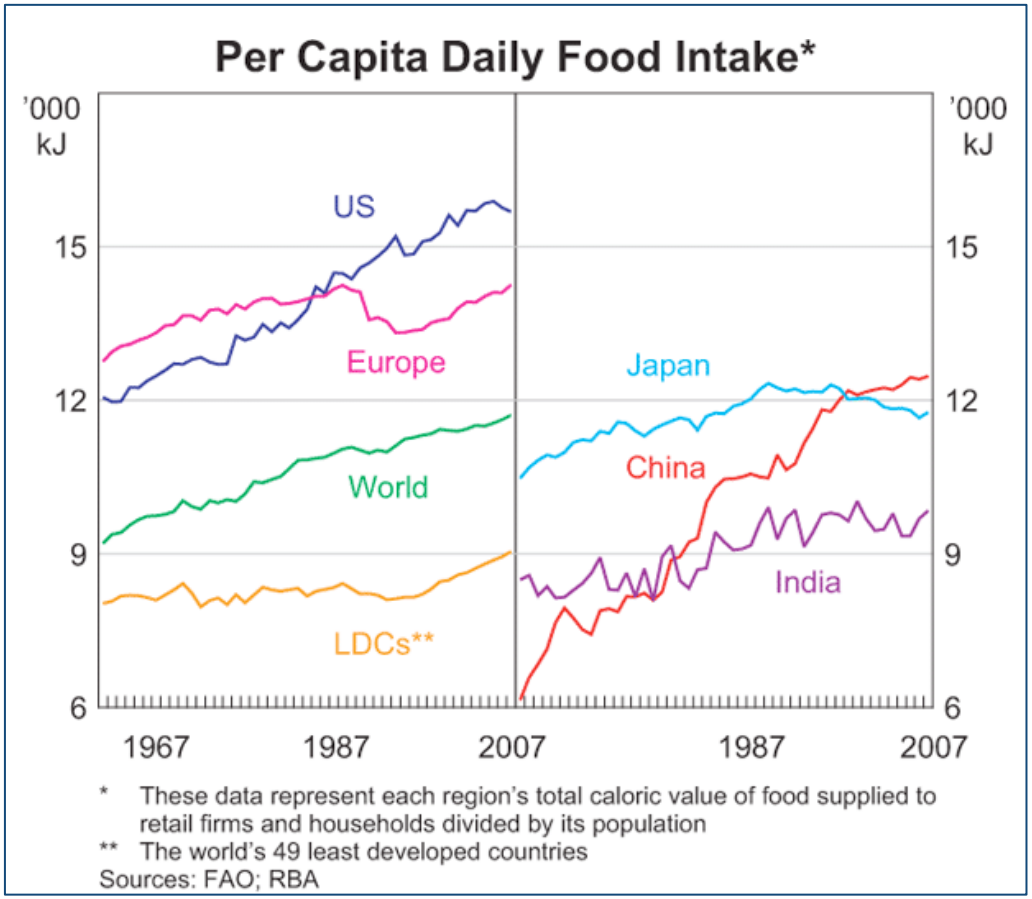


Separation between food production and consumption

Changing patterns in economic growth

Engel's law

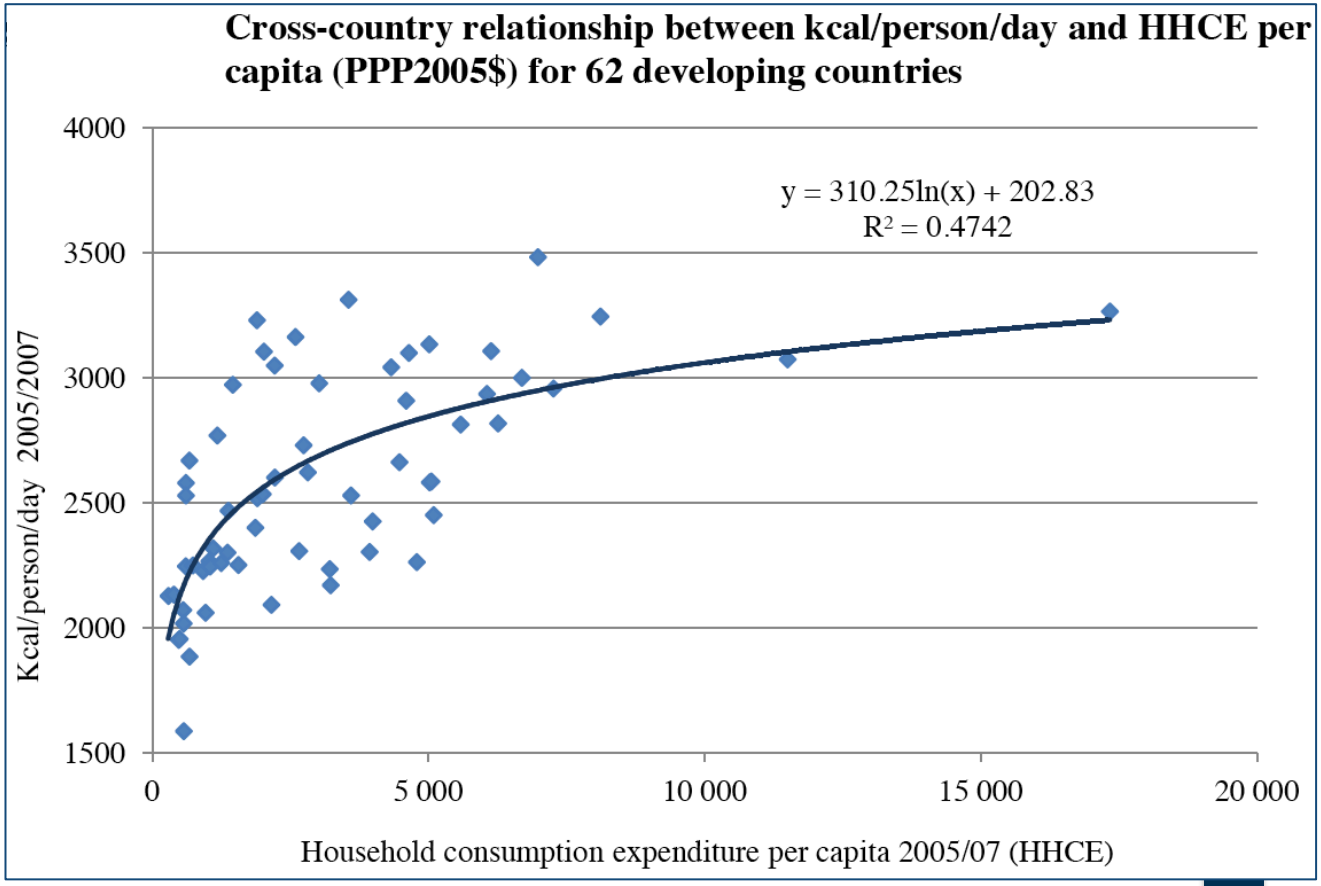
- as income rises, food consumption grows …



