Friedman School
of Nutrition Science and Policy

Nutrition Transition and Agricultural Transformation:
A Preston Curve Approach

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The U.S. Government's Global Hunger & Food Security Initiative

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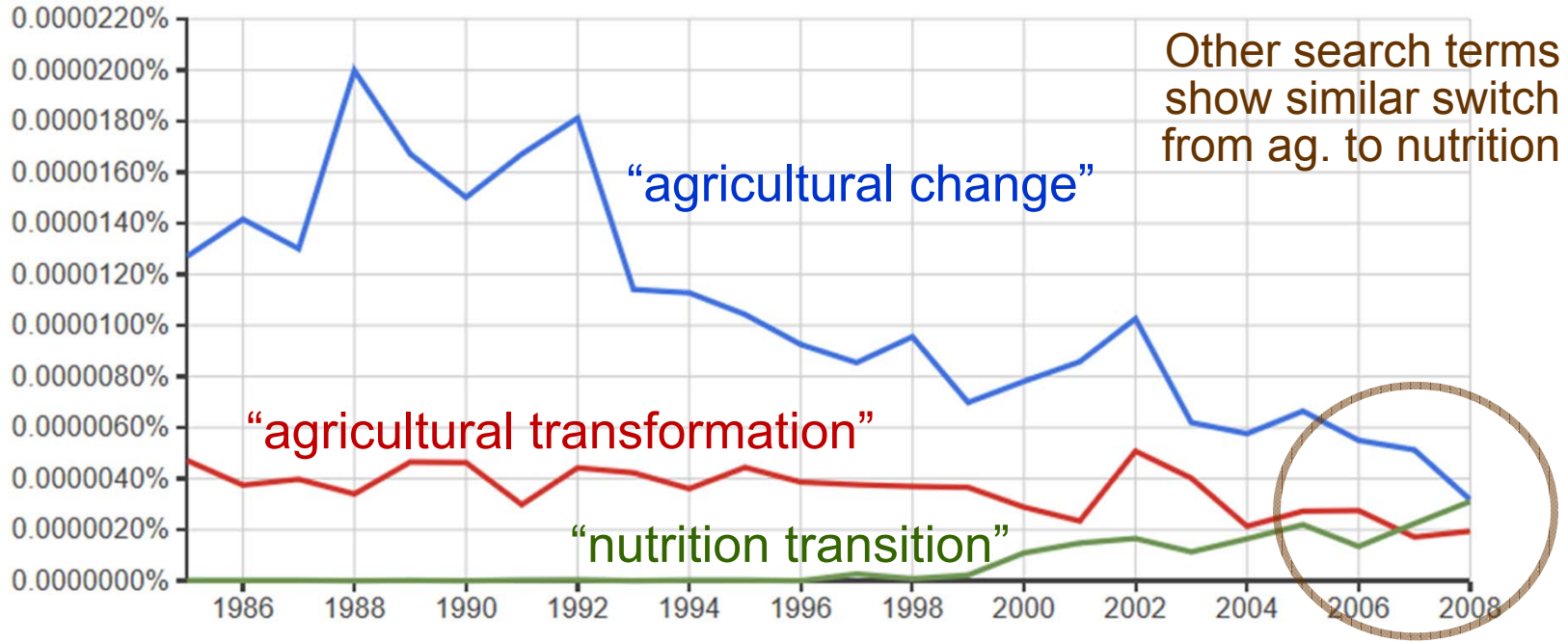
Agriculture and the nutrition transition in English-language books

Google books Ngram Viewer

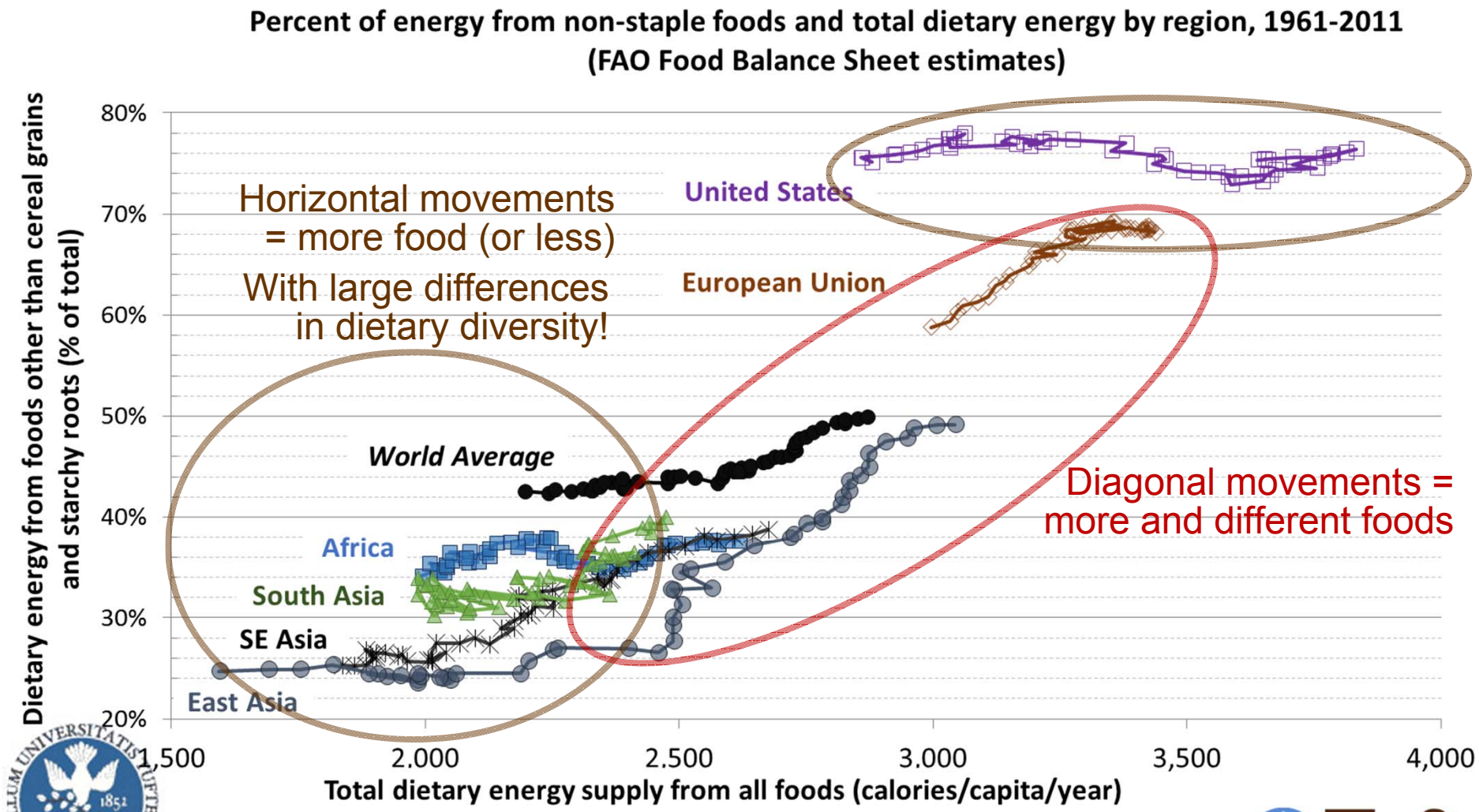
Graph these comma-separated phrases: agricultural change,agricultural transformation,nutrition transition ☑ case-insensitive

between 1985 and 2008 from the corpus English with smoothing of 0 . Search lots of books



Source: Google Ngrams, downloaded July 2015 from books.google.com/ngrams/graph?content=agricultural+change,agricultural+transformation,nutrition+transition&case_insensitive=on&year_start=1985&year_end=2015&smoothing=0.

The ag.-nutrition transition in food supplies



Source: Author's calculations from FAO Food Balance Sheets, http://faostat3.fao.org/download/FB/FBS/E (June 2015).

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What has changed?
Fifteen years into the 21st c., we have:

- **Renewed and changing attention to food**
  - Much new attention to diet quality and nutritional influences on health
  - Many new food-related technologies, policies and public-sector programs

- **Rapid transformation of agriculture and food systems**
  - Urban growth ≥ population growth in most regions outside Africa
  - Farm population and area growth is slowing or has stopped
  - Food markets are rapidly commercializing & intensifying everywhere
  - Gender roles are changing, in households and in education/employment

- **Rapid transition in demography and disease**
  - Child mortality and birth rates are declining or already low
  - Disease burdens shift from infectious to non-communicable diseases
  - ***In shift from under- to over-consumption, diets remain #1 health risk***

Is all this change just *more of the same*?

- **Strategy**
  - test for shifts in the global average *at each level of national income*
  - this generalizes the Preston curve (Preston 1975, Bloom & Canning 2007), first applied to life expectancy

- **Data**
  - national income: purchasing power per capita (*not household income!*)
  - health outcomes: burden of disease
  - body size: heights and weights
  - diet quality: NutriCoDE indexes
  - ag. transformation: rural pop. growth, ag. employment and earnings
  - policy choices: price effects of agricultural policies

- **Method**
  - all data are nationally representative; results are weighted by population
  - each test uses all available countries, then subsets of countries
  - start with modeled estimates for all (>160) countries
  - then survey observations, for selected (>40) countries

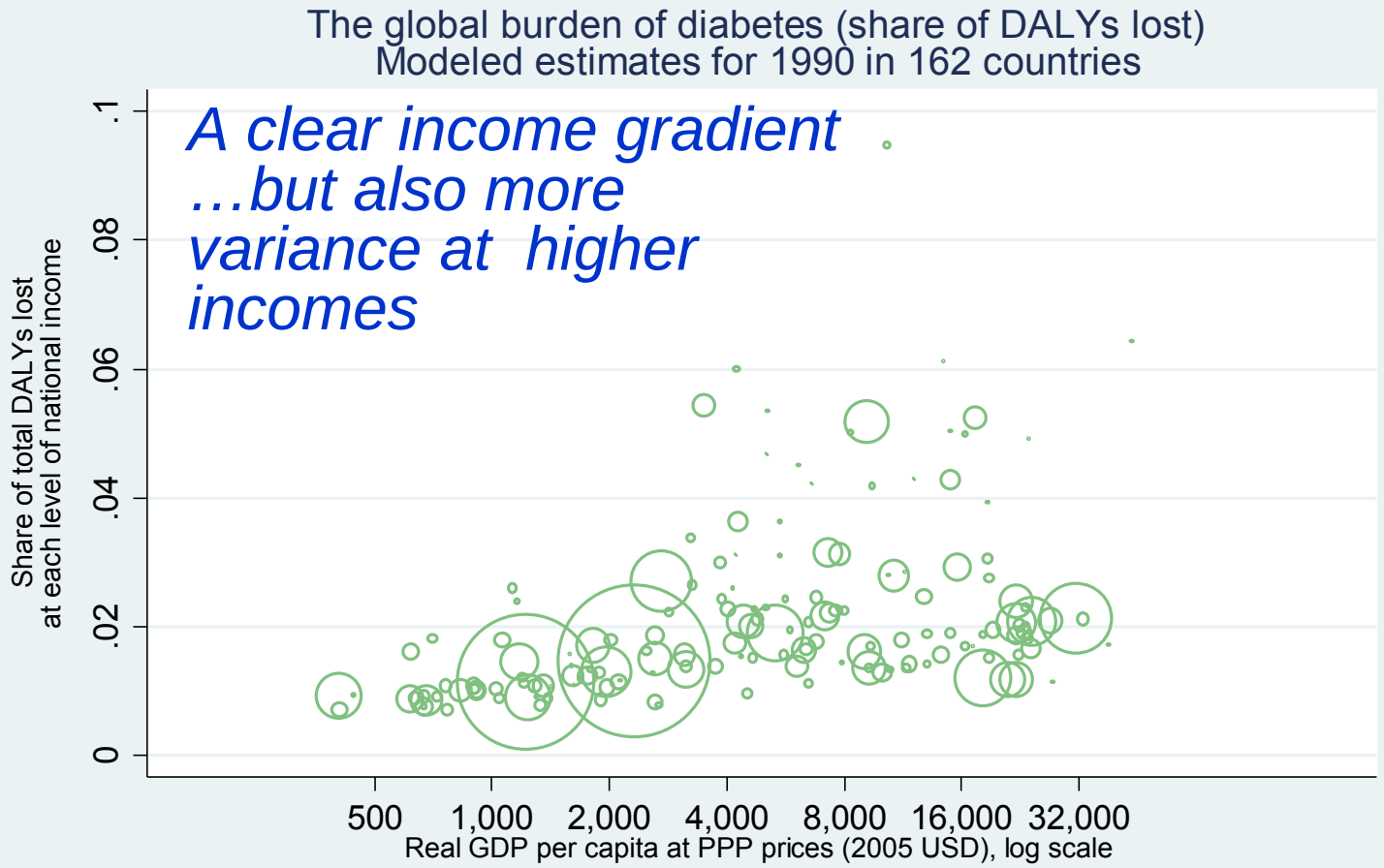
We can look only where there is data

- **National income**
  - GDP per capita at PPP prices, from Penn World Tables 8.1
- **Health**
  - Fraction of DALYs lost, from Global Burden of Disease study
- **Body size**
  - Height and weight Z scores, from GBD estimates and survey data
- **Diet quality**
  - Lower- and higher-risk foods, from dietary recall and modeled estimates
- **Agriculture**
  - Rural pop. growth, ag. employment & earnings from ILO, UNPP and WB
- **Policy choices**
  - Price comparisons from WB Distortions to Agricultural Incentives project

