Use of Micro and Macro Frameworks in Estimating Poverty Implications of Changes in Food Prices

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Motivation

- Food prices appear to have become volatile in the recent years
  - Significant spikes are becoming common (2008, 2010)
- In the long run, food prices may be on the rise as well
  - Driven by increasing demand for biofuels, population growth
- Many people are concerned about higher food prices
  - Food expenditure represents 60+ percent of poor households' budgets, possible welfare implications
  - Food producing households might benefit
- What do higher food prices mean for development?
  - We need good tools to analyze what the past changes mean and what we can do about it through better policy

WB food price index 1960–2010

1970's oil crisis

2010 food crisis

2008 food crisis
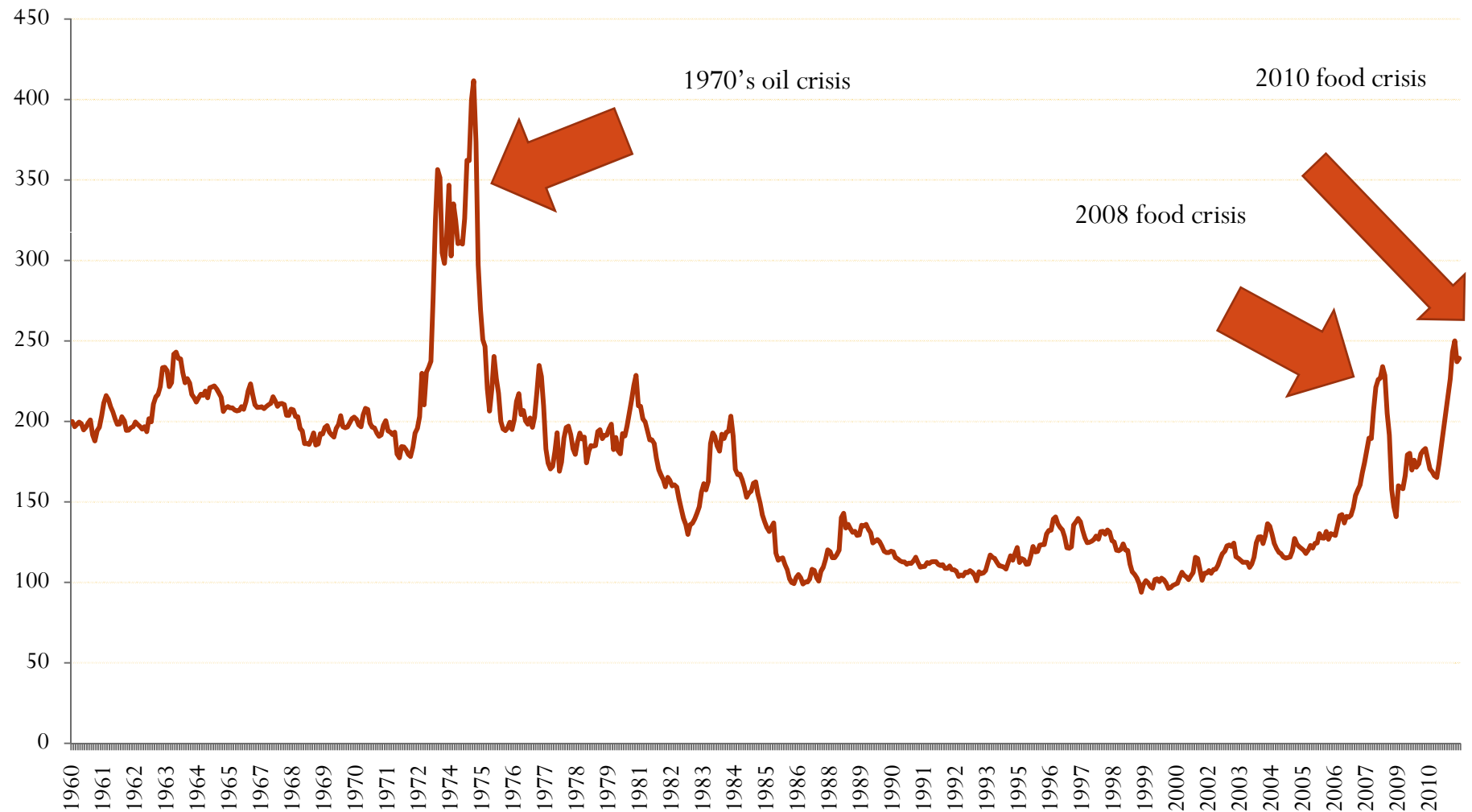
Many possible methodologies to study impacts of food prices—a few examples

- Ex post micro-level studies
  - Household surveys asking about impact of previously higher food prices
  - Econometric estimates of the impact of food prices on consumption (need panel data)
  - Very slow… may take too long to conduct a survey
- Ex ante micro-level studies
  - Simulation of food price impacts on households
  - Need to formulate a set of assumptions
  - Using already available household survey data—answers may be ready quickly
- Ex ante macro-level studies
  - Using macro (global) models to simulate economy wide impacts of food crises
  - Less precise in calculating poverty impacts—extrapolation of macro changes on poverty
- Combination of both approaches
  - Macro/global model with detailed household surveys
  - Households may be included in the global model (costly to do)
  - Models may be only loosely connected (much easier to do)

Food prices have risen… where do we start our analysis?