Changing patterns in economic growth

Engel's law

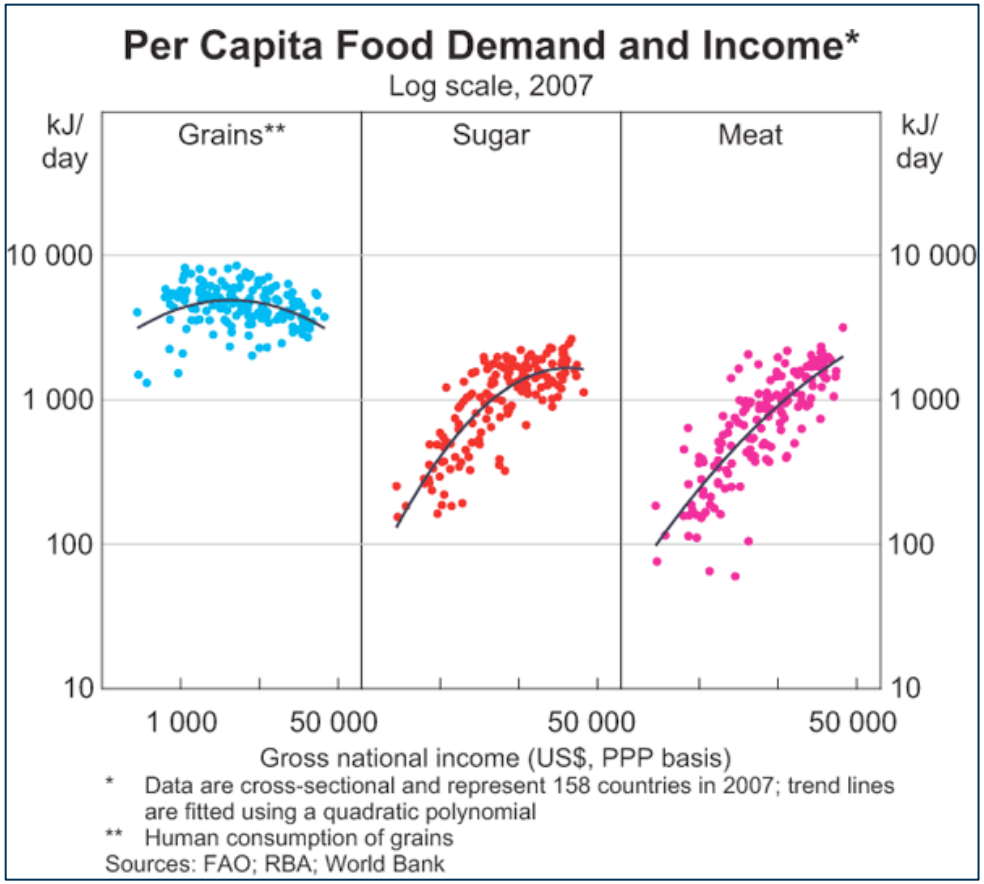
- … but les than proportionally



Changing patterns in economic growth

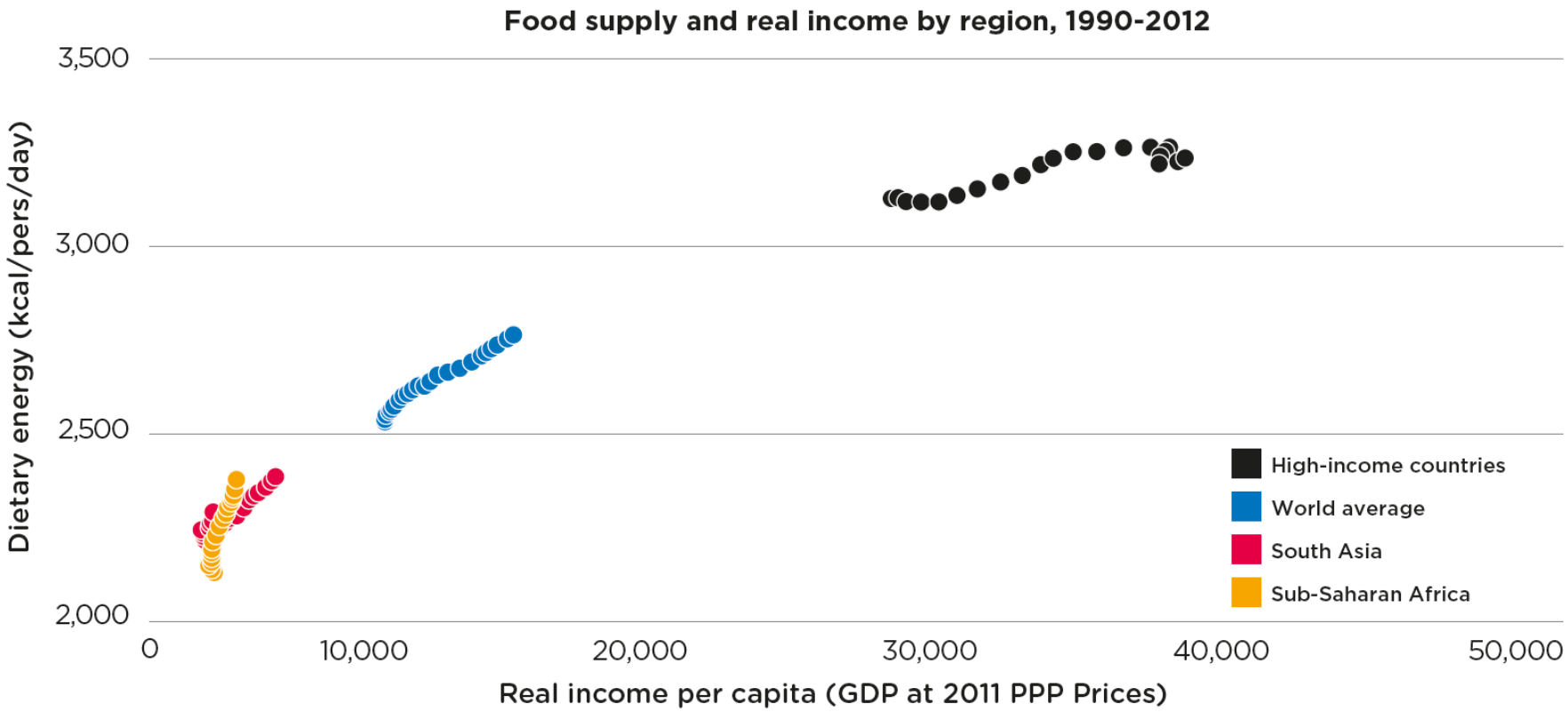
Engel's law

- as income rises, the proportion of income spent on food falls