Start with the signature diet-related disease:

diabetes

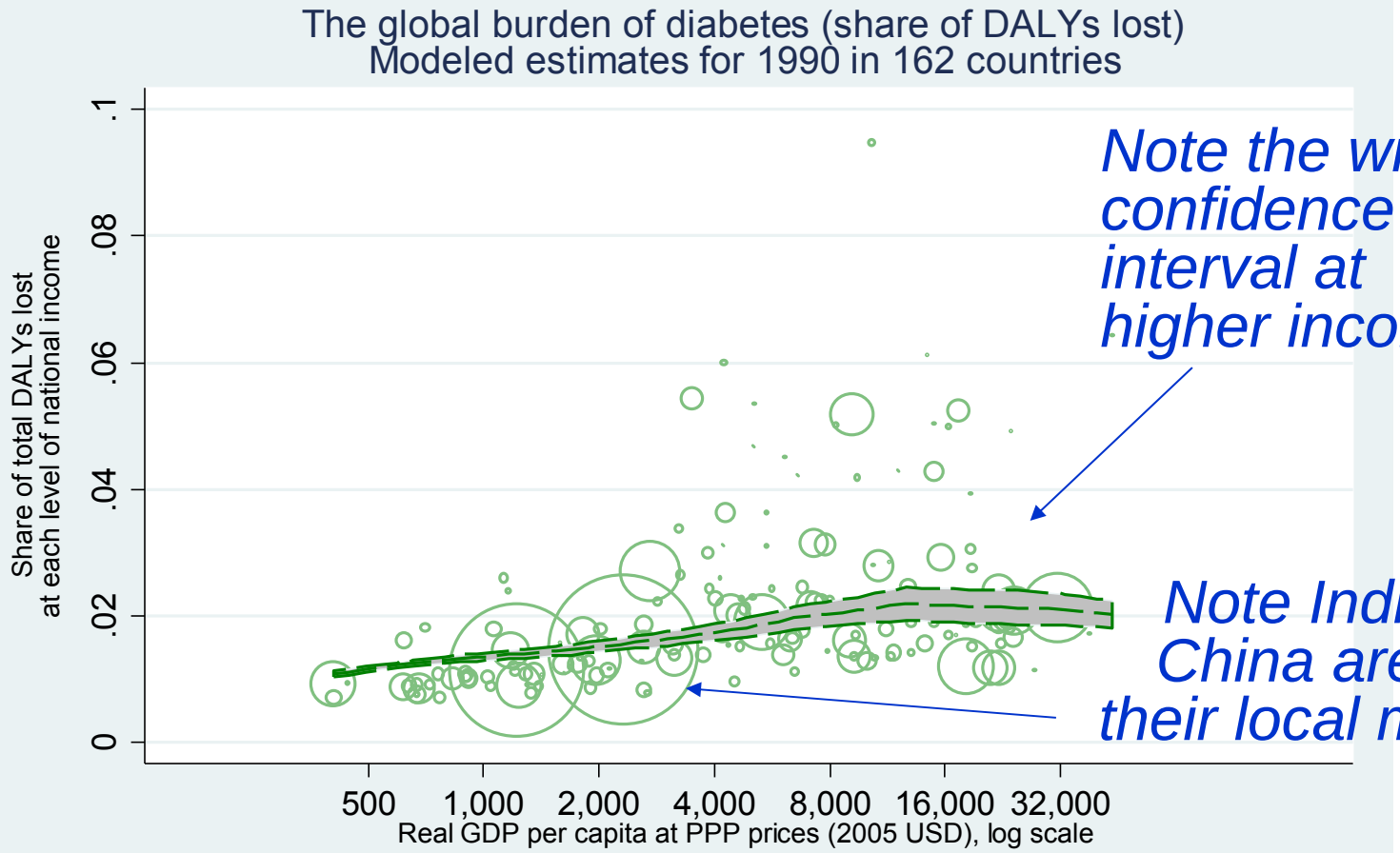
Diabetes burdens in 1990



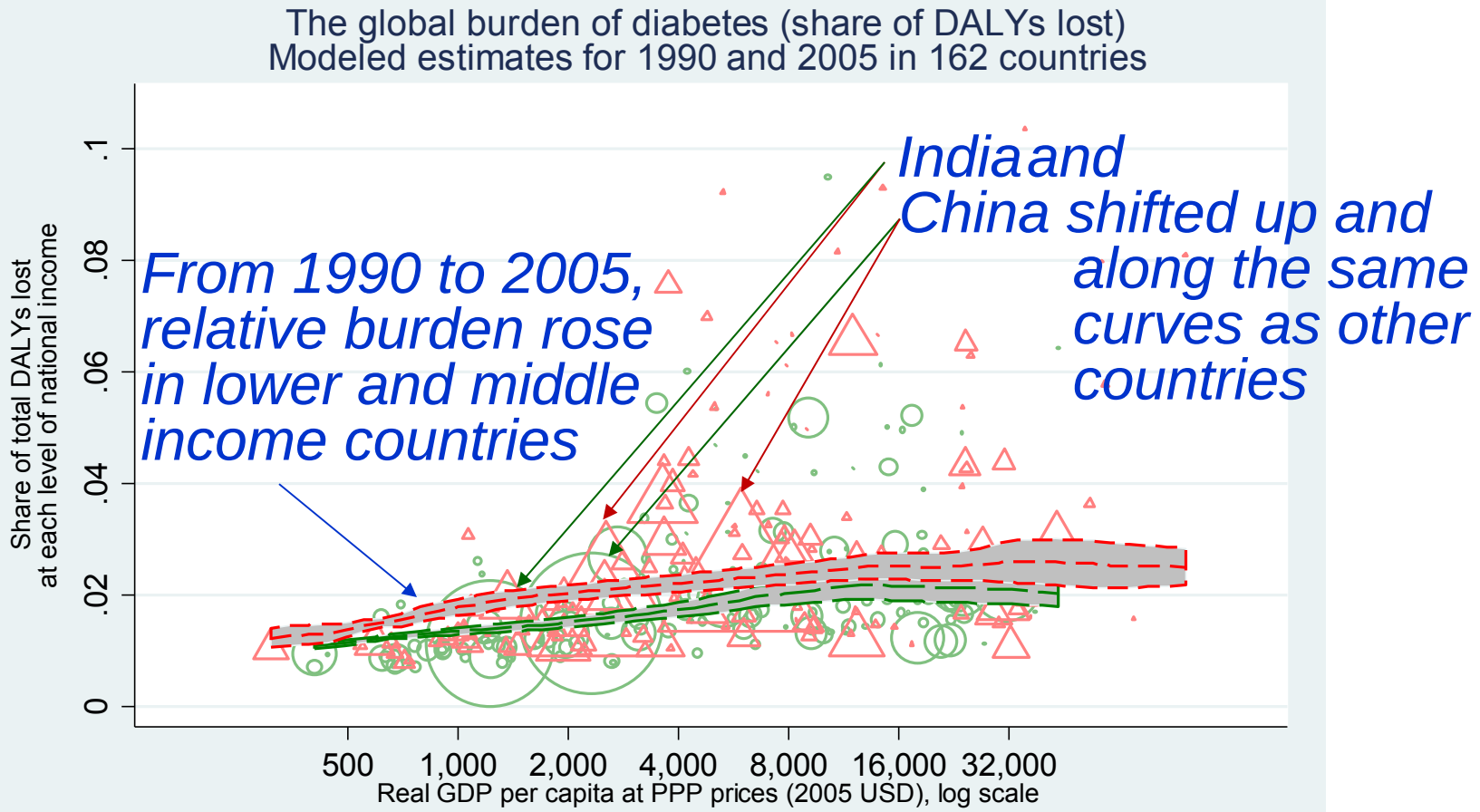
Note: Symbols are sized by population, with year shown as 1990=green circles.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.

Diabetes burdens in 1990, with local means



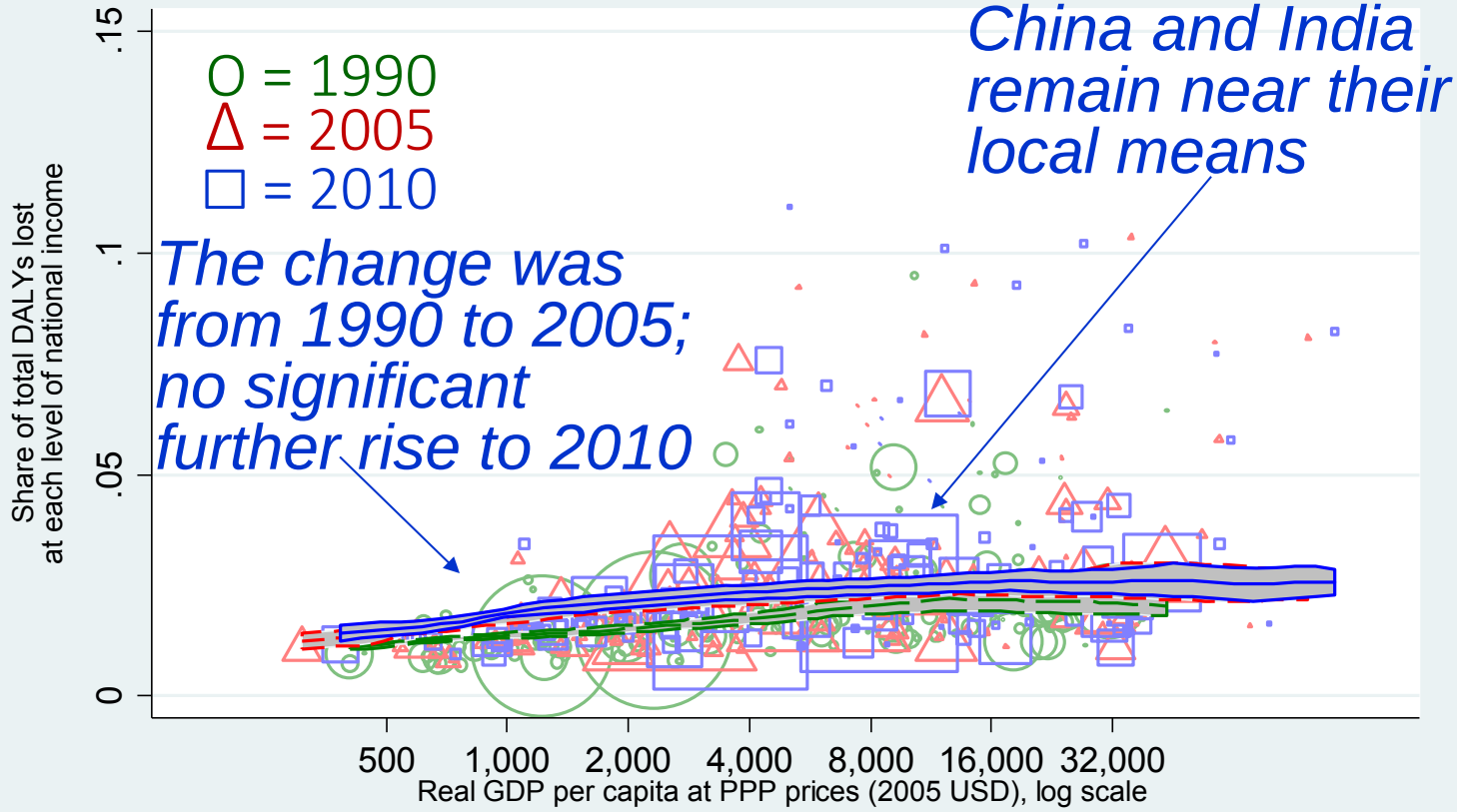
Changes in diabetes from 1990 to 2005



Note: Symbols are sized by population, with year shown as 1990=green circles and 2005=red triangles.
Lines show each year's local means and confidence intervals
estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.