- Methodology depends on the questions we ask
  - Are we interested in ex post analysis or would we like to make predictions?
  - Do we need a macro model or will a micro model be sufficient?
    - What are the driving forces of the changes?
    - Change in global demand/supply?
    - Domestic productivity/weather shocks?
    - How much of the economy is likely to be impacted?
  - What types of behavior do we need to model?
    - Is the impact only short-term or is it likely to stay with us?
    - Can farmers adjust production/input use to higher prices?
    - Are wages and other prices likely to be affected?
- Data requirements depend on the scope of the analysis
  - Do we have enough data?
    - Global/regional analysis requires a sufficient sample of comparable surveys
    - Ex post analyses often require good panel data

# Previous uses of combined micro and macro frameworks in informing policymakers

- Food crises have been extensively studied using combined micro/macro tools
  - The 2008 crisis is estimated to have put 105 million people in poverty (Ivanic and Martin, 2008)
  - The food crisis of 2010 is estimated to have put 44 million in poverty (Ivanic, Martin, Zaman 2011)
- They have also been used to make policy recommendations
  - A modest annual increase in agricultural productivity is found to offset most of the negative poverty impacts of rising demand (Ivanic and Martin 2010)
  - Productivity-raising policies found more effective than import protection policies

Example: Assessment of short-run impact of food 2010 food price crisis on global poverty

- Work in collaboration with Will Martin and Hassan Zaman
- We evaluated poverty impacts for a representative sample of developing countries
  - We used a set of 28 recent household surveys
    - Information on households income, food purchases, production & sales
  - We evaluated changes in global and domestic food prices
    - Countries may be to a large degree insulated from the observed changes in global prices
- We extrapolated the sample results to the rest of the developing countries
  - Weighted by population
  - Separate calculations for the groups of low- and middle-income countries

Large number of household surveys is a necessary basis for global analysis
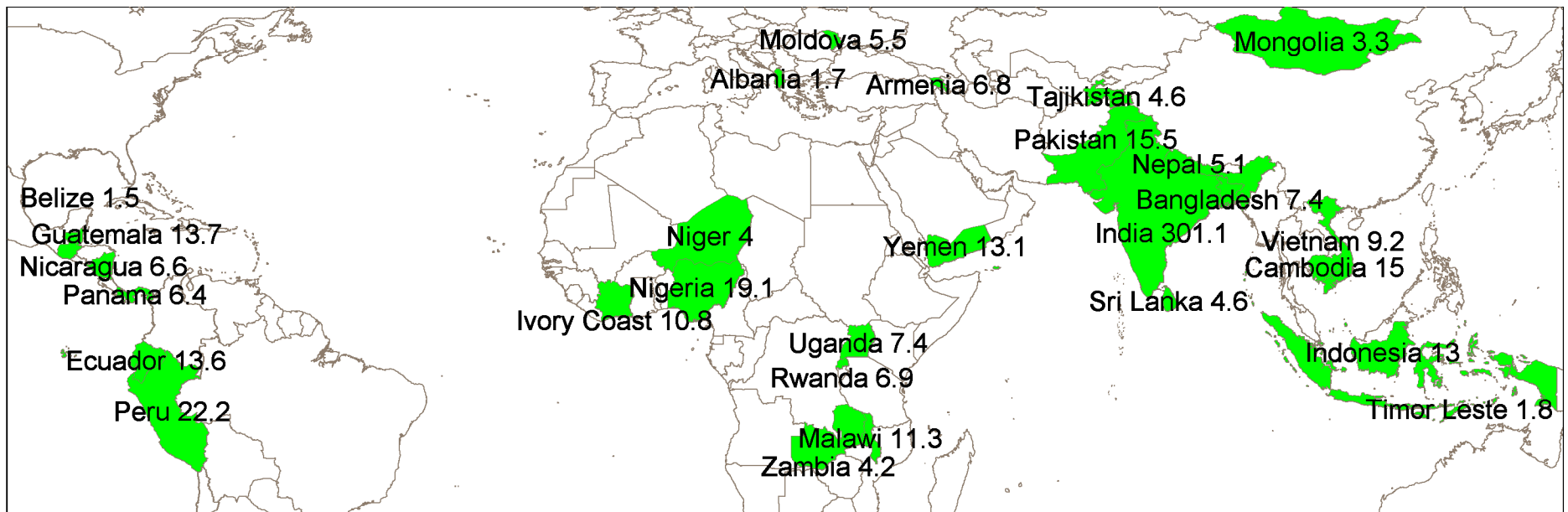
- We have household surveys for 28 developing countries representing 42 percent of middle-income countries (by population)
- Survey conducted between 2000–2009
- All surveys contain information on expenditures, production and sales of 38 agricultural and food, and non-food commodities