Changing patterns in economic growth

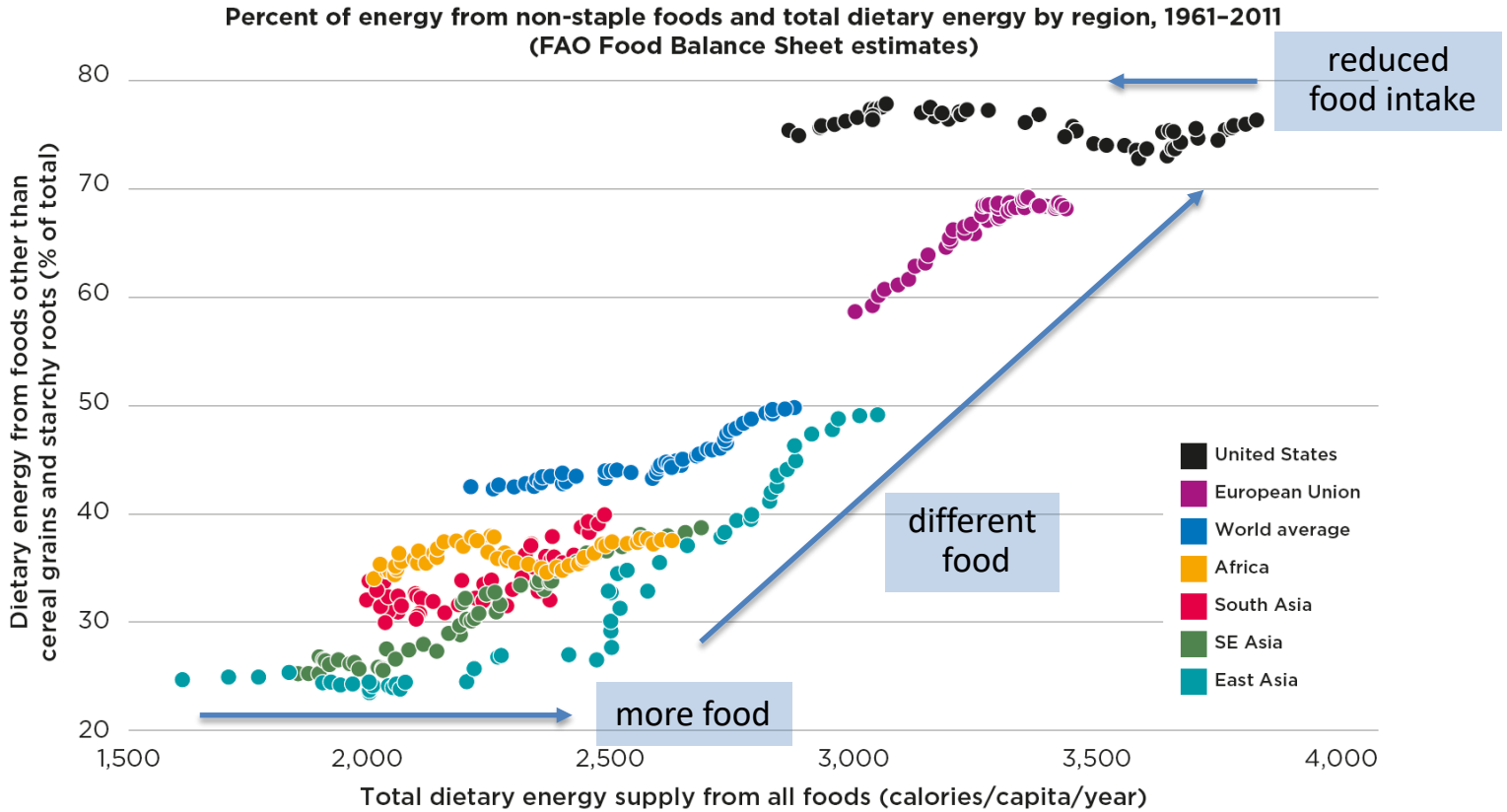
Food transition



- Africa and South Asia still have far to go

Changing patterns in economic growth

Food transition



- food consumption shifts to meet nutrient needs mostly from foods other than starchy staples

