



Consumer demand for healthy diets:

Modeling the impact of food access on consumption

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Motivation

- This work is part of the *Food Prices for Nutrition* project, which tries to measure *food access*
 - Food access is driven by income (household earnings plus safety net transfers) and prices of available items
 - Actual consumption is driven by other factors: individual time use and preferences; food culture and aspirations, preferences for animal-sourced foods
- This paper begins to explore how improved access might affect actual consumption
 - Improved access could come from:
 - lower prices for healthy items
 - higher income from employment, or safety nets and nutrition assistance
- But, since people cannot see, taste or smell the healthiness of food, what drives food choice?
 - Income elasticity for healthy foods may be low or even negative
 - Price elasticity for healthy foods may be low, so little impact of availability & price
 - Need estimates of changes in consumption as incomes rise and prices change

Will access to healthy foods raise diet quality?

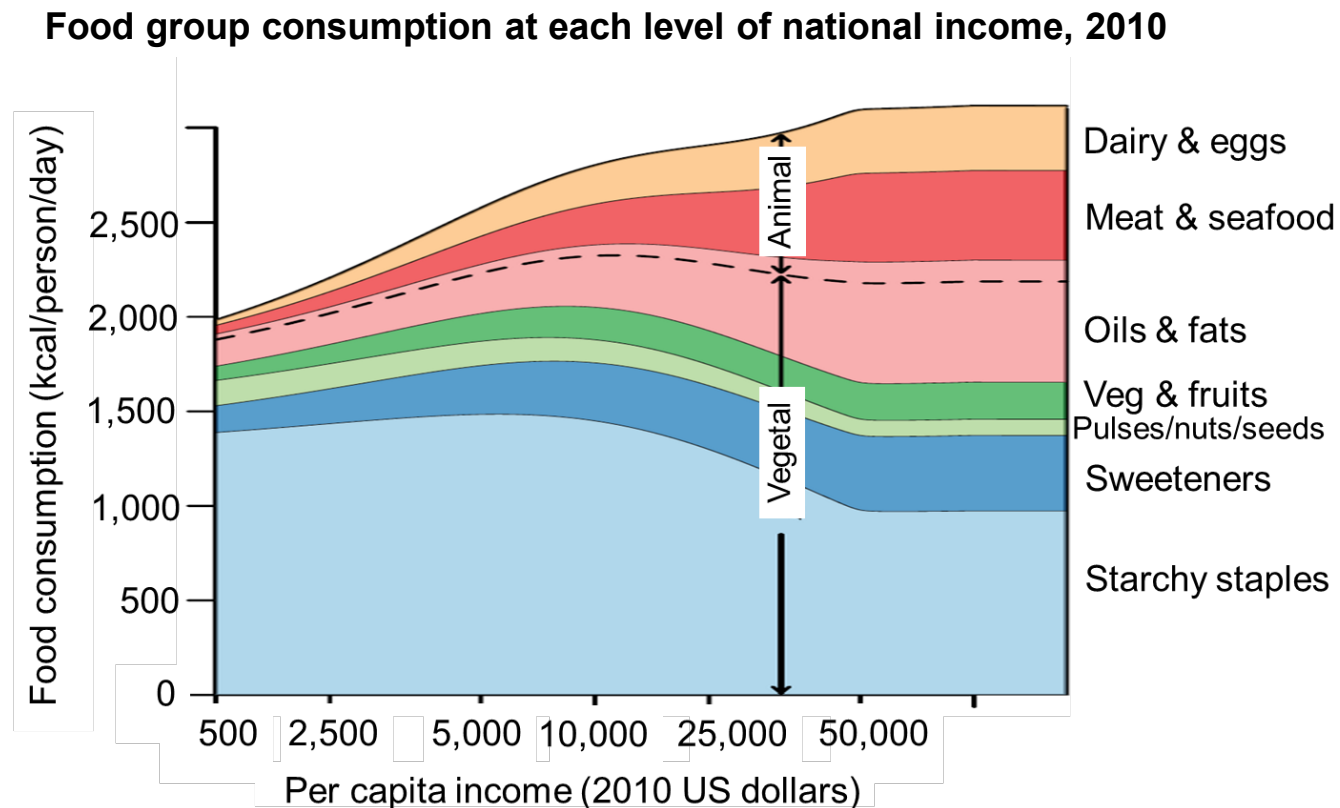
- There is a big literature on this, using diverse metrics for diet quality and food access
 - mostly location-specific studies, conditional on a particular context
 - mostly specific aspects of diet quality or food access, not the big picture
- To advance *Food Prices for Nutrition* work, we want:
 - diet quality measured relative to a healthy diet basket
 - food access measured as market prices and household income
 - preferences measured in a consistent way for all the world's people
- This initial paper uses:
 - a complete demand system for all foods, healthy & unhealthy, developed to study dietary transition between food groups by Gouel & Guimard (2018)
 - preferences are a global average for all people in cross-section around 2010, as derived demand for traded farm commodities to guide global agriculture