Diabetes burdens have risen in poor countries



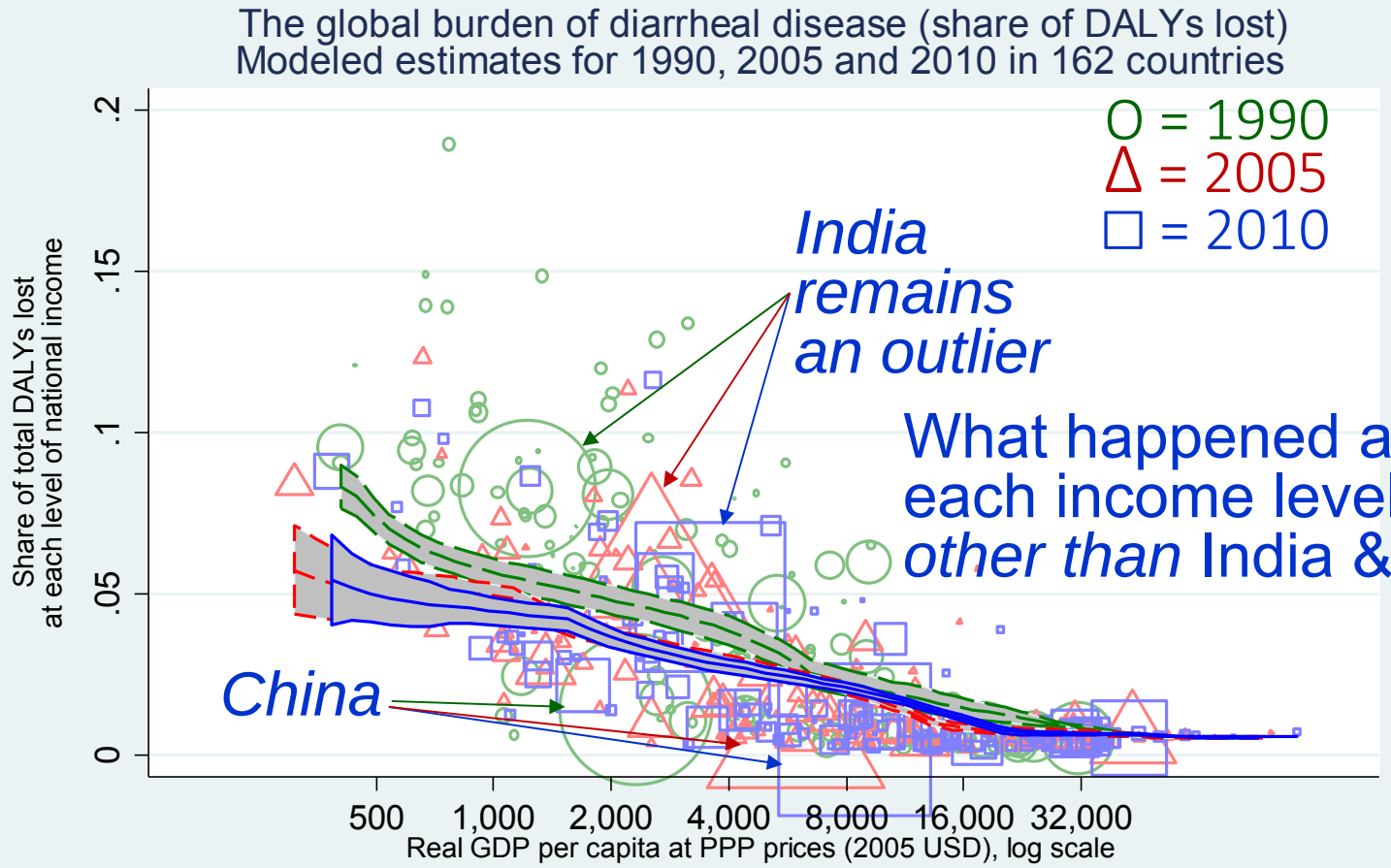
Note: Symbols are sized by population, with year shown as 1990=green circles, 2005=red triangles, and 2010=blue squares. Lines show each year's local means and confidence intervals estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.

Now contrast with the signature illness of undernourishment:

diarrheal disease

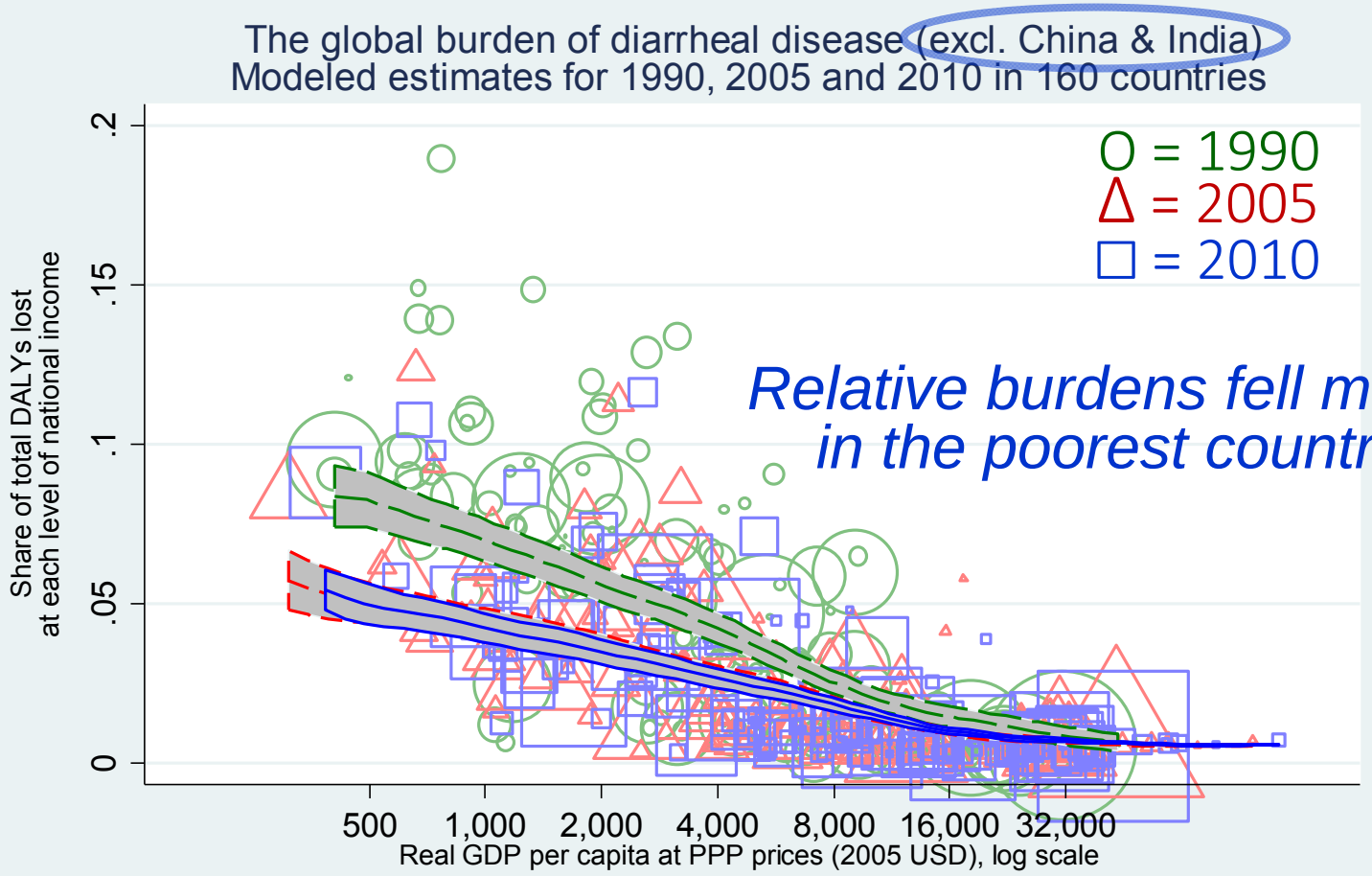
Diarrheal disease burdens have fallen



Note: Symbols are sized by population, with year shown as 1990=green circles, 2005=red triangles, and 2010=blue squares. Lines show each year's local means and confidence intervals estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.

Diarrheal disease burdens have fallen very fast



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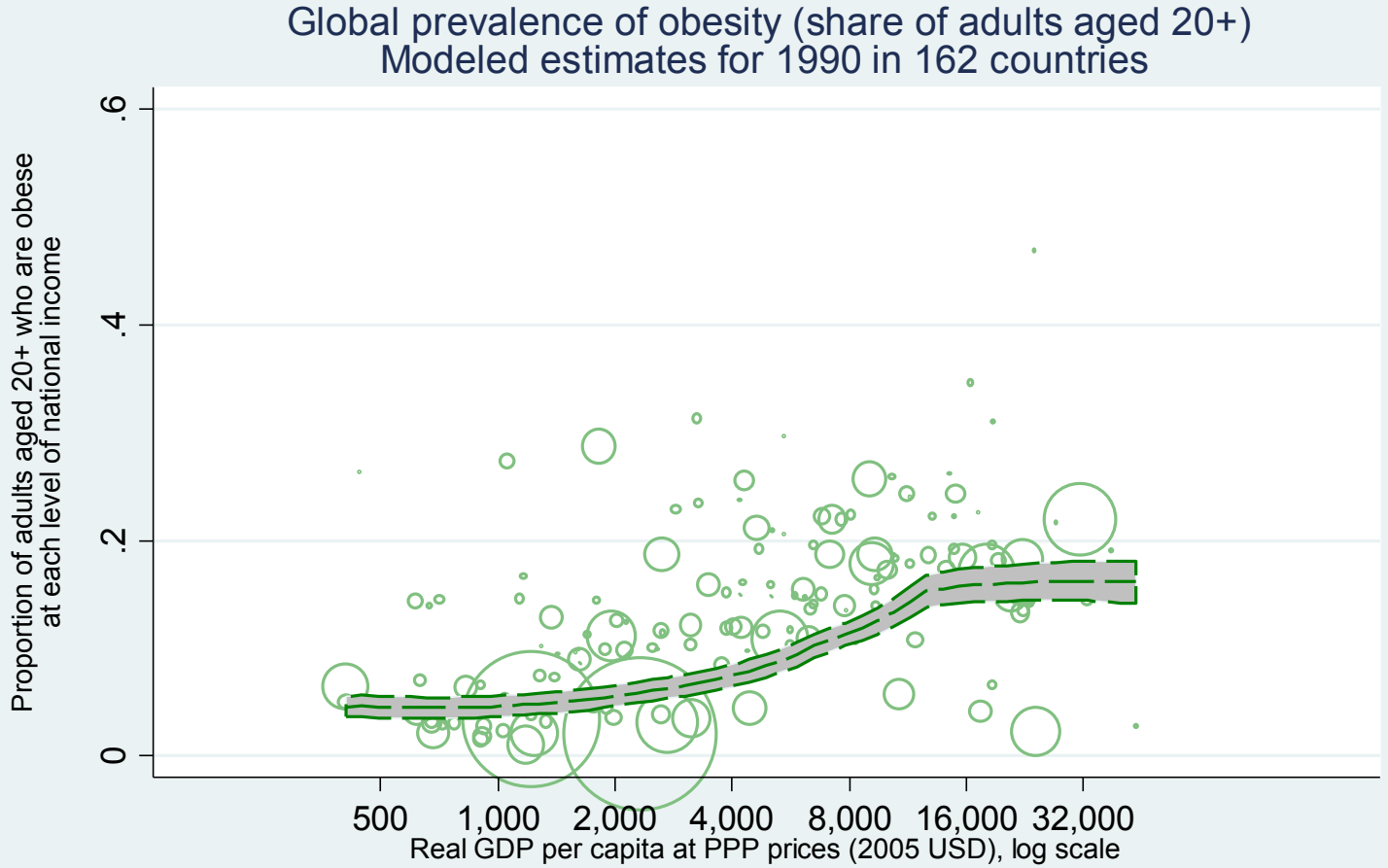
Source: Global Burden of Disease Study, Results by Cause; GDP and population are from PWT 8.1.