The complexity of malnutrition

Multiple causes

	Covariate	Idiosyncratic
Chronic	Low domestic agricultural productivity	Income poverty, Market access
Transitory	Food price surge	Livelihood disruption, Market access

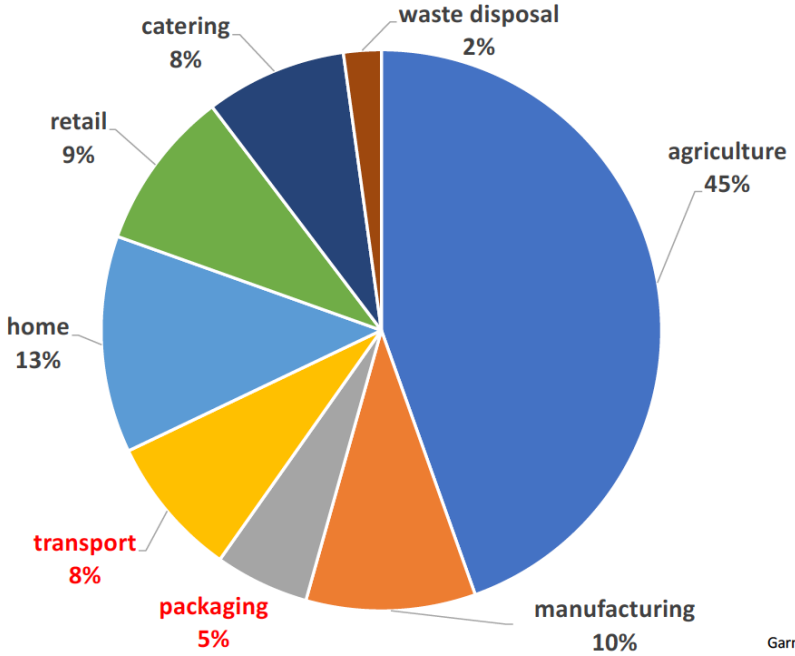
The complexity of malnutrition

Multiple effects

The complexity of malnutrition

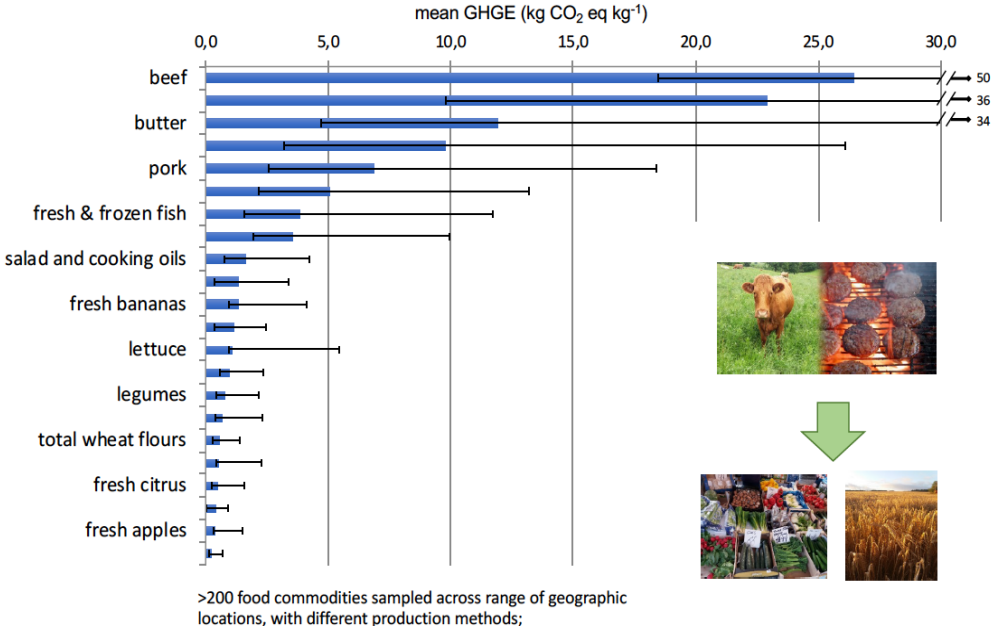
Climate change

Share of GHG emissions in the food system



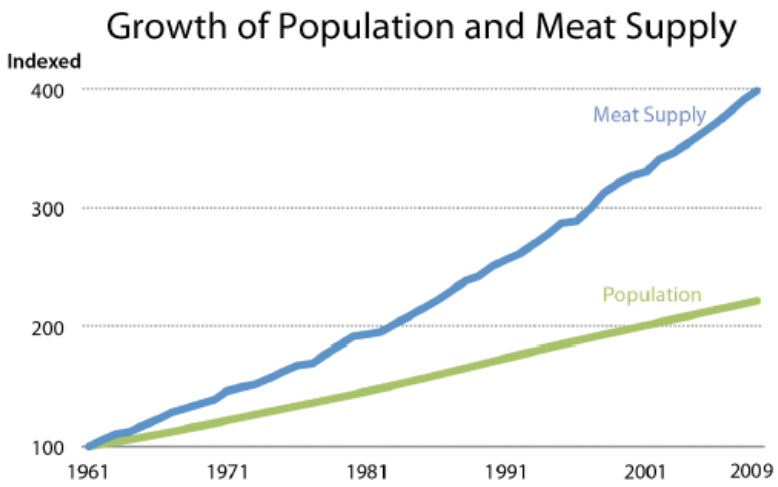
Garnett

GHG emissions

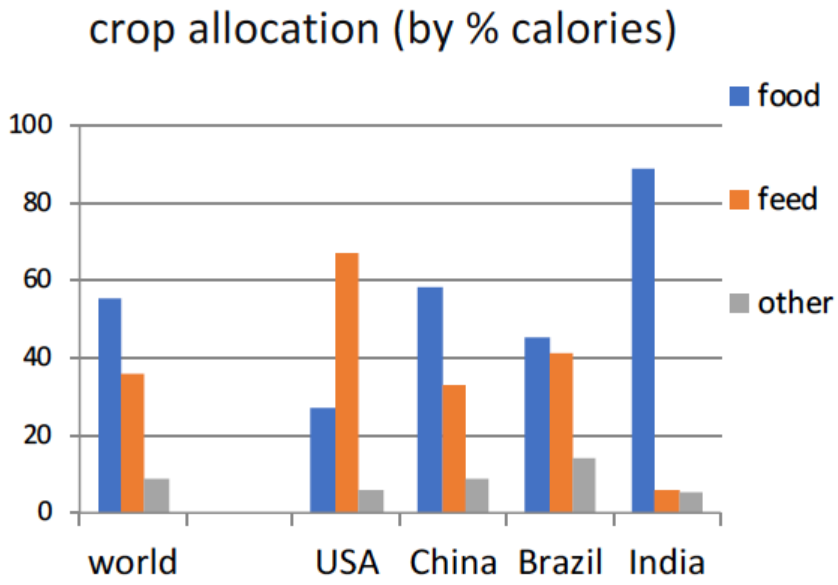


The complexity of malnutrition

Industry, resources



Growth of population and meat supply, Indexed 1961=100 (FAO 2012a, UN 2012)

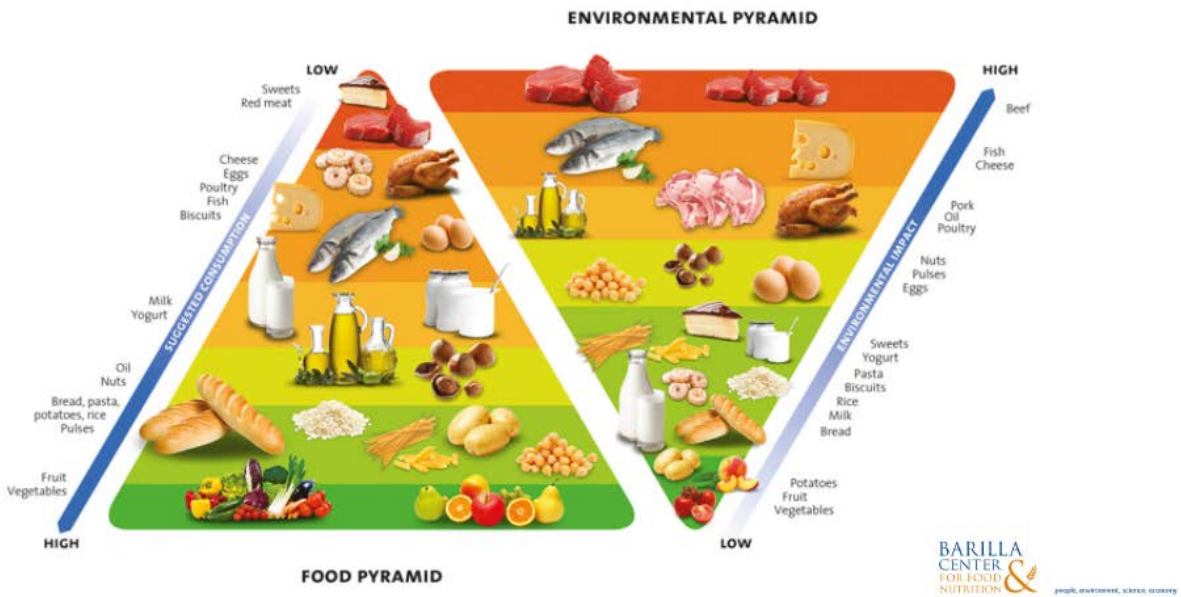


- 70% of global agricultural land is used for livestock
- methane production by ruminants

The complexity of malnutrition

Sustainable diets

- Diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations



The complexity of malnutrition

Culture, identity

vs.

The complexity of malnutrition

Economics, politics

Climate activist Greta Thunberg meets Pope Francis at Saint Peter's Square at the Vatican, April 17, 2019. | Photo: Reuters

vs.