Data and Methods

- Use a flexible representation of the effects of income growth on diets
 - To capture the nutritional transition
- Use a Healthy Diet Basket Index (HDBI) to quantify the nutritional consequences of diets
 - Like a production function for health
- Look at dietary patterns at different points on the global distribution of income
- Examine what changes in food prices would be needed to improve diet quality at different levels of income

Representing the nutritional transition

- Food preferences based on the demand system estimated by Gouel & Guimard (2018)
 - global average demand for agricultural products, derived from final use
 - estimated from each country's quantity used from food balance sheets in 2010, at trade unit values of each farm product from Berthou and Emlinger (2011)
- Income effects as in Figure:
 - Use a MAIDADS model due to Preckel, Cranfield & Hertel (2010), designed for food demand with non-linearities at lower & upper bounds
 - Use this to model how changes in income alters consumption of healthy diet basket foods
 - Also includes price effects, but a lesser focus



Source: Adapted from Gouel & Guimard (2018), Figure 2.

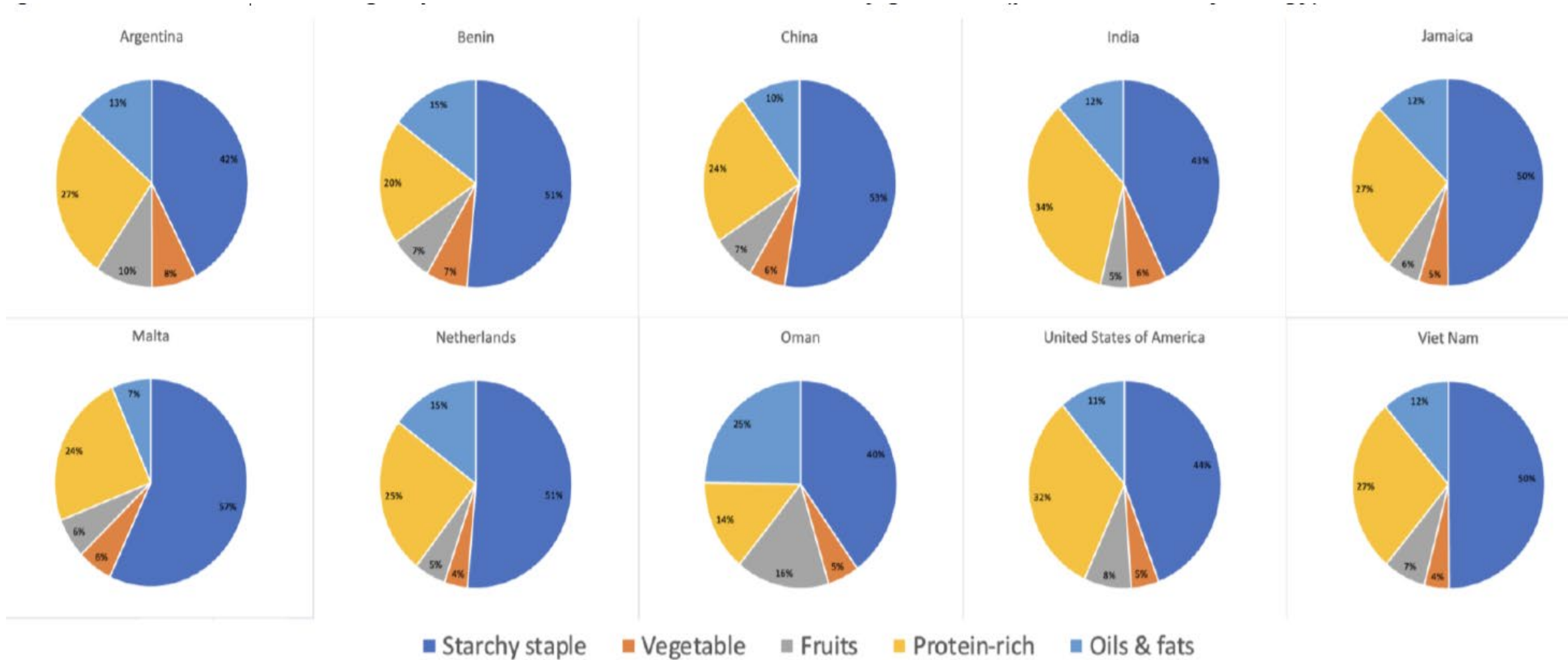
Need for Diet Quality Measures

- It's enormously helpful to have a measure of diet quality when analyzing impacts of interventions
 - Otherwise hard to say whether an intervention improves nutritional outcomes