The most visible kind of change:

adult obesity

Adult obesity had a clear income gradient in 1990



Note: Symbols are sized by population, with year shown as 1990=green circles.
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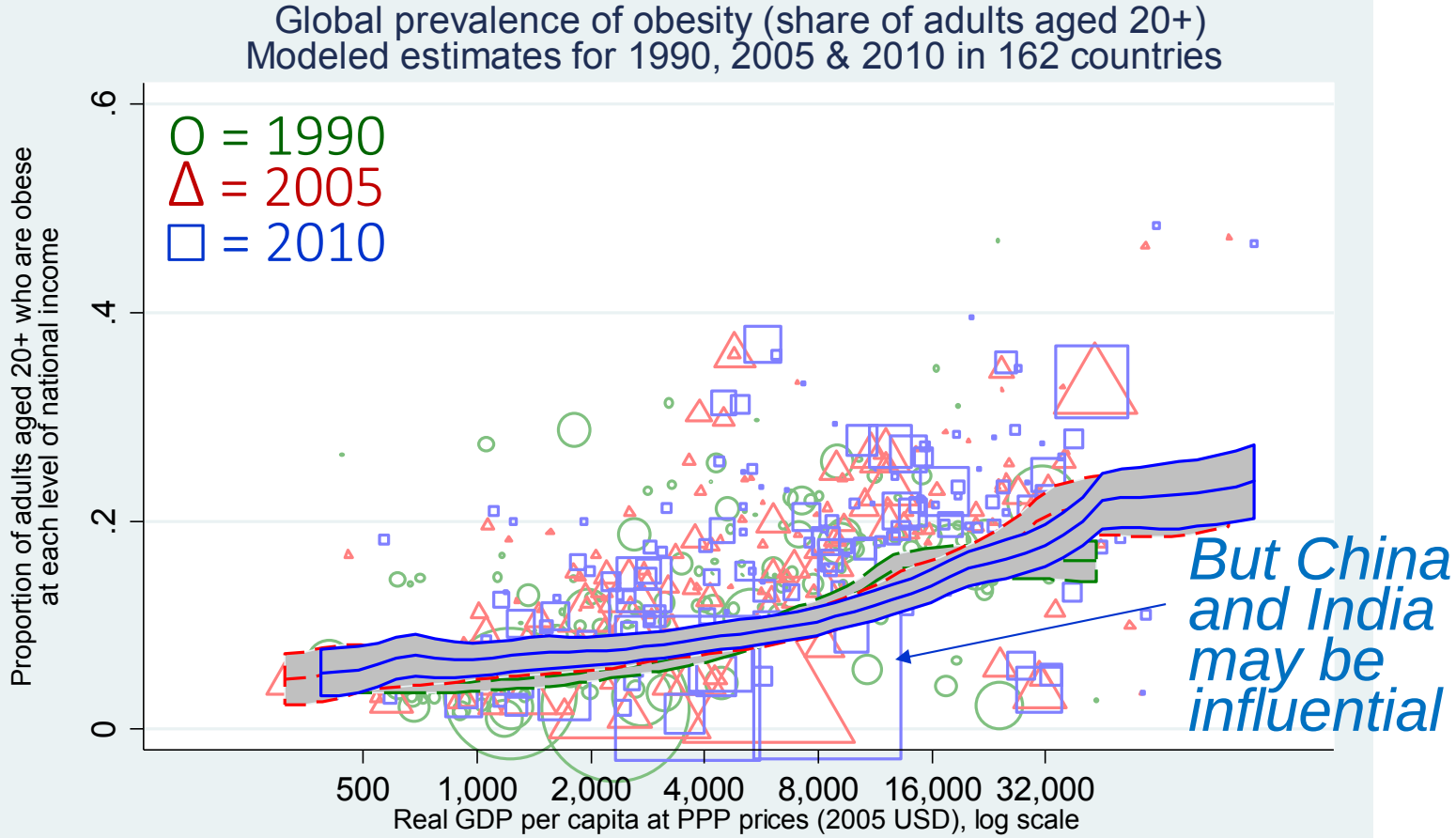
Source: Global Burden of Disease Study; GDP and population are from PWT 8.1.

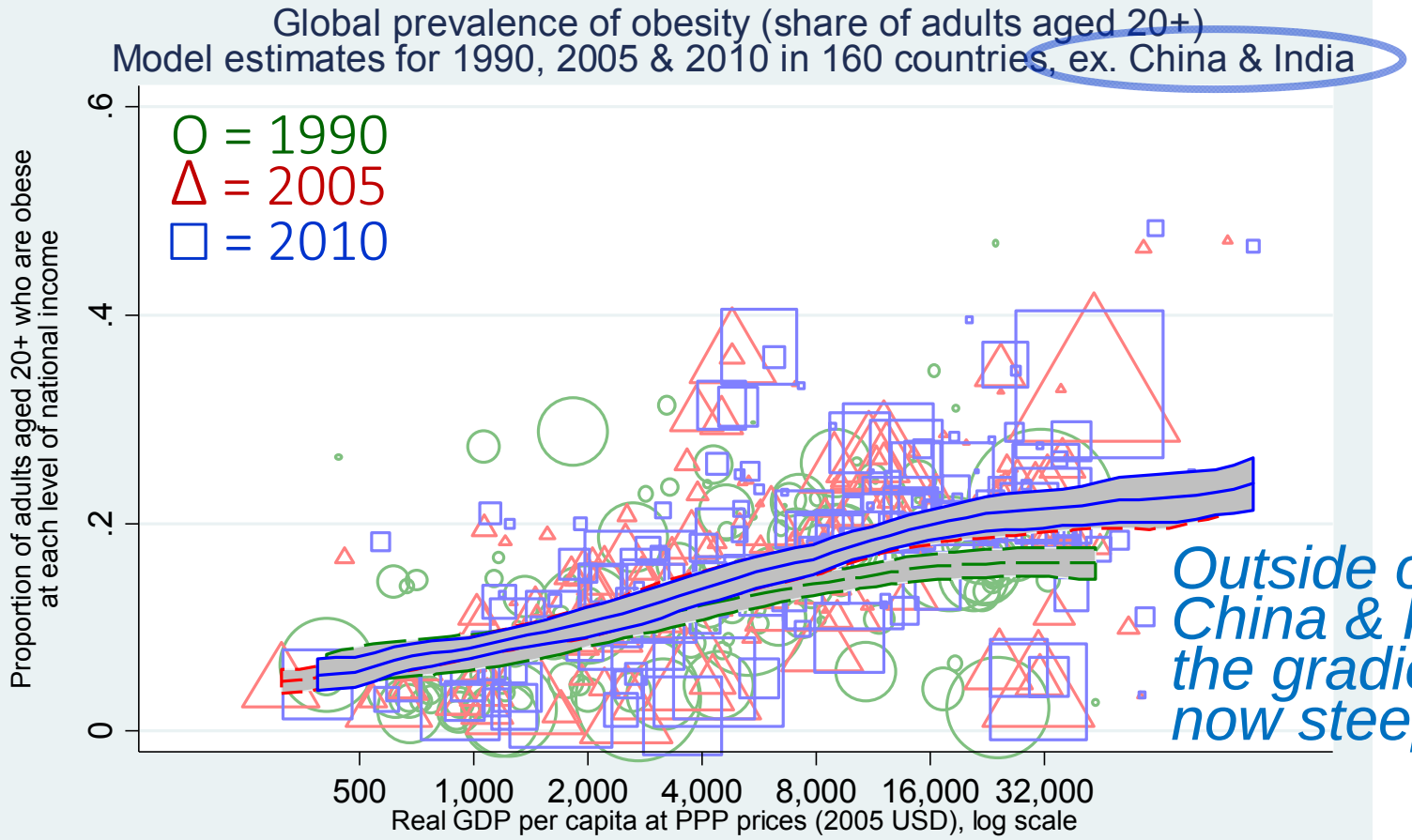
From 1990 to 2010, did the income gradient shift?



Note: Symbols are sized by population, with year shown as 1990=green circles, 2005=red triangles, and 2010=blue squares. Lines show each year's local means and confidence intervals estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study; GDP and population are from PWT 8.1.

Adult obesity has shifted up in richer countries



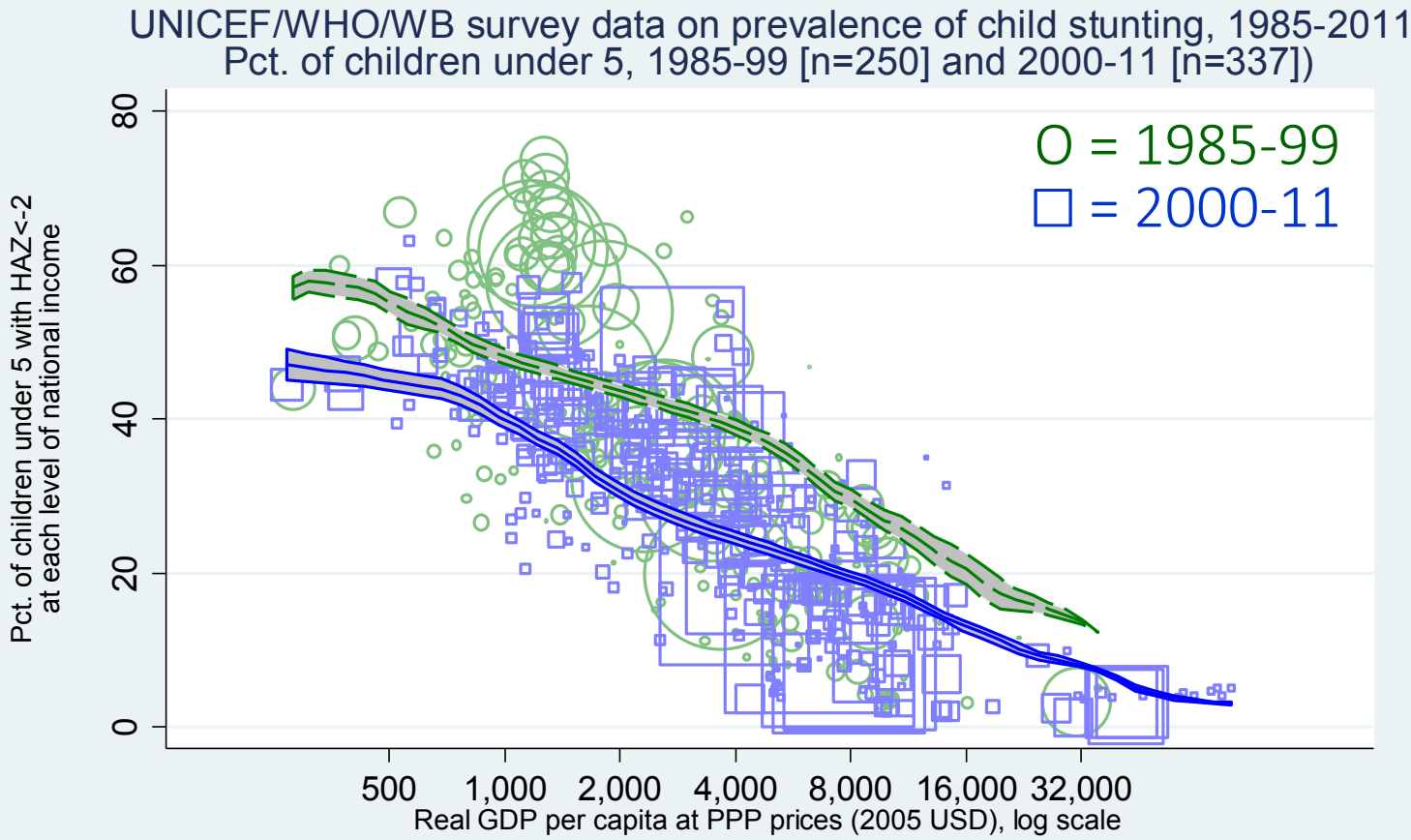
Note: Symbols are sized by population, with year shown as 1990=green circles, 2005=red triangles, and 2010=blue squares. Lines show each year's local means and confidence intervals estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: Global Burden of Disease Study; GDP and population are from PWT 8.1.