# Also necessary: good information on price changes

- Global price data for key commodities
  - Obtained from the Global Economic Monitor
- Domestic prices
  - FAO's Global Information and Early Warning System (GIEWS)
- Price coverage is far from perfect
  - Global price changes for 23 out of 38 commodities
    - E.g. Pork, dairy, processed food were missing
  - Domestic price changes for 22 out of 28 countries
    - On average only 2-3 main commodities available
- When no domestic price was available, use an alternative price transmission parameters
  - E.g. GTAP private consumption shares

Key global price changes observed June 2010-December 2010

Commodity	Price change (percent)
Sugar	76
Sorghum	69
Wheat	68
Maize	64
Soybeans	34
Groundnut oil	31
Barley	30
Rice	21
Beef	17
Oranges (proxy for fruits)	-40

Domestic price changes often weakly correlated with global price changes

Wheat price change (June 2010–December 2010)


Source: GEM, FAO
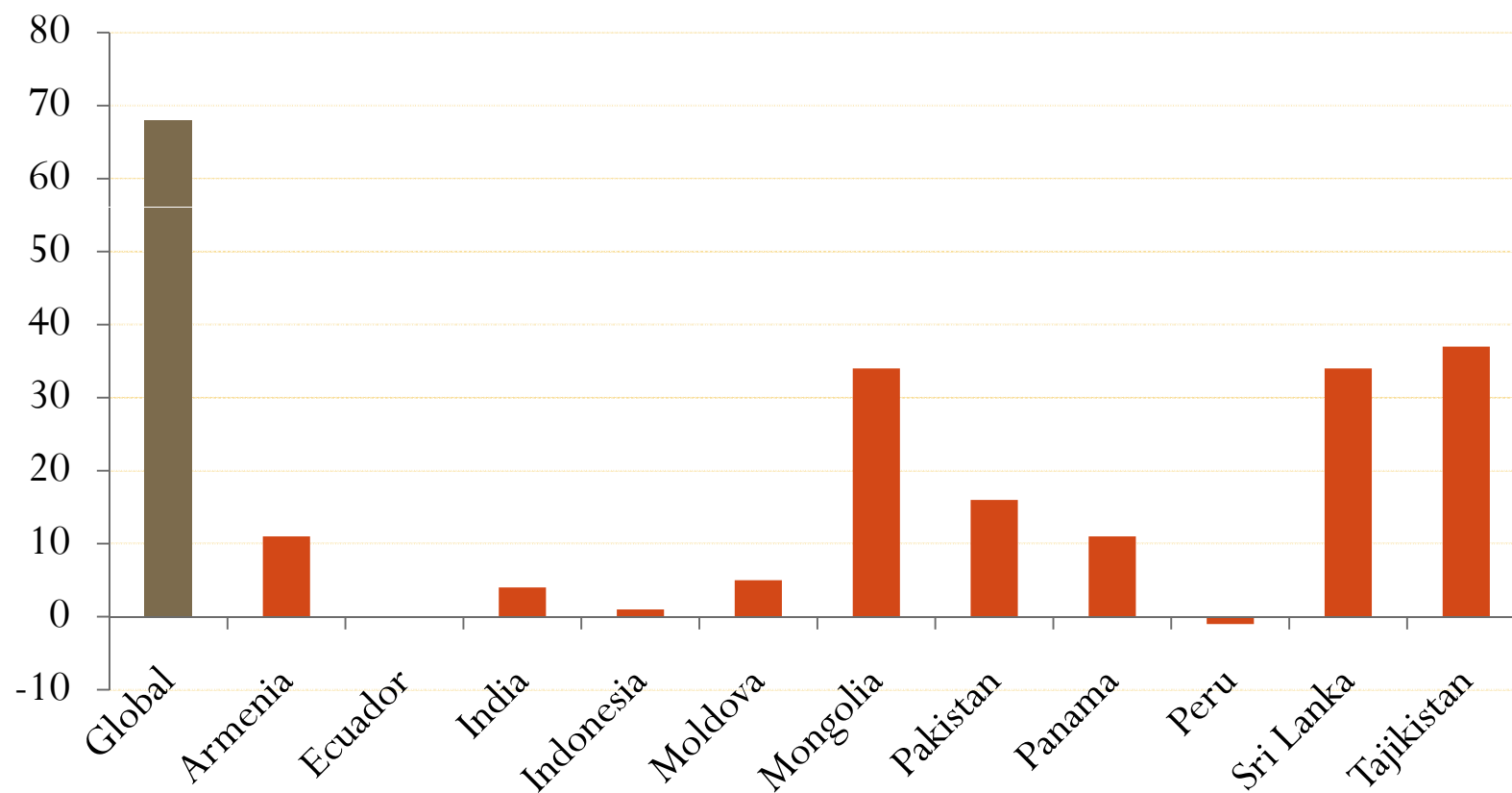
Calculation of changes in household welfare