- Want something akin to economists' utility and social welfare functions
 - That permit assessment of whether an intervention improves outcomes
- A diet quality measure lets us assess whether nutritional outcomes improve and, if so, by how much?

Herforth et al begin with Food-Based dietary guidelines for 10 countries

- Countries chosen based partly on availability of dietary guidelines, but also to incorporate diversity in income levels, geography and traditional staples
 - Argentina, Benin, China, India, Jamaica, Malta, Netherlands, Oman, USA, Viet Nam
- Dietary guidelines expressed as a share of total calories for a 2330 cal diet
 - Despite the countries' diversity, the dietary guidelines surprisingly similar
 - eg starchy staples should be about half of dietary energy; protein rich foods about a quarter; vegetables & fruit 10-15%.
- Provides a basis for Healthy Diet Targets, with deviations from these guidelines implying lower quality diets

Shares of food groups in national dietary guidelines



Healthy Diet Basket (HDBI) Index (Herforth et al 2022)

- Measure shares of calories from the food groups typically considered in diets like EAT-Lancet

$$\circ q_i = \frac{Q_i}{\sum Q_j}$$

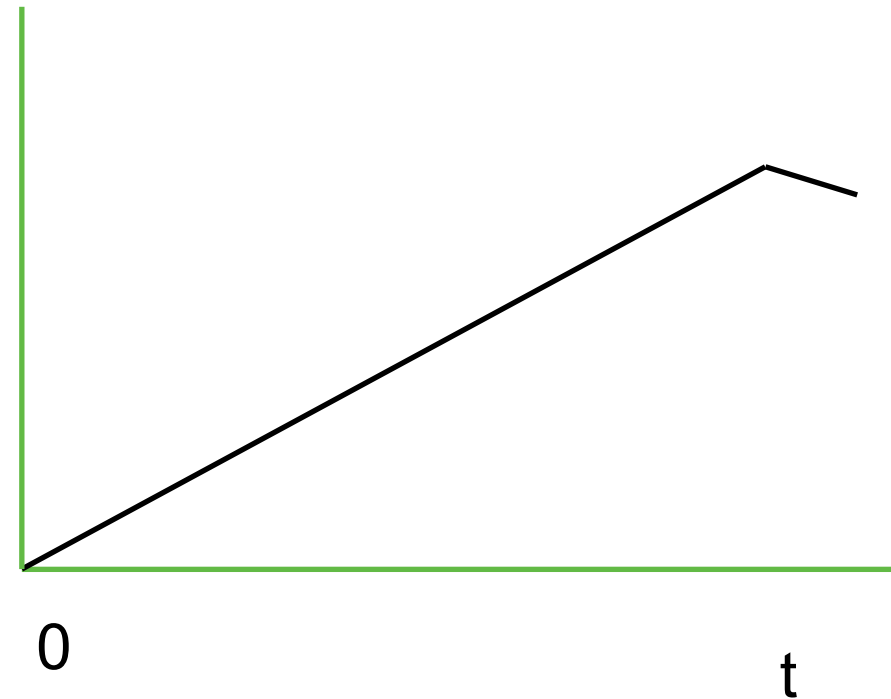
- Compare those with shares in the target diet, t_i
- $HDBI = (1 - \sum(t_i - q_i))$ where $(t_i - q_i) > 0$
 - Alternatively, may measure cases where $(t_i - q_i) < 0$