The complexity of malnutrition

The challenge is to join-up sectors

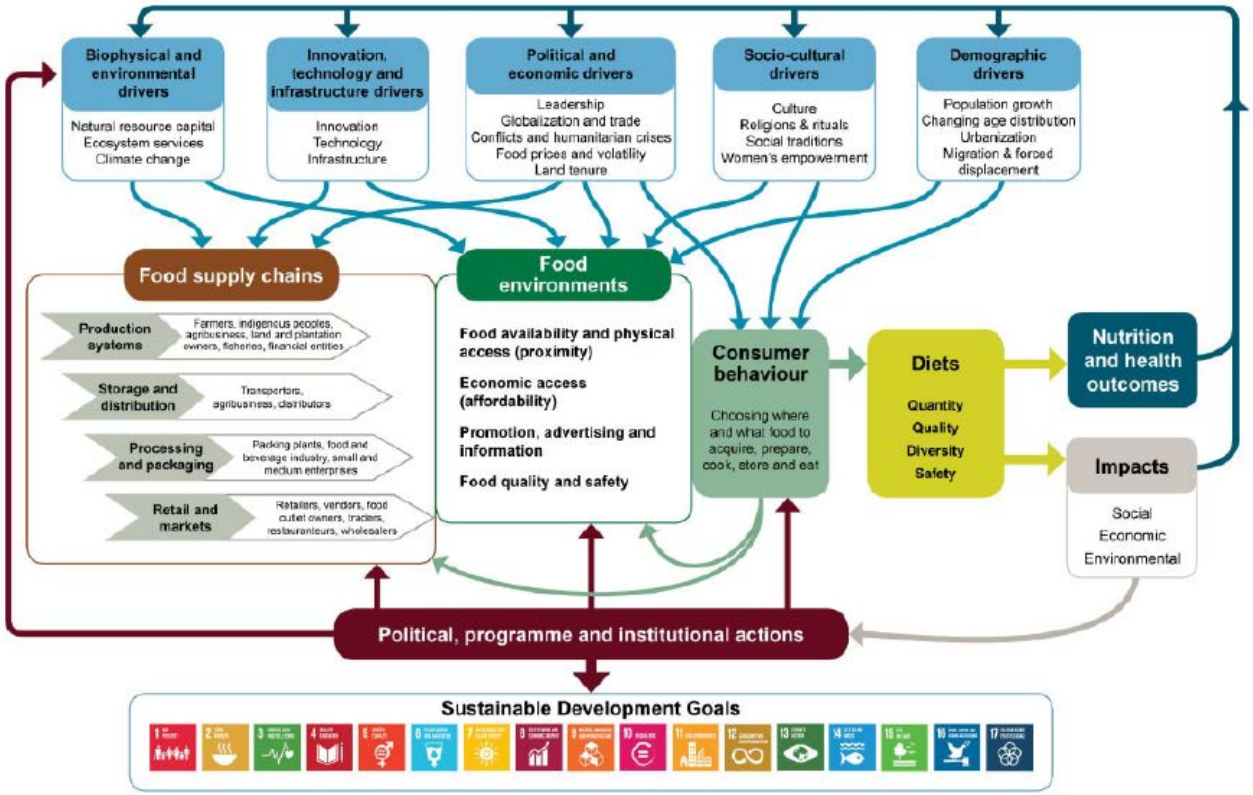
HARD!