The main development goal:

child stunting

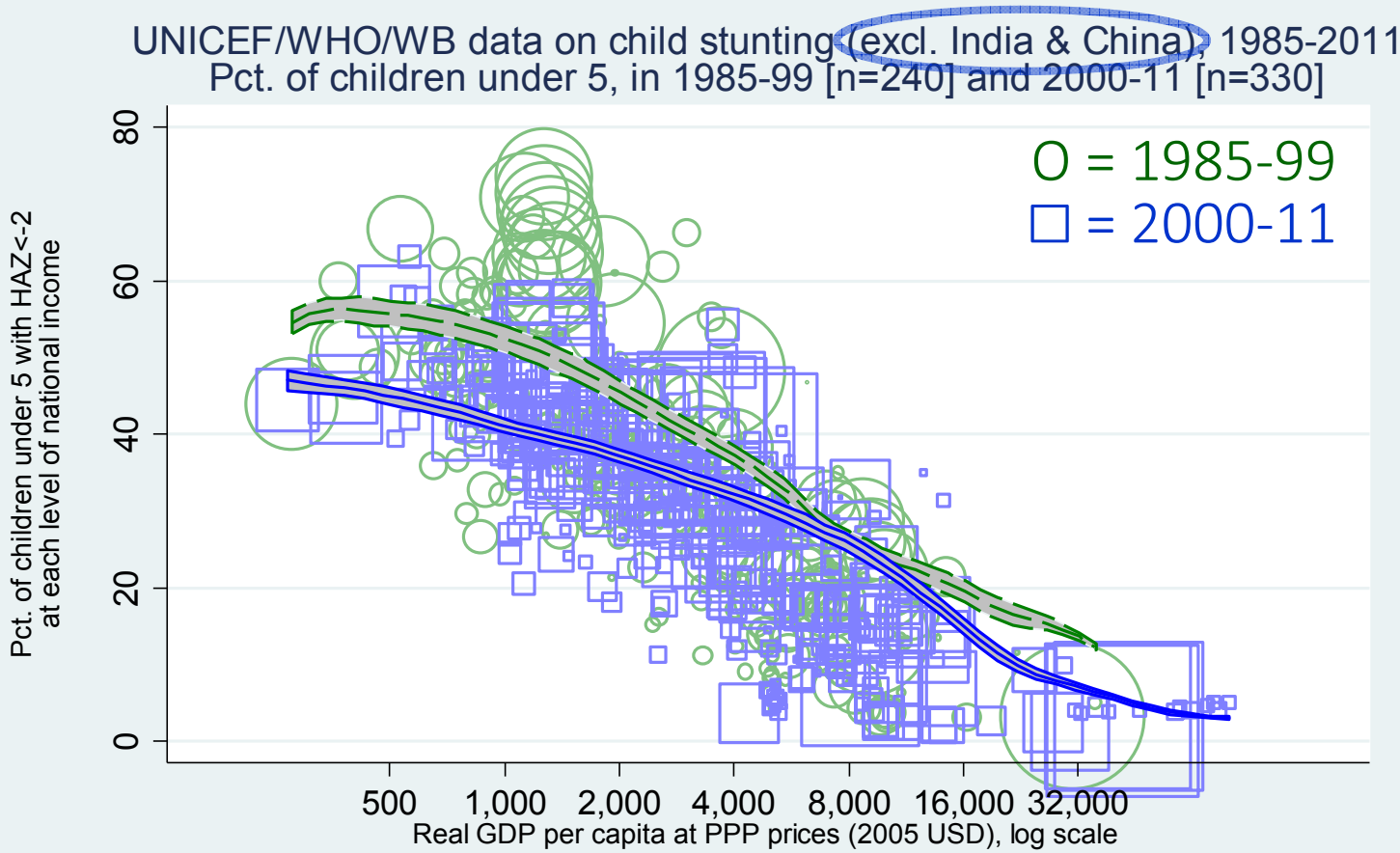
Child stunting rates have shifted down



Note: Symbols are sized by population, with decades shown by green circles for 1986-99 (250 surveys in 103 countries) and blue squares for 2000-2011 (337 surveys in 117 countries). Lines show local means and confidence intervals for each period estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: World Bank, WHO and UNICEF joint data; GDP and population are from PWT 8.1.

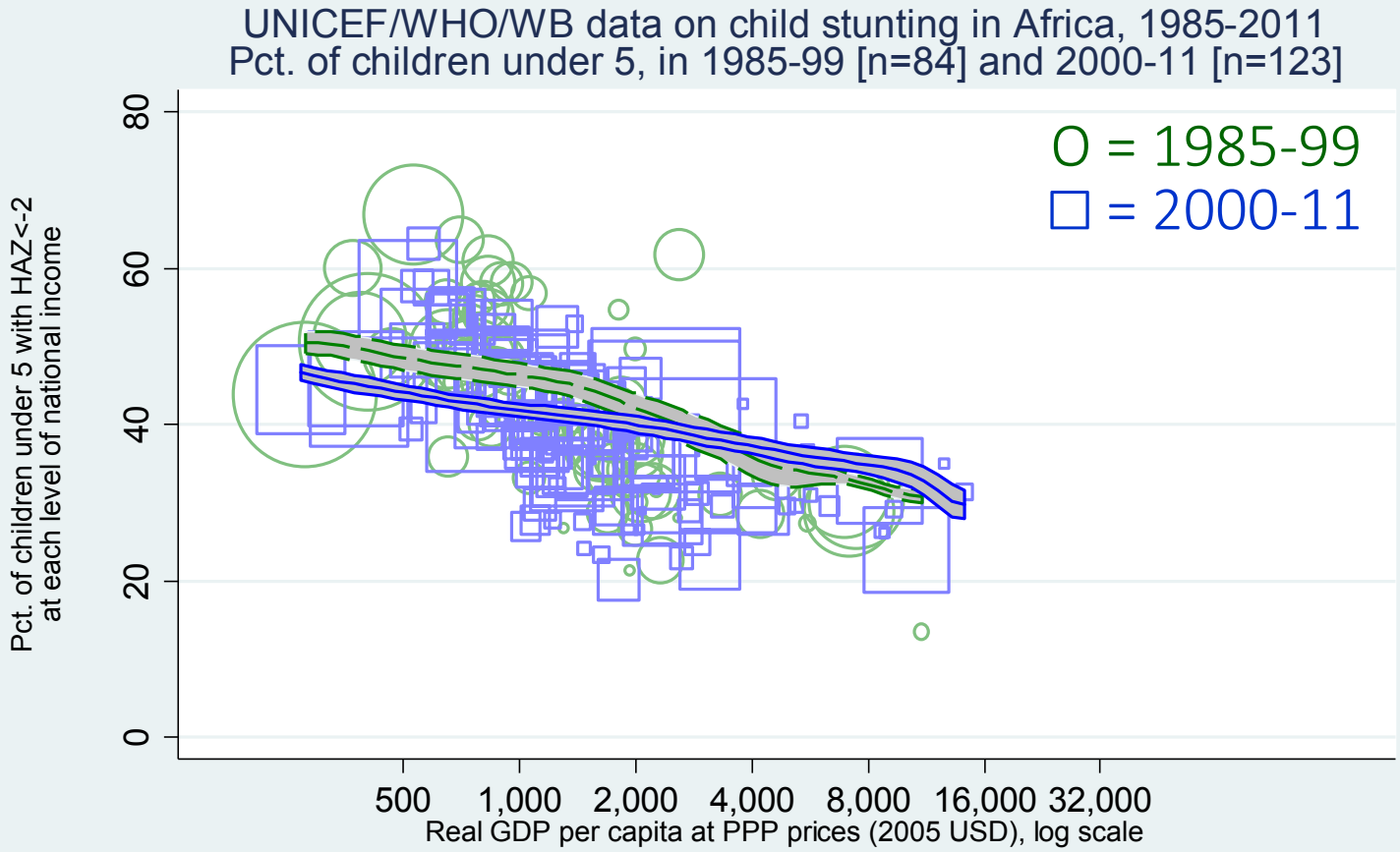
Outside China and India, child stunting has shifted down the most for the poorest



Note: Symbols are sized by population, with decades shown by green circles for 1986-99 (240 surveys in 101 countries) and blue squares for 2000-2011 (330 surveys in 115 countries). Lines show local means and confidence intervals for each period estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75. (Excludes India and China.)

Source: World Bank, WHO & UNICEF joint data; GDP and population are from PWT 8.1.

Child stunting has shifted down within Africa



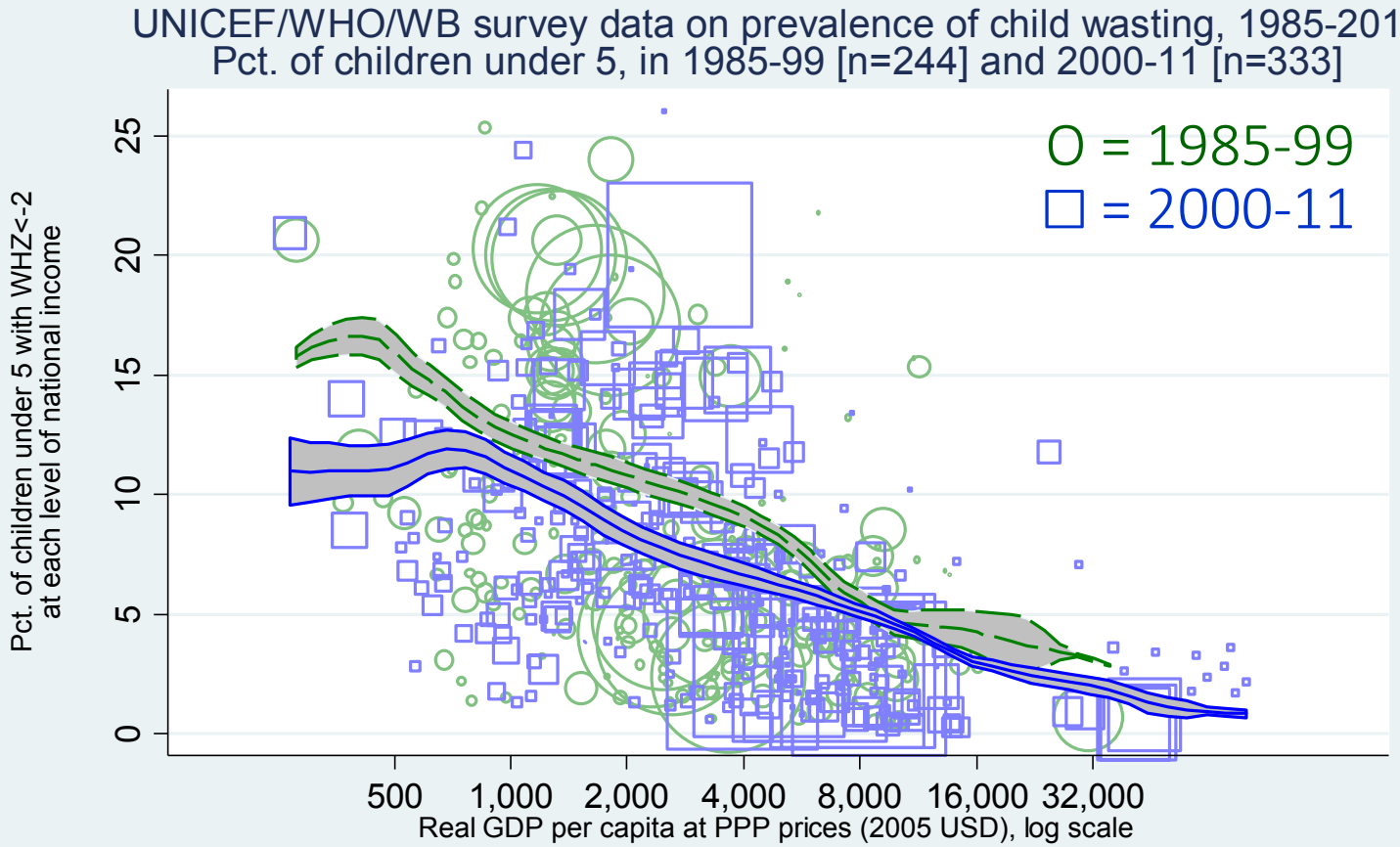
Note: Symbols are sized by population, with decades shown by green circles for 1986-99 (84 surveys in 40 countries) and blue squares for 2000-2011 (123 surveys in 42 countries). Lines show local means and confidence intervals for each period estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: World Bank, WHO & UNICEF joint data; GDP and population are from PWT 8.1.

Less prevalent, but still serious:

child wasting

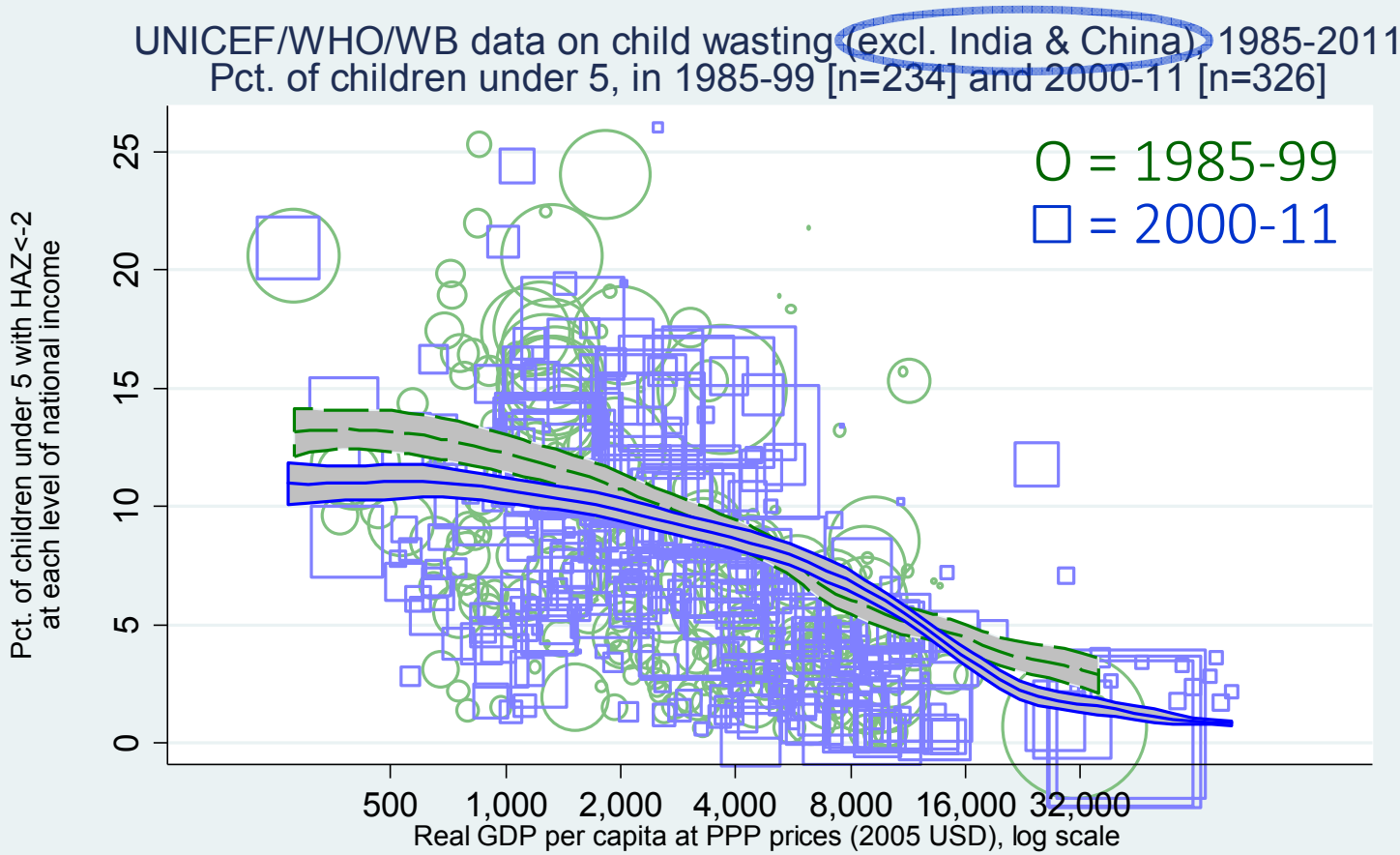
Child wasting rates have also fallen



Note: Symbols are sized by population, with decades shown by green circles for 1986-99 (244 surveys in 102 countries) and blue squares for 2000-2011 (333 surveys in 116 countries). Lines show local means and confidence intervals for each period estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: World Bank, WHO and UNICEF joint data; GDP and population are from PWT 8.1.

Child wasting has fallen outside China & India, too

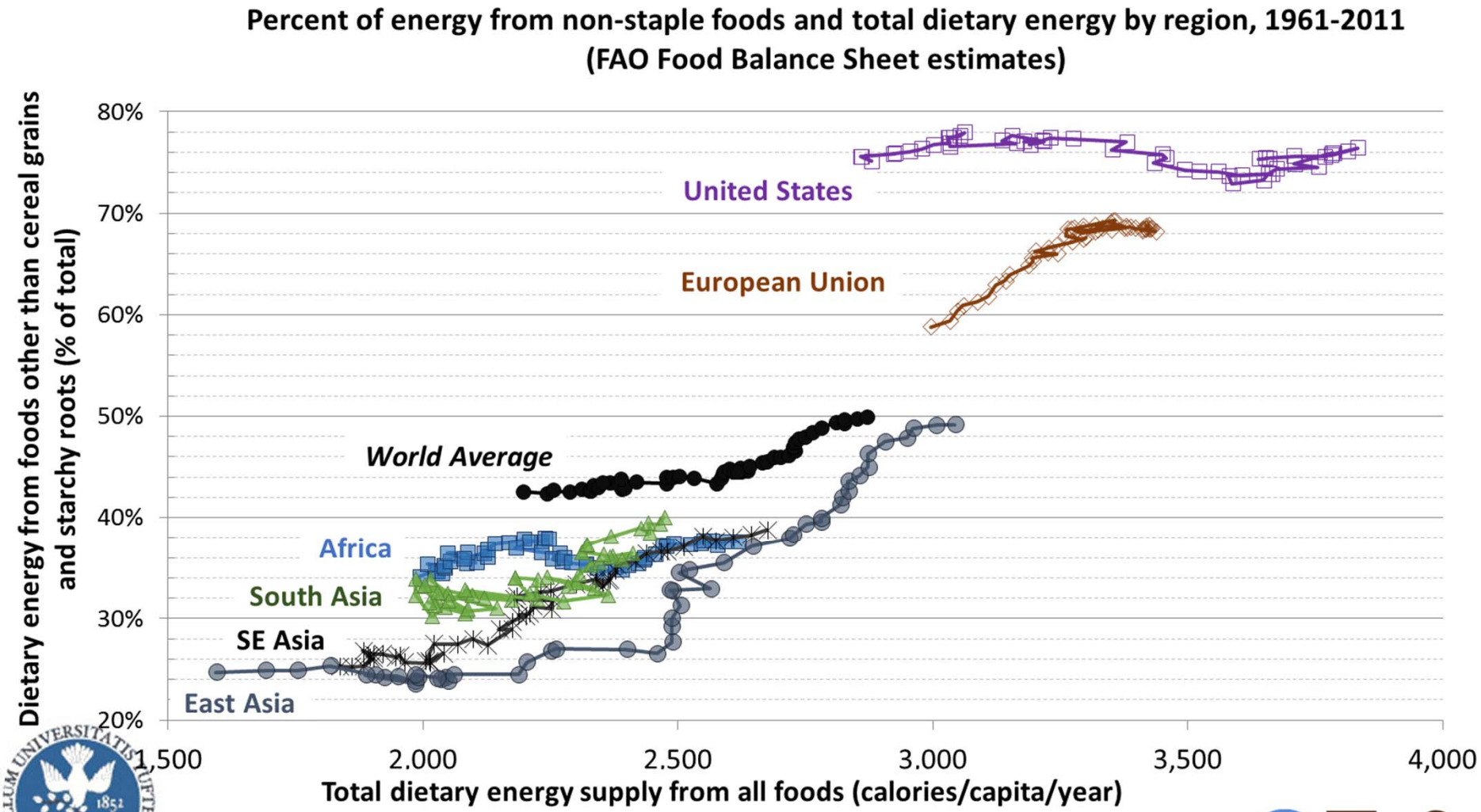


Note: Symbols are sized by population, with decades shown by green circles for 1986-99 (234 surveys in 100 countries) and blue squares for 2000-2011 (326 surveys in 114 countries). Lines show local means and confidence intervals for each period estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75. (Excludes India and China.)

Source: World Bank, WHO & UNICEF joint data; GDP and population are from PWT 8.1.

What has happened to diet quality?

Food balance sheets are useful, but limited



Source: Author's calculations from FAO Food Balance Sheets, http://faostat3.fao.org/download/FB/FBS/E (June 2015).

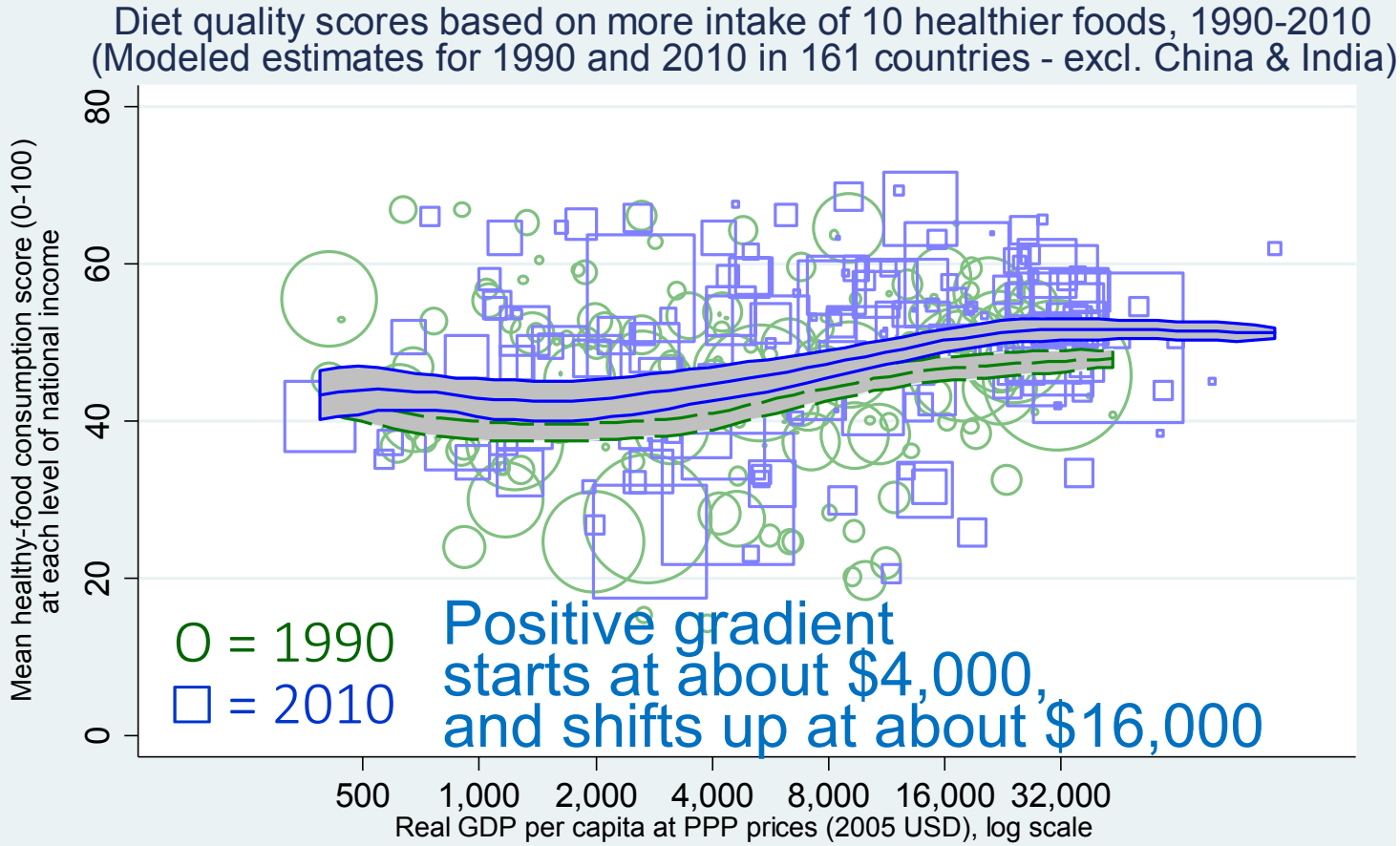
Diet quality is multi-dimensional

The GBD Nutrition and Chronic Diseases Expert Group (NutriCoDE) approach:

- More healthy foods
  - Diet score is higher (better) for more intake of protective, lower-risk items:
    - Fruits, vegetables, fish, milk, beans & legumes, nuts & seeds
    - Whole grains, fiber
    - Polyunsaturated fatty acids, plant omega-3s
- Less unhealthy foods
  - Diet score is higher (better) for *less* intake of unhealthy, higher-risk items:
    - Sugar-sweetened beverages
    - Red meats, processed meats
    - Saturated fat, trans fat, dietary cholesterol
    - Sodium

Source: Imamura et al. (2015). Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment. *Lancet Global Health*, 3(3), e132-e142.