Target diet	Calories Q_i
Starchy staples	1160
Pulses & nuts	300
Vegetables & fruit	270
Oils & fats	300
Meat & seafood	157
Dairy & egg	143
Total excl sugars	2330

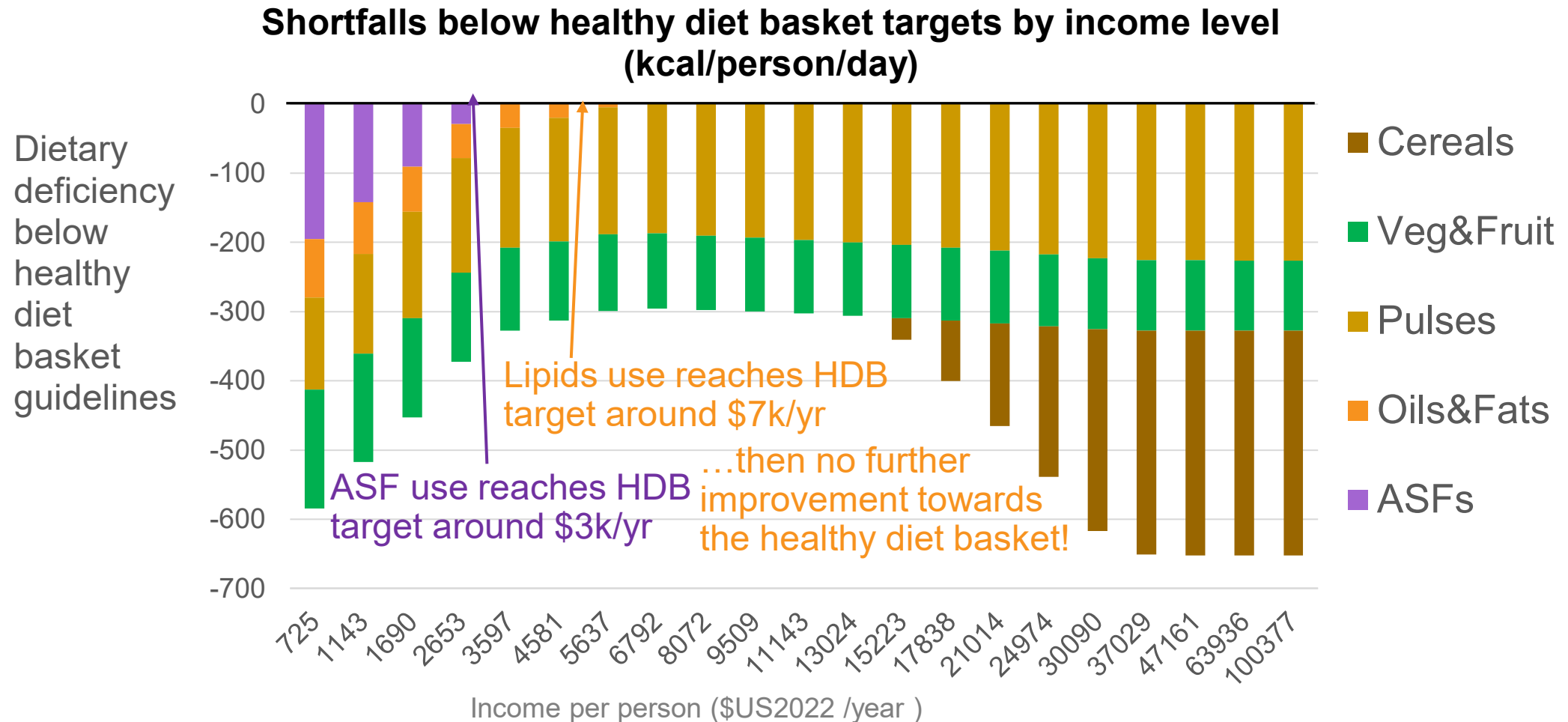
Interpretation of the Healthy Diet Basket Index