Tradeoffs
Tensions

Policy implications

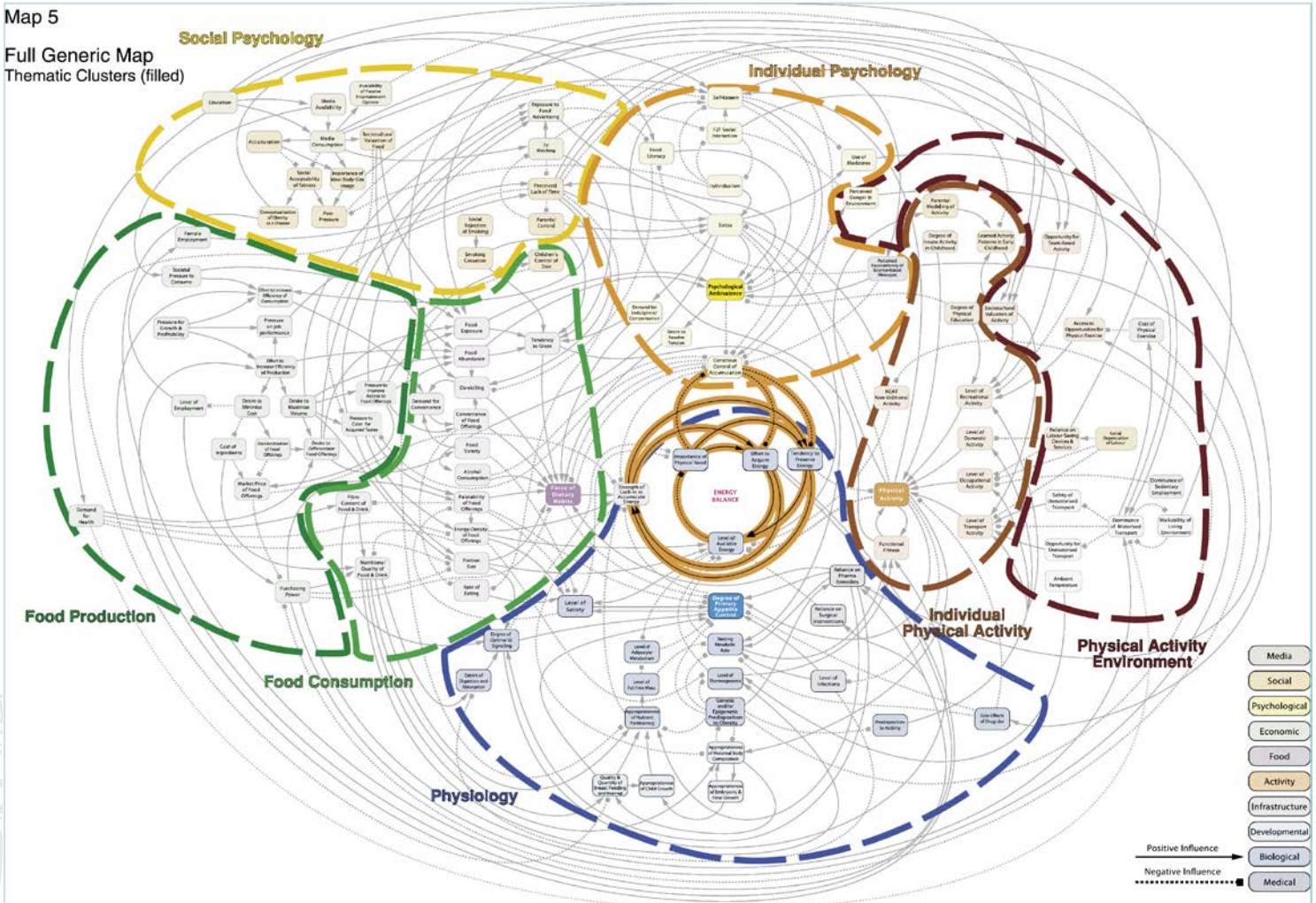
Complexity: No silver bullet

- Need for a systemic approach
- Need for inter-/multi-disciplinary approaches