- We measure how each household's per capita real income has been impacted by changes in food prices
- We consider
  - Change in household agricultural profits $\Delta\pi$
    - Ignoring input costs and output responses in the short run, only focusing on sales
  - Change in household cost of living Δc
    - We measure the cost of initial level of utility
    - We assume CDE preferences
  - Net welfare change $\Delta w = \Delta\pi - \Delta c$
- We consider 0.6 as the size elasticity of the cost of living
  - Doubling household size requires only 60 percent higher income to maintain the same level of welfare

Aggregate poverty statistics

- We establish the poverty level of utility (income)
  - PovCalNet data
- Count households that move out and into poverty (poverty headcount)
- Measure the average distance from the poverty line for those who are poor (poverty gap)

Poverty line

In poverty

Δw

Out of poverty

Δw

Poverty gap

Δw

Δw

Poverty gap
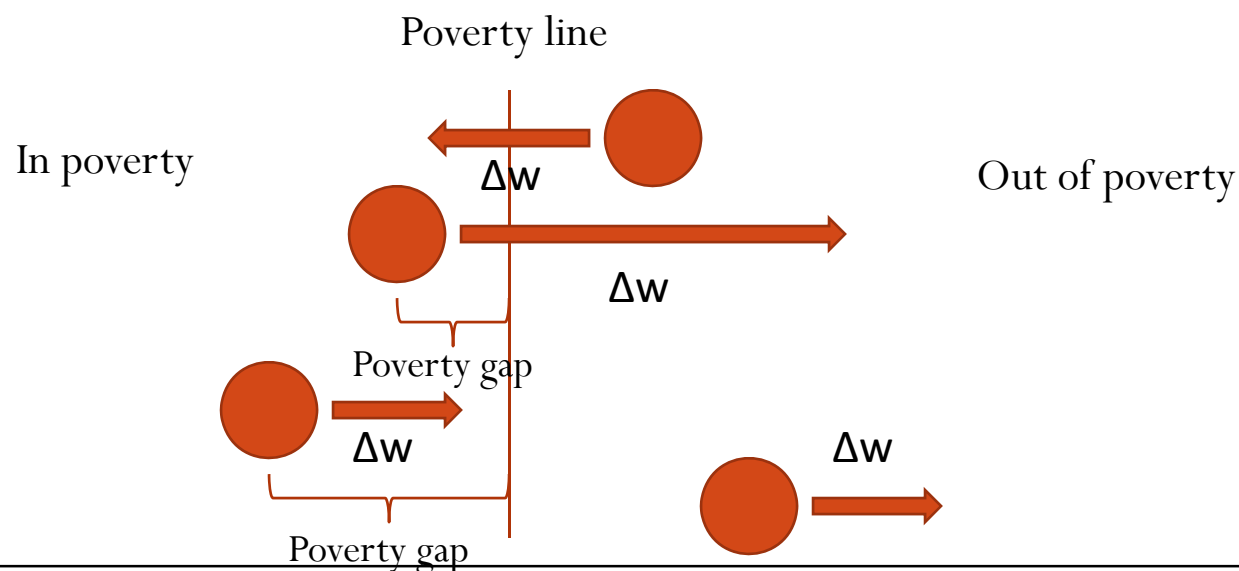
We calculate poverty changes for each country in our sample
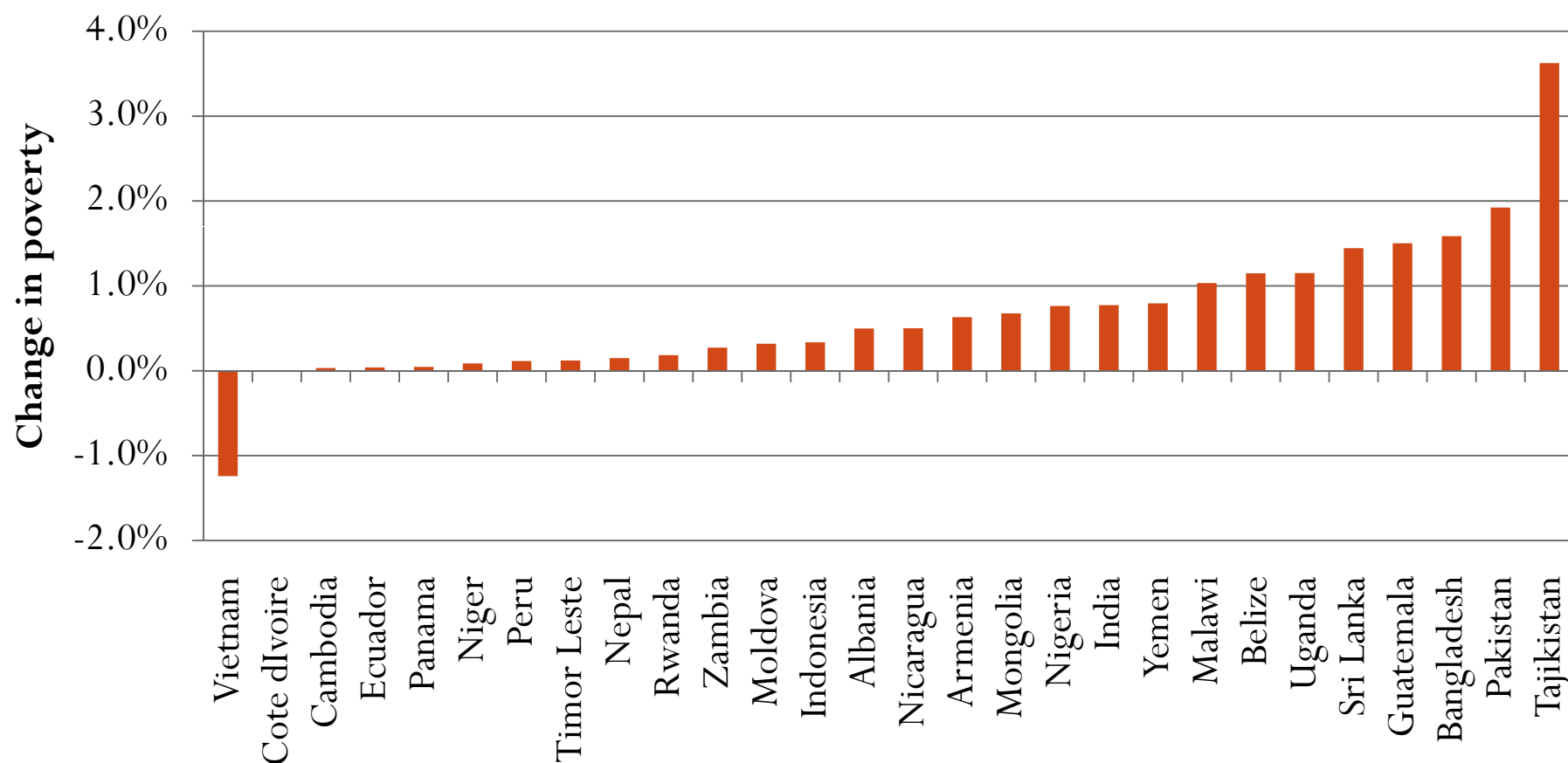
We may use the richness of our model to decompose our answers
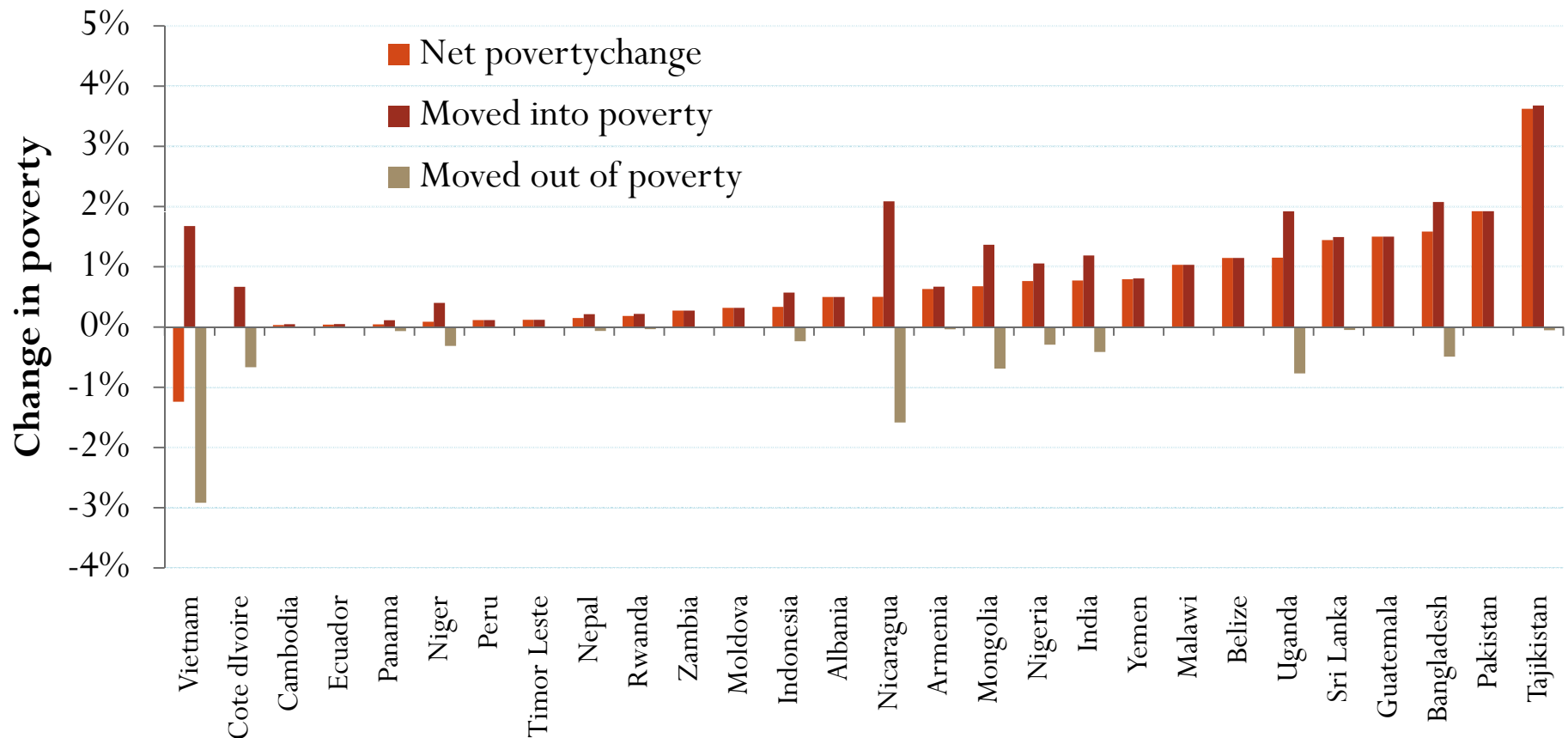
# How can we draw conclusions for the rest of the world?