- $HDBI = (1 - \sum(t_i - q_i))$
- A diet matching the recommended diet has an index value of 1
 $t_i - q_i = 0$ for all i
- A pessimal diet includes only one small nutrient category
 - eg a heavily unbalanced diet consisting only of dairy and eggs would have an HDBI of 0.06

Contribution of Nutrient i to HDBI

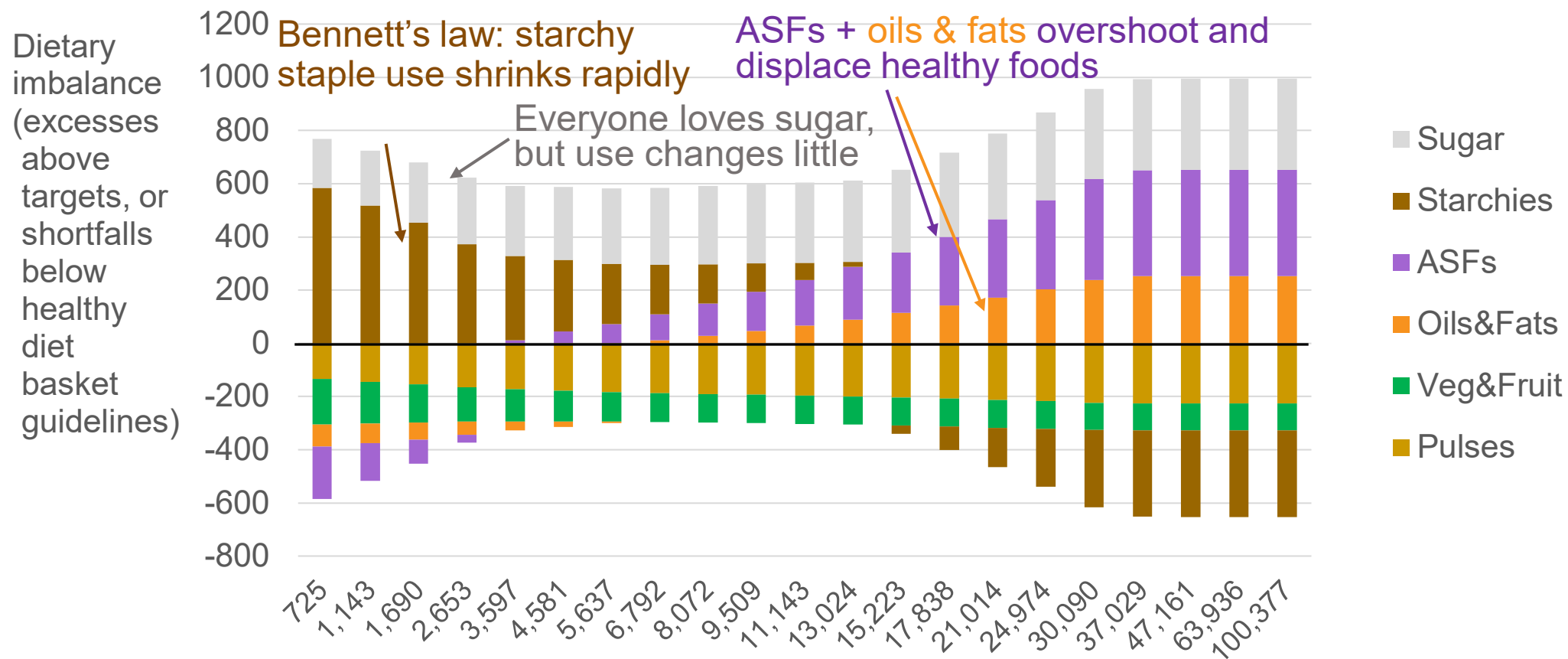


Will income growth alone close gaps in consumption below healthy diet basket targets?