Policy implications

Complexity: the case of obesity #1



Policy implications

Complexity: the case of obesity #2

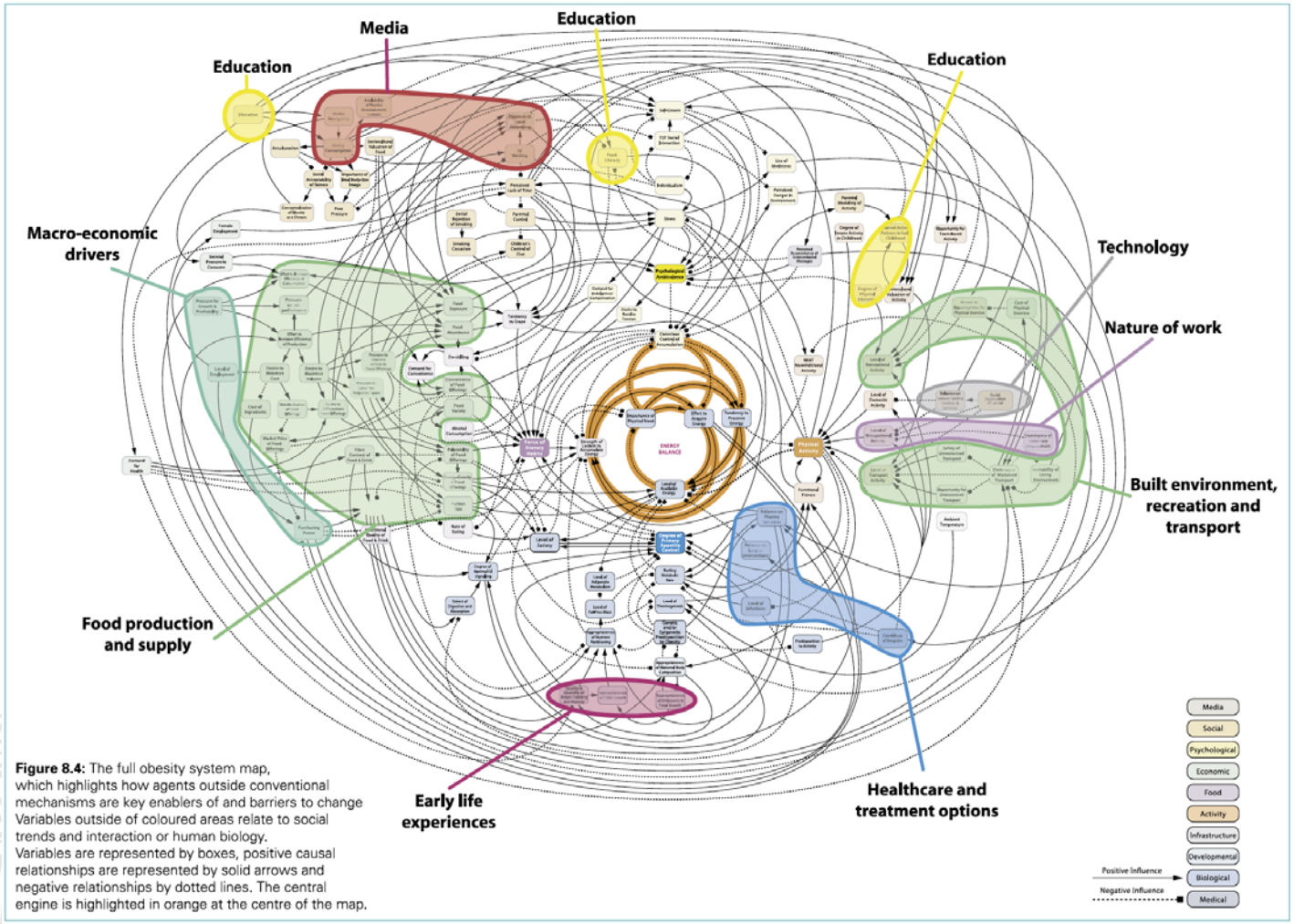
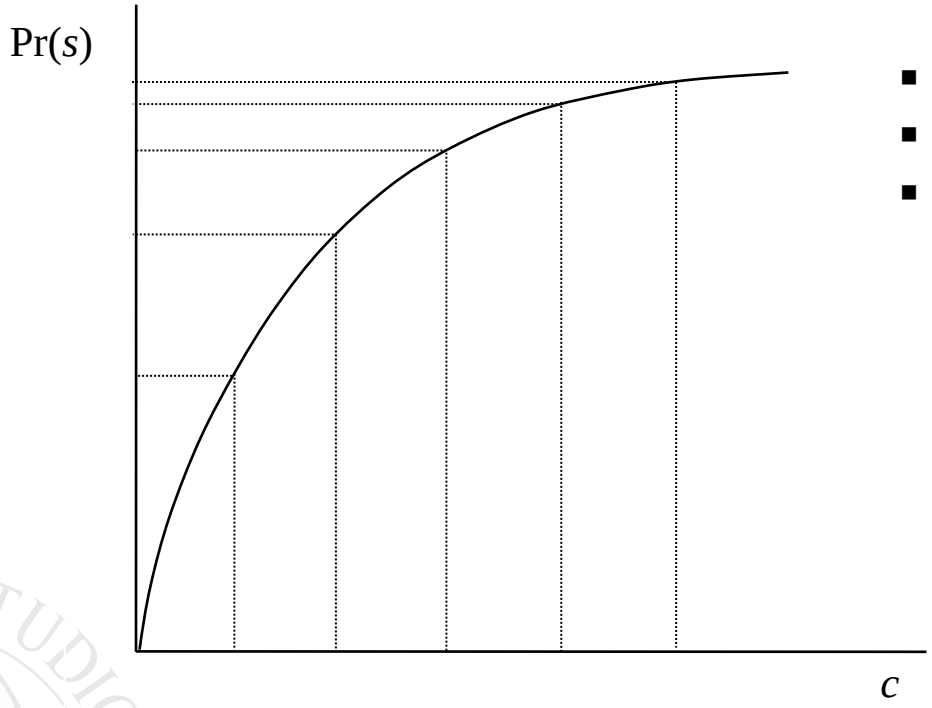