- We calculate population-weighted average poverty change for two groups of developing countries
  - Low-income countries (+1.1 percent of population)
  - Middle-income countries (+0.7 percent of population)
- We apply poverty changes to the global population
  - Low-income countries: 828 million
  - Middle-income countries: 4,758 million
- We obtain global poverty change
  - Low-income countries: +9.5 million
  - Middle-income countries: +34.1 million
  - Total change: +43.7 million

How do we assess robustness of our poverty change estimates?

- Our sample may be biased
  - The results may be driven by any one of the countries included in the sample?
- Our result may not be generally valid
  - Poverty change may be dependent on poverty definition
- Our assumptions may be wrong
  - With detailed price changes generally unavailable, we risk feeding the model with irrelevant price changes
- We run a set of sensitivity analyses in order to understand how robust our results are

Sample sensitivity analysis

- We verify that our result is not very sensitive to any specific country result

- We repeat our poverty calculations 28 times, each time excluding one country

- We find that our results remain stable throughout
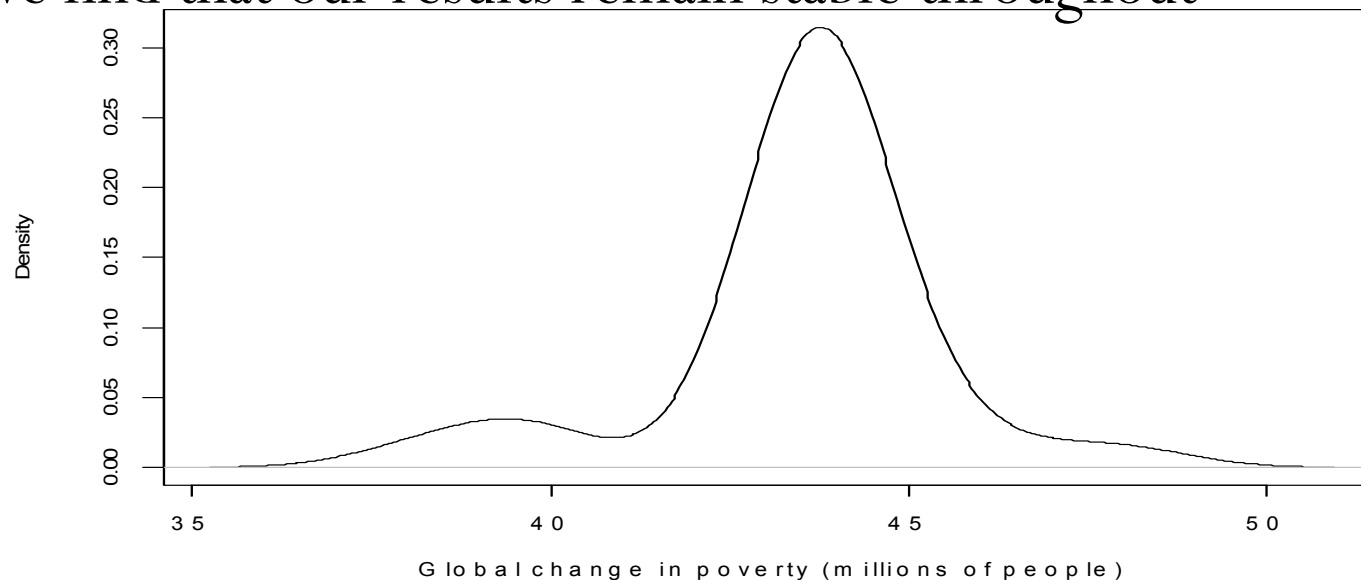
Our results are robust with respect to poverty line