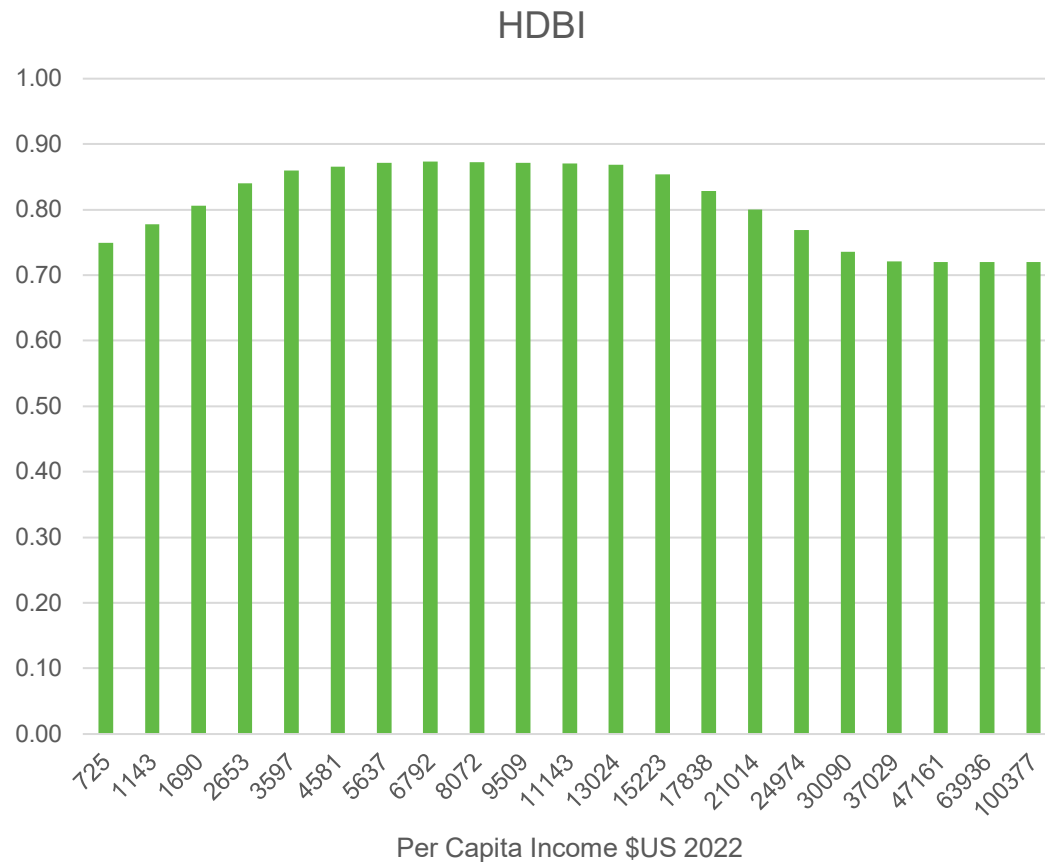


Which foods are consumed above the target needed for a healthy diet basket?

Excesses and deficiencies relative to healthy diet basket targets by income level (kcal/person/day)



Evolution of the HDBI with Income



- At very low incomes, the index is around 0.75.
- It rises through World Bank's Low and Lower-Middle Income groups to peak at 0.87 in the Upper-Middle Income group
 - As diets diversify from starchy staples
- Then it declines as incomes rise and oils/fats and Animal Source Foods exceed targets
 - The richest have lower quality diets than the poorest, at around 0.72
- Revealed preference not a good indicator of dietary quality

How to improve nutritional outcomes?

- One approach is to focus on income growth
 - Higher incomes increase the options available
 - Perhaps higher incomes will let people consume better food?
 - As we've seen this is the case for people at the income levels of low and middle income countries
 - But does not appear to be the case for higher income countries
- Huge set of interventions that work by changing consumer prices
 - Taxes/tariffs on “unhealthy” foods?
 - Investing in productivity growth in production of healthy foods?
 - Lower costs of preparing healthy foods?
- Changing the properties of foods
 - Biofortification?
 - Reducing fat or salt or sugar or refining in processed foods?
- Education and/or Moral Suasion?

What role for price-based measures?