Figure 8.4: The full obesity system map, which highlights how agents outside conventional mechanisms are key enablers of and barriers to change Variables outside of coloured areas relate to social trends and interaction or human biology. Variables are represented by boxes, positive causal relationships are represented by solid arrows and negative relationships by dotted lines. The central engine is highlighted in orange at the centre of the map.

Policy implications

Non linearity of impacts

- survival function concave in food consumption and individual health status (Ravallion, 1997)



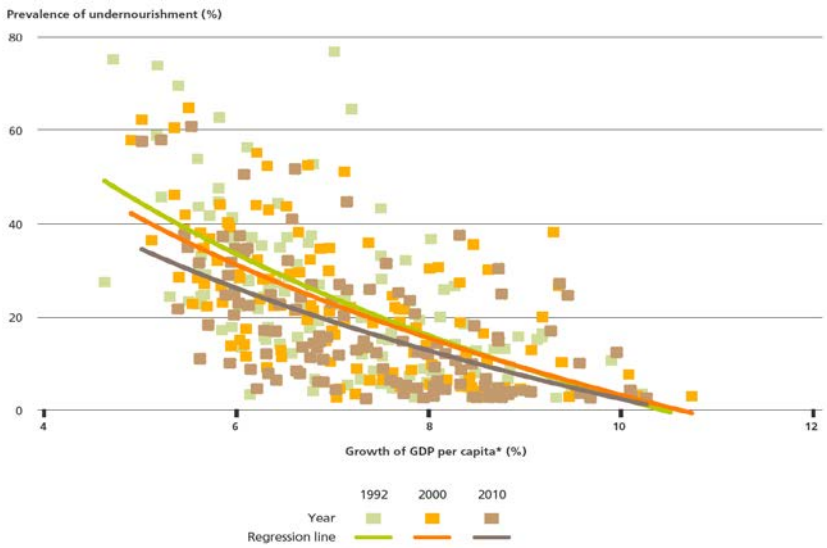
- gain from consumption stabilization
- gain from early warning
- many determinants: not a single shock, importance of consumption recent history of vulnerable groups

Policy implications

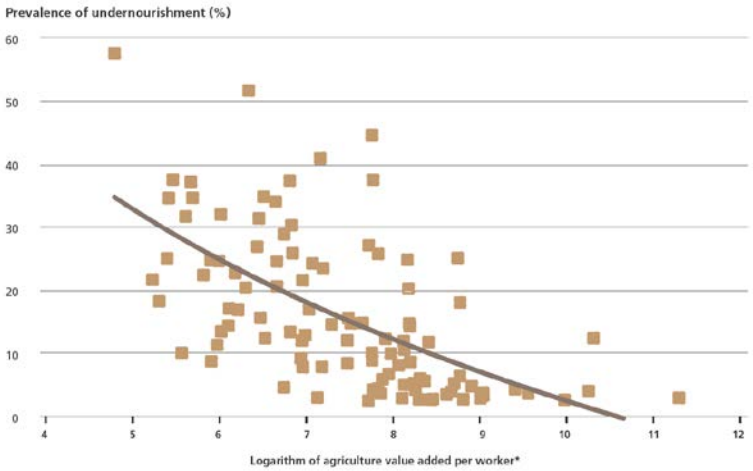
Determinants of undernourishment reduction

- inclusive economic growth
- agricultural yields growth

} **via poverty reduction**



inclusive growth



agricultural yields

Selected readings

- Deaton, A. (2013). *The Great Escape: Health, Wealth, and the Origins of Inequality*. New Haven, CT: Princeton University Press.
- FAO, IFAD, UNICEF, WFP and WHO (2019). *The State of Food Security and Nutrition in the World 2019*. Rome: FAO.
- Safeguarding against economic slowdowns and downturns. Rome, FAO.
- Finaret, A.B., and Masters, W.A. (2019). Beyond Calories: The New Economics of Nutrition. *Annual Review of Resource Economics* 11: 237-259.
- Masters, W.A. (2016). "The Economic Causes of Malnutrition". In Eggersdorfer M., Kraemer K., Cordaro J.B., Fanzo J., Gibney M., Kennedy E., Labrique A., and Steffen J. (eds.). *Good Nutrition: Perspectives for the 21st Century*. Basel: Karger, pp. 92–104.
- Popkin, B.M., Corvalan, C., and Grummer-Strawn, L.M. (2019). Dynamics of the Double Burden of Malnutrition and the Changing Nutrition Reality. *The Lancet* December 15, 2019
- Sen, A. (1982). *Poverty and Famines: An Essay on Entitlement and Deprivation*. New York: Oxford University Press.

Thanks a lot for your attention

donato.romano@unifi.it