Poverty line	Net change in global poverty, millions of people	Gross reductions in poverty, millions of people	Gross increases in poverty, millions of people
PPP USD/person/day			
1.00	46.5	-19.2	65.7
1.13	47.0	-20.9	67.9
1.19	44.4	-23.4	67.8
1.25	**43.7**	**-24.0**	**67.7**
1.31	42.1	-25.2	67.3
1.38	41.5	-20.9	67.9
2.00	26.9	-23.1	50.0

- Poverty changes vary little with small changes in poverty line
- Significant changes in poverty line affect poverty outcomes more significantly

Possible extensions of the analysis to answer long-run questions

- Use a CGE model to estimate long-run impacts of several key variables
  - Wage rages
  - Output responses
  - Land use
- Include quantity adjustments among producers
  - Price and productivity driven
- Integrate closely micro and macro model
  - Assure consistency between the models
  - The models may also be united into one

Research question: Poverty impacts of global food price projections 2010–2050

- Global population is projected to rise by 34 percent with regional variation
  - Sub-Saharan Africa rise of 120 percent
  - Very low population growth in East Asia: 10 percent
  - Moderate growth in Latin America: 33 percent
  - Decline in Europe and Central Asia of 4 percent
- Developing country growth also projected strong
  - Capital stock in East Asia to grow by 800 percent
  - Very high factor productivity growth in East and South Asia

How can global growth affect food prices?

- Growth in population raises demand for food and food prices in two ways
  - Population growth increases food demand directly
    - More mouths to feed with the same amount of land
  - Income growth increases demand
    - Income elasticity of food is high for low-income countries
    - Especially East & South Asia can afford more food as their per capita incomes grow significantly
- Growth can affect supply of food too
  - Growth of capital stock "pulls" resources out of agriculture in developing countries
    - Rybczynski effect
  - Improvements in agricultural productivity raise output
    - The same amount of land can produce more food
    - Higher effective prices attract additional resources

How global growth affects poverty

- Rising food demand and food prices
  - Harm consumers who have to pay more for food
  - Help net-selling farm households whose incomes rise
- Higher productivity and larger endowments
  - Raise real incomes and lower poverty
  - Higher agricultural productivity
    - Raises agricultural output and effective producer prices
    - Higher supply lowers actual prices
- Technology adoption rate
  - A high rate of adoption of higher agricultural productivity by smallholder farmers may help the poor who are often smallholders as well

What analytical framework?

- Use a global CGE model to examine the impact of projections on agricultural outcomes
  - Exogenous variables: population growth, factor accumulation, productivity changes
  - Outputs: price changes
- To examine the impact of price changes on poverty we use a detailed household model
  - Exogenous variables: price changes & productivity gains
  - Outputs: individual households' changes in welfare and poverty

Global general equilibrium model

- Standard GTAP model
  - Six World Bank defined regions
- Latest GTAP database
  - Expanded agricultural commodity detail (FAO data)
    - 22 original agricultural and food commodities split in 38
      - E.g. split Soybeans and Groundnuts from "Oil seeds"
      - Focus on "orphan" crops such as sorghum, cassava etc.
- Parameter values
  - Doubled the trade elasticities for long run analysis
  - Raised value-added substitution in "Forestry" and "Fishing" to allow for growth in these industries
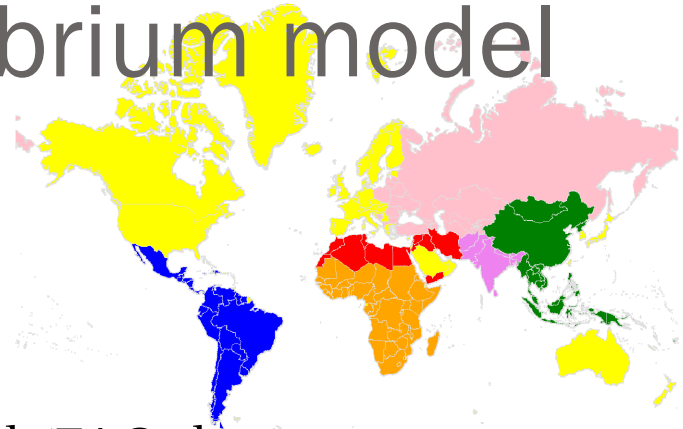
Household model

- Calculate welfare changes for each household
  - Change in the cost of living
  - Change in business income
  - Change in wage income
- Take into account the second-order impacts
  - Households adjust their consumption and production with respect to changing prices
    - Demand (CDE)
    - Supply (CRETH)
   - Supply and demand parameters consistent with CGE model