- Price elasticities of demand appear to be larger at lower income levels
 - Poorer people must adjust their consumption in response to price changes
 - Budget shares of food are higher, so income effects of higher prices are larger– reinforcing substitution effects
- Consider a Tinbergen approach
 - What price changes needed to hit nutritional targets?
 - Six targets and six instruments
 - But pulses & nuts almost completely unresponsive to price changes
 - So only 5 commodity prices relevant

Initial application to median of the bottom 10% of global income distribution-- \$1690 in \$US 2022

- Use the matrix of uncompensated elasticities of demand

- $$\begin{bmatrix} \Delta Q \end{bmatrix} = \begin{bmatrix} \eta \end{bmatrix} \cdot \begin{bmatrix} \Delta P \end{bmatrix}$$

- Invert the η matrix to find changes in prices needed to hit dietary targets

- $$\begin{bmatrix} \Delta P^* \end{bmatrix} = \begin{bmatrix} \eta \end{bmatrix}^{-1} \cdot \begin{bmatrix} \Delta Q \end{bmatrix}$$

Price Elasticities at the 10th percentile, excl pulses & sugar

	Starchies	V&F	Oils	Meat-Seafood	Dairy-Egg
Starchies	-0.083	0.025	0.000	0.020	0.010
V&F	-0.019	-0.330	0.000	0.087	0.049
Oils	-0.019	0.019	-0.160	0.019	0.014
Meat-Seafood	-0.042	0.090	-0.003	-0.427	0.051
Dairy-Egg	-0.045	0.185	-0.002	0.154	-0.731

Average own price elasticity= -0.35

Because of project focus, consider only declines in prices associated with a 10% move towards target, 10th percentile of income distn

- Raises the HDBI from 0.81 to 0.84
- Suggests that changes in prices can materially improve diets in poorer countries
 - Elasticities are high enough to matter
- Animal-sourced foods and vegetables/fruit are heavily under-consumed at this income level
 - And these are the products with the highest price elasticities

Elasticities at the median income level of \$13,024 in 2022

	Starchies	V&F	Oils	Meat-Seafood	Dairy-Egg
Starchies	-0.104	0.008	-0.003	-0.001	0.006
V&F	0.033	-0.257	0.005	0.025	0.069
Oils	0.002	0.002	-0.094	-0.001	0.001
Meat-Seafood	0.030	0.054	-0.004	-0.185	0.048
Dairy-Egg	0.012	0.026	0.002	0.010	-0.333

Average own price elasticity= -0.19

Elasticities at the 80th percentile inc level of \$37,029 in 2022

	Starchies	V&F	Oils	Meat-Seafood	Dairy-Egg
Starchies	-0.019	0.000	-0.000	-0.000	-0.000
Veg& Fruit	0.001	-0.039	-0.000	-0.000	0.000
Oils	0.000	0.000	-0.008	-0.000	-0.000
Meat-Seafood	0.001	0.000	-0.001	-0.017	-0.000
Dairy-Egg	0.000	0.000	-0.000	-0.000	-0.034

Average own price elasticity= -0.023

Declining effect of price based policies in improving nutrition

- Average own price elasticities at the 80th percentile only 6 percent of their value at the 10th percentile of the income distribution
 - The own-price elasticities that matter for these groups are Starchy Staples, & Vegetables & Fruit
 - But these are only -0.02 and -0.04 at the 80th percentile of the income distribution
- Clearly, improving diets at higher income levels will need to rely more heavily upon policy instruments other than those operating through prices

Summary and Conclusions

- Develop an index of diet quality to examine responsiveness to income growth and price changes
- Use the MAIDADs demand system of Gouel and Guimbard to examine impacts of income growth and price changes on diets
 - Income growth improves diet quality up to today's upper middle income level, then deteriorates
- Reducing prices of healthy foods such as dairy products, vegetables and fruit can improve diet quality for people at today's 10th percentile income level
 - But unlikely to be effective at middle and high income levels
 - Price elasticities much lower than at low income levels & especially for foods like pulses underconsumed at high income levels

References

Gouel, C. and Guimbard, H. (2018), 'Nutrition Transition and the Structure of Global Food Demand' *Amer. J. Agr. Econ.* 101(2): 383–403

Herforth, A., Venkat, A., Yan Bai, Costlow, L., Holleman, C., and Masters, W. (2022) 'Methods and options to monitor the cost and affordability of a healthy diet globally', Background paper for *The State of Food Security and Nutrition*, FAO, Rome.