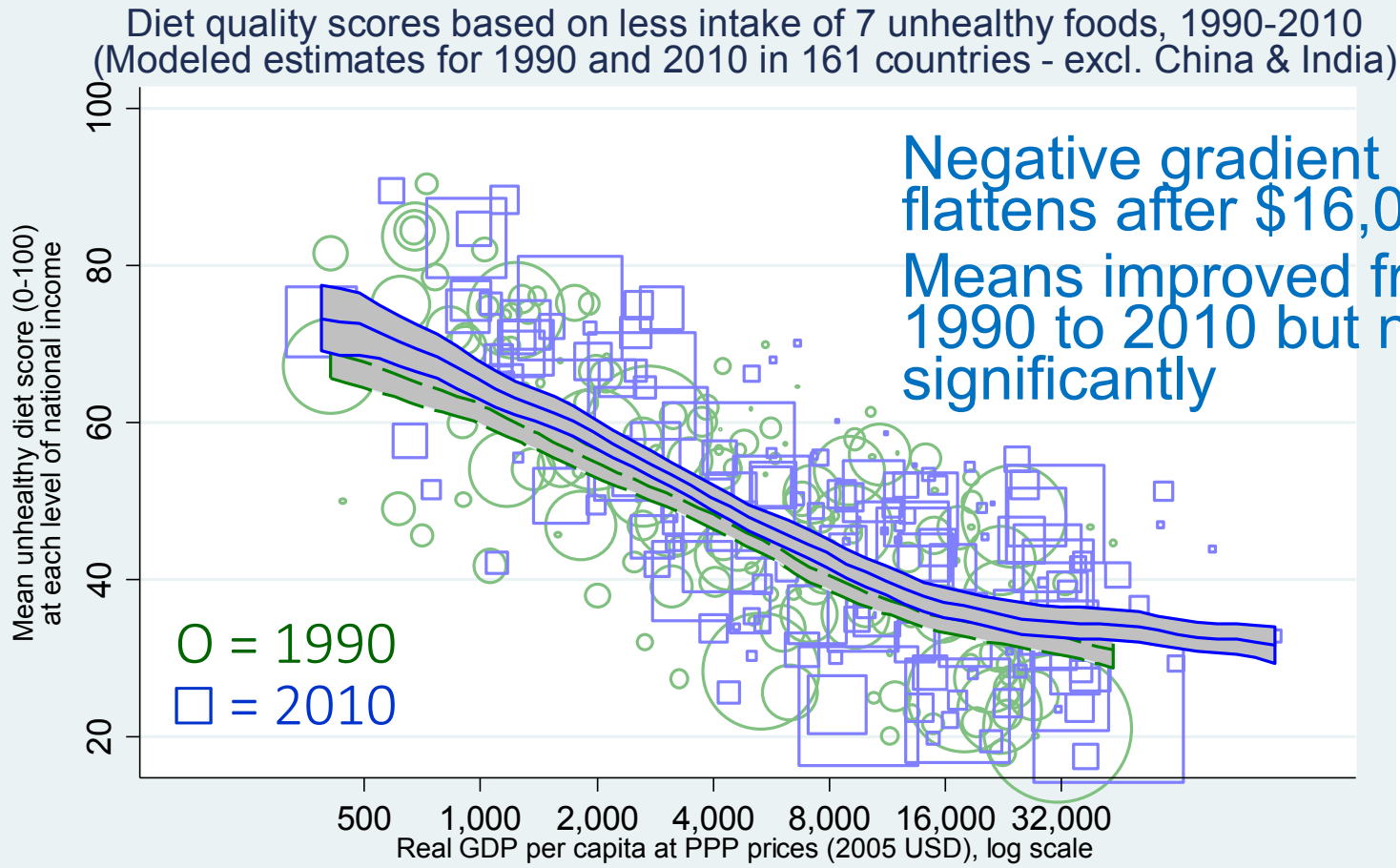
Imamura et al. index of healthy food use



Note: Symbols are sized by population, with year shown as 1990=green circles, 2010=blue squares.
Diet score is scaled so that higher values = more intake of 10 healthy items: fruits, fruits, vegetables, beans and legumes, nuts and seeds, whole grains, milk, polyunsaturated fatty acids, fish, plant omega-3s, and dietary fibre.
Lines show means and confidence intervals estimated by lpolyci, weighted by population and with a bandwidth of 0.75.

Source: Nutrition and Chronic Diseases Expert Group (NutriCoDE); GDP and population are from PWT 8.1.

Imamura et al. index of unhealthy food use



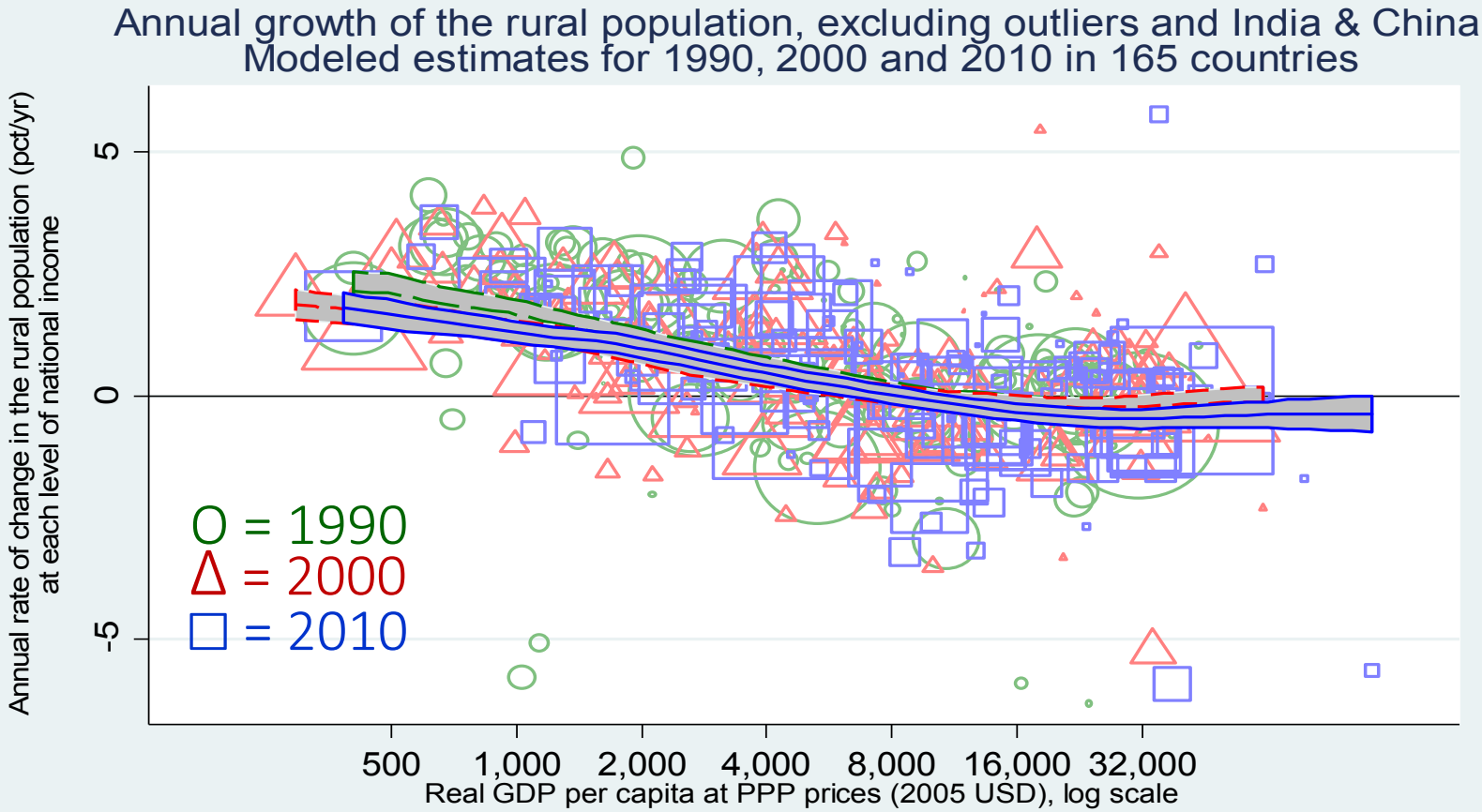
Note: Symbols are sized by population, with year shown as 1990=green circles, 2010=blue squares.
Diet score is scaled so that higher values = less intake of 7 unhealthy items: Red meats, processed meats, sugar-sweetened beverages, saturated fat, trans fat, dietary cholesterol, and sodium.
Lines show means and confidence intervals estimated by lpolyci, weighted by population and with a bandwidth of 0.75.

Source: Nutrition and Chronic Diseases Expert Group (NutriCoDE); GDP and population are from PWT 8.1.

We can look for similar shifts in:

agricultural transformation

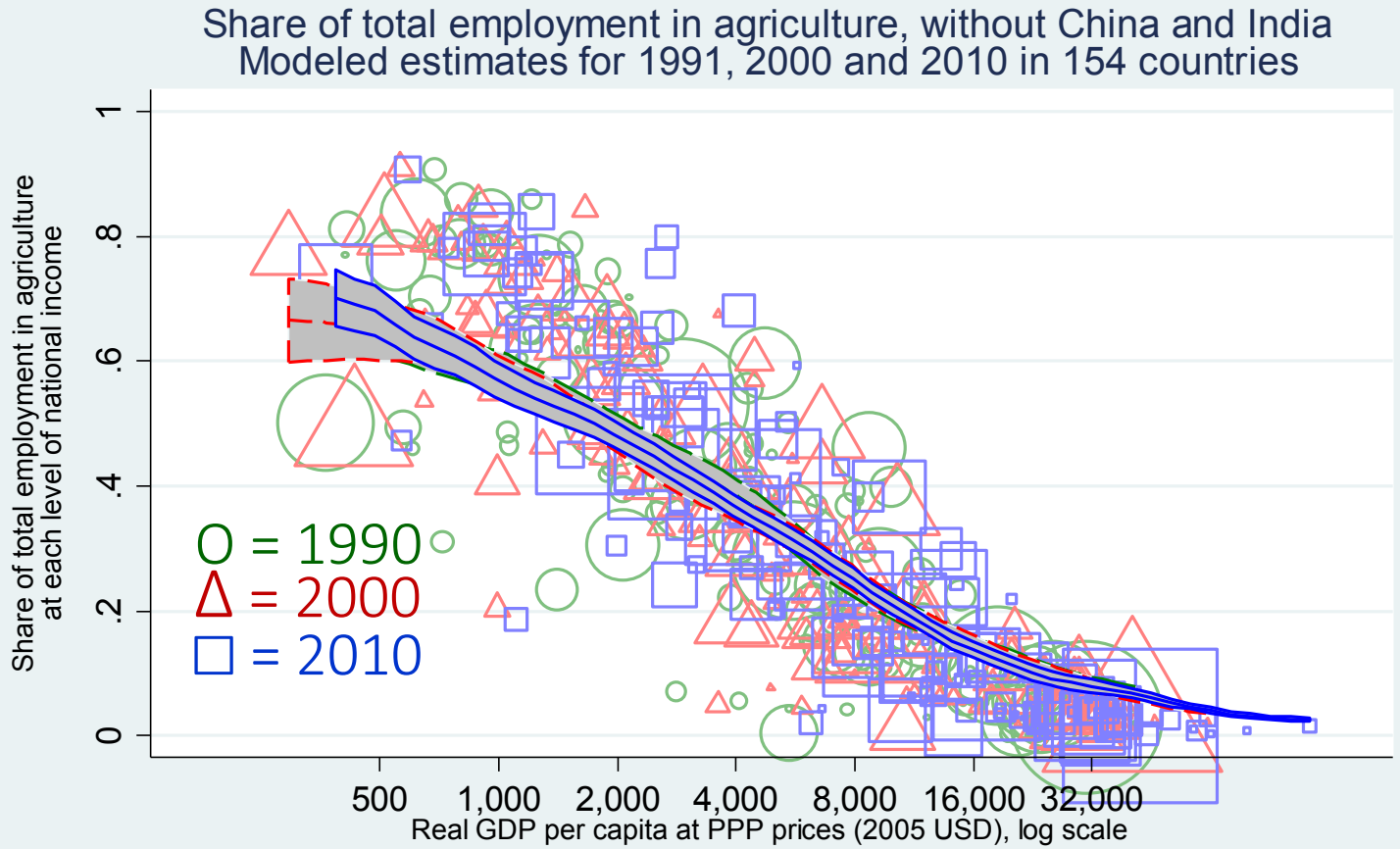
The poorest still have rapid rural population growth



Note: Symbols are sized by population, with year shown as 1991=green circles, 2000=red triangles, 2010=blue squares. Lines show means and confidence intervals for each year at each level of income, estimated by -lpolyci- with population weights and a bandwidth of 0.75. Excluded outliers are Afghan., Andorra & Falkland Is. in 1990, Andorra & W.Sah. in 2000, Japan in 2010.

Source: UN (2013) World Population Prospects; GDP and population from PWT 8.1.