Scenarios

- Four broad scenarios
  - Baseline (projected growth)
  - Higher agricultural TFP worldwide (additional 1pct p.a.)
  - Higher agricultural TFP in developing countries (additional 1pct p.a.)
  - Protection of primary agriculture in developing countries
    - Raise self-sufficiency—halve import shares in 2050
- Additional analyses
  - Higher productivity in individual crops
  - Type of technical change
    - **Factor** productivity or **total** productivity
  - Assessing the importance of the adoption rate

Global aggregate changes

Commodity	Baseline		AgTFP+1	
	Output	Price (CPI)	Output	Price (CPI)
Primary agriculture	126.9	115.6	179.1	4.8
Processed food	124.6	14.0	154.6	-1.8
All food	126.0	48.3	164.7	1.4
Energy	206.7	-6.0	212.4	0.8
Nondurables	204.7	-4.7	209.7	-0.6
Durables	203.5	-6.4	205.5	-0.2
Services	177.1	-5.9	179.6	-0.4

- Food prices are significantly lowered by higher agricultural TFP

# Poverty impacts by country of higher agricultural TFP & protection (relative to baseline)
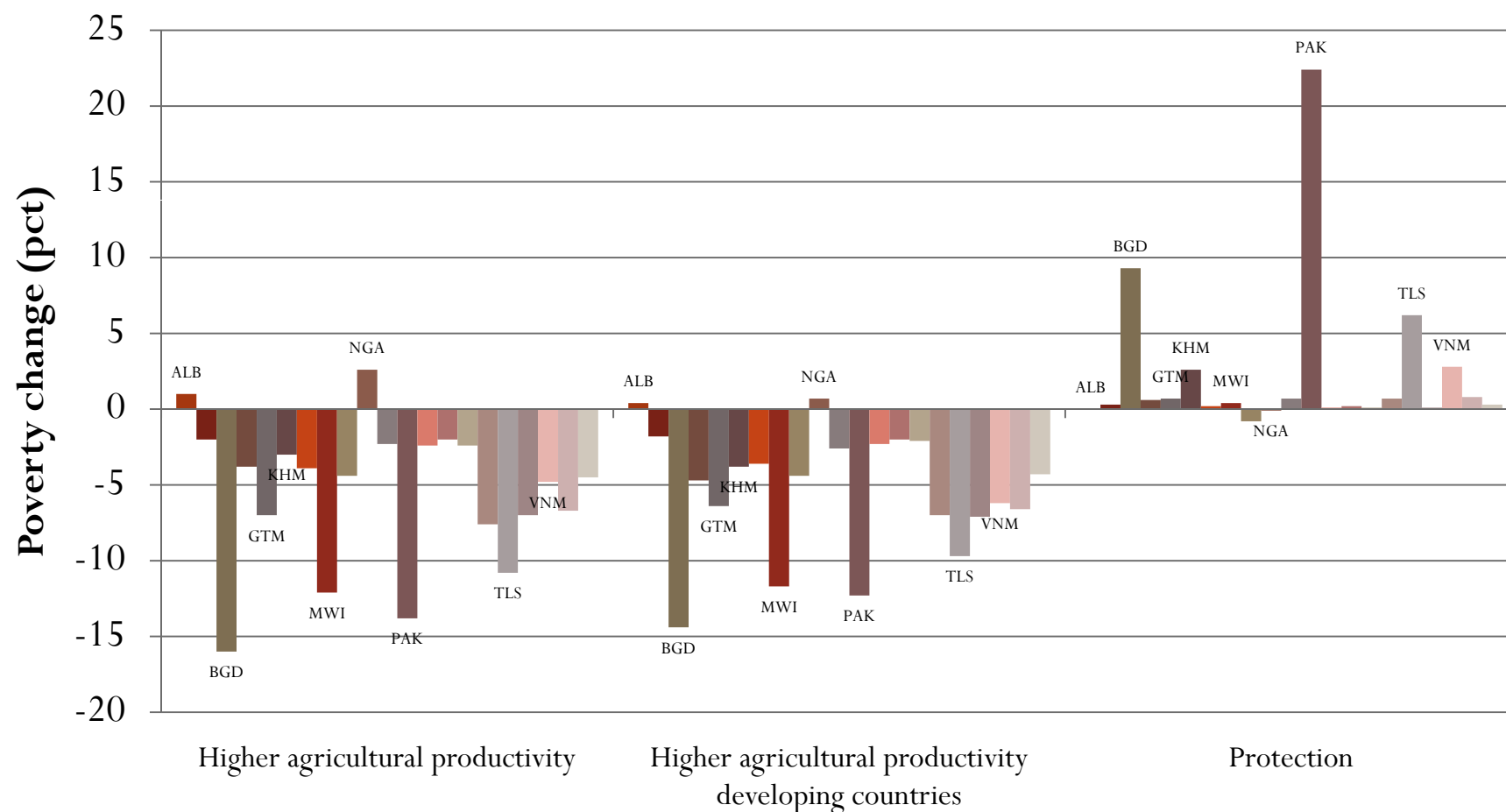
Decomposition of global poverty impacts (relative to baseline)