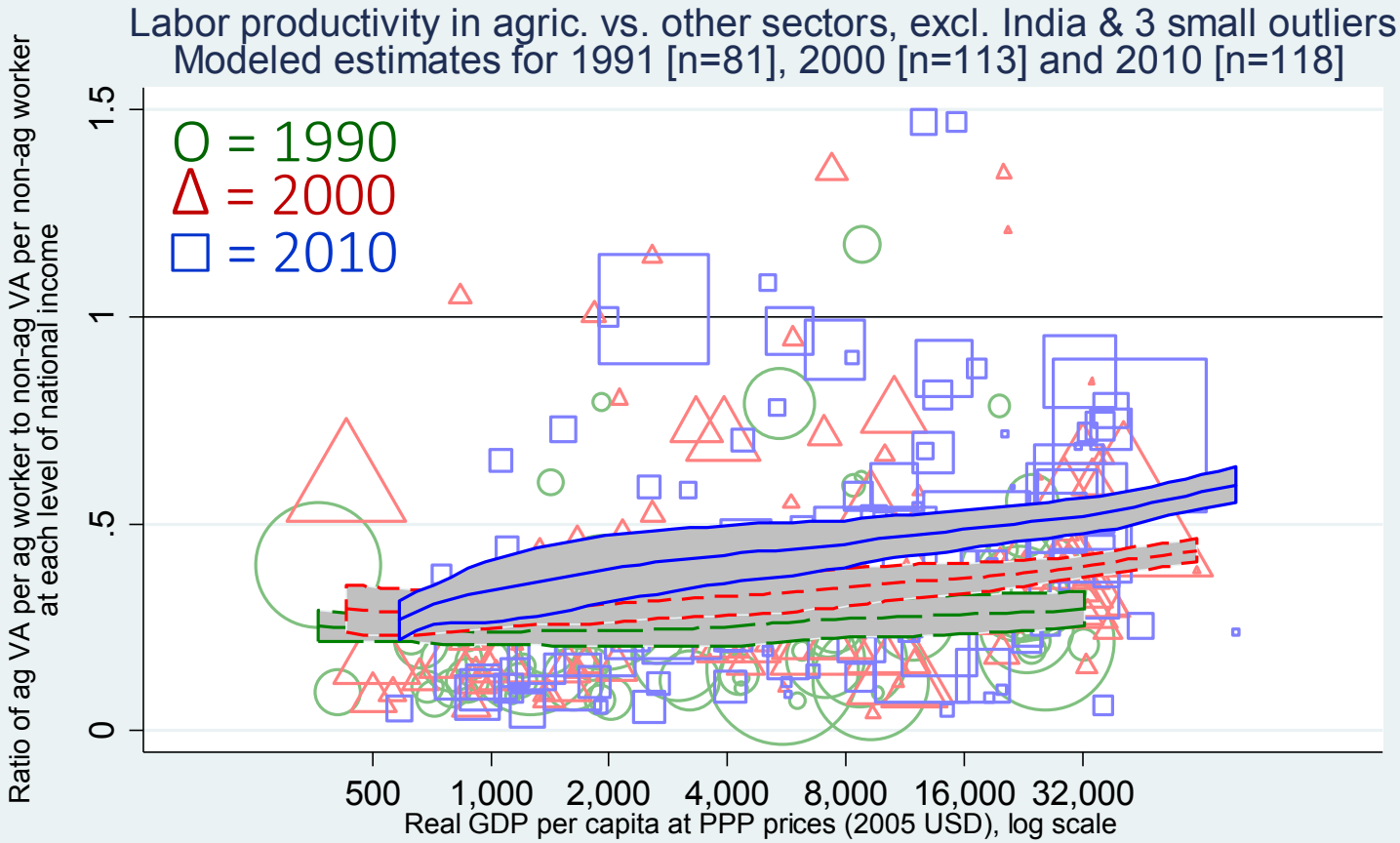
The poorest still have large majorities on farms



Note: Symbols are sized by population, with year shown as 1991=green circles, 2000=red triangles, 2010=blue squares. Lines show means and confidence intervals for each year at each level of income, estimated by -lpolyci- with population weights and a bandwidth of 0.75. Agriculture includes forestry, hunting and fishing.

Source: ILO (2015) WESO Trends 2015; GDP and population are from PWT 8.1.

Only for the richest have farm earnings shifted up



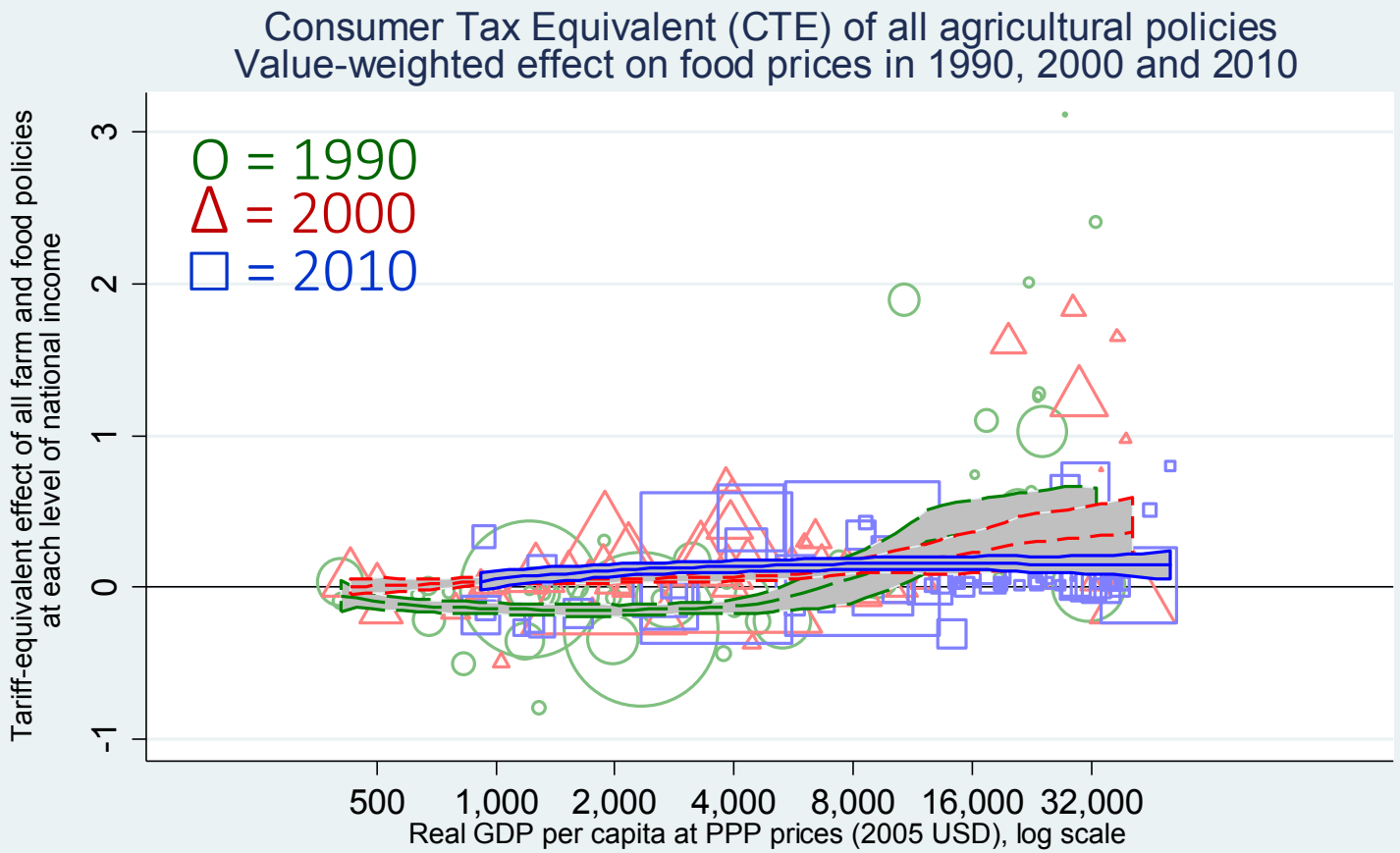
Note: Symbols are sized by population, with year shown as 1991=green circles, 2000=red triangles, 2010=blue squares. Lines show means and confidence intervals for each year at each level of income, estimated by -lpolyci- with population weights and a bandwidth of 0.75. Excluded outliers are Guyana in 2000, Slovenia and Malta in 2010.

Source: ILO (2015) WESO Trends 2015 & World Bank 2015; GDP and population are from PWT 8.1.

How have governments responded?

food price policy

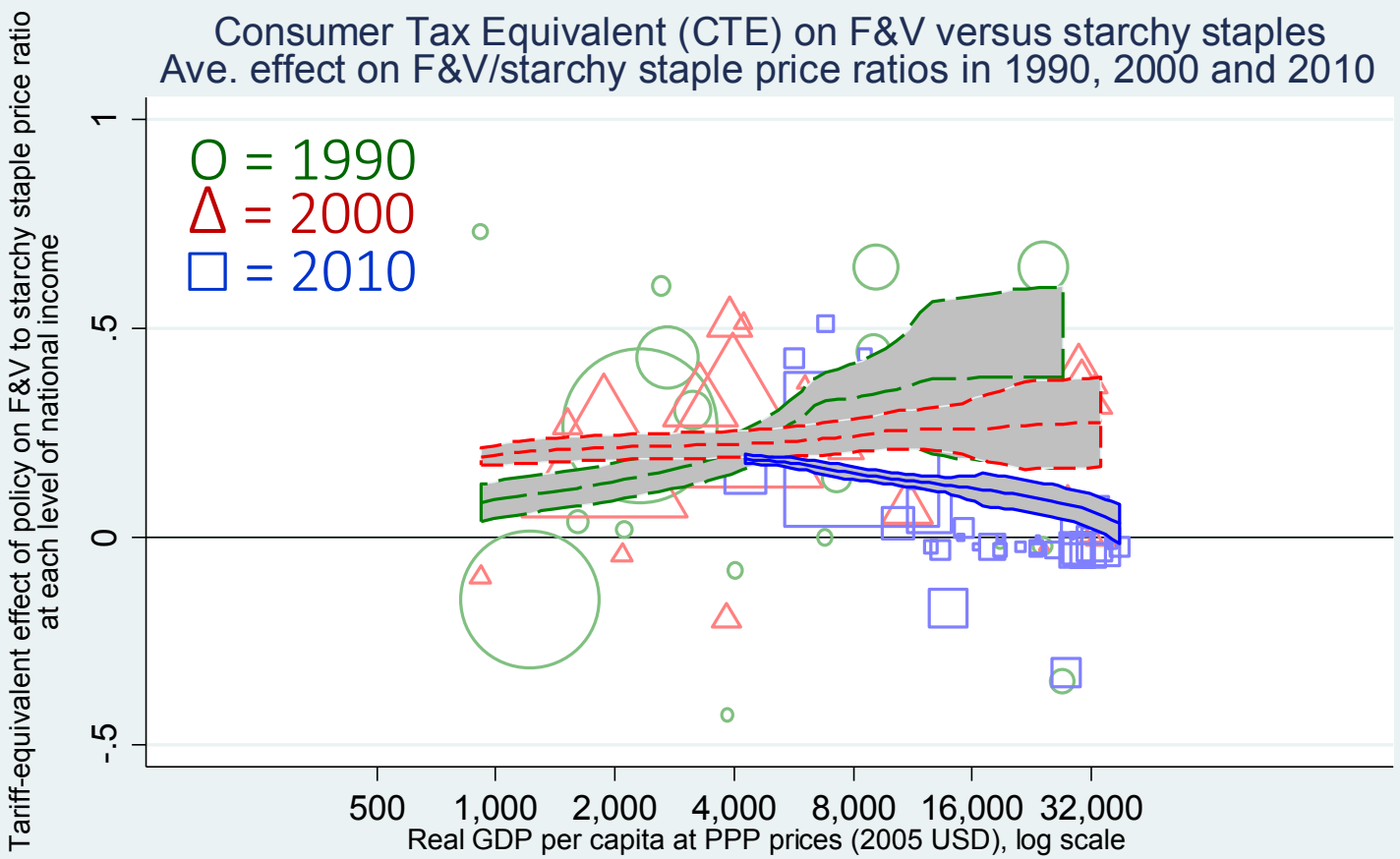
Food policy's "development paradox" is no longer



Note: Symbols are sized by population, with decades shown by green circles for 1990 (62 countries), red triangles for 2000 (77 countries) and blue squares for 2010 (69 countries).
Lines show local means and confidence intervals for each year estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: World Bank, Distortions to Agricultural Incentives project; GDP and population from PWT 8.1.

Food policy's pro-staples bias is diminished



Note: Symbols are sized by population, with decades shown by green circles for 1990 (29 countries), red triangles for 2000 (31 countries) and blue squares for 2010 (33 countries).
Lines show local means and confidence intervals for each year estimated by -lpolyci-, weighted by population and with a bandwidth of 0.75.

Source: World Bank, Distortions to Agricultural Incentives; GDP and population from PWT 8.1.

Fifteen years into the 21st century, what's changed?

The Preston curve approach reveals a lot:

- **The present is like the past, only more so**
  - most change is movement along a stable development path
    -- although some variables have shifted, at some income levels

- **Significant global shifts include:**
  - for the poorest, much less stunting, wasting and diarrheal disease
  - at middle-income levels, more diabetes and other diet-related disease
  - in the richest countries, more obesity but also more healthy food intake

- **The most surprising shifts may be in policy choices**
  - no longer pushing food prices down in poor countries/up in rich countries
  - no longer keeping starchy staples cheaper than F&V

Looking forward, what can we learn from the past?

Bending these curves requires concerted action:

- **To complete the eradication of undernutrition**
  --sharp declines have been achieved by both shifting & moving along the curves
- **To treat the existing burden of diet-related disease**
  --at higher incomes diabetes is controlled, despite rising obesity
- **To prevent future increases in diet-related disease**
  - upward shifts in the income gradient for obesity may be reversible
- **To take advantage of changes in food price policy**
  - ending policies that favor starchy staples creates incentives for new investment

…But note the evidence is still very limited!
Many results rest on inference from few observations
We can only see where there is data.

thank you!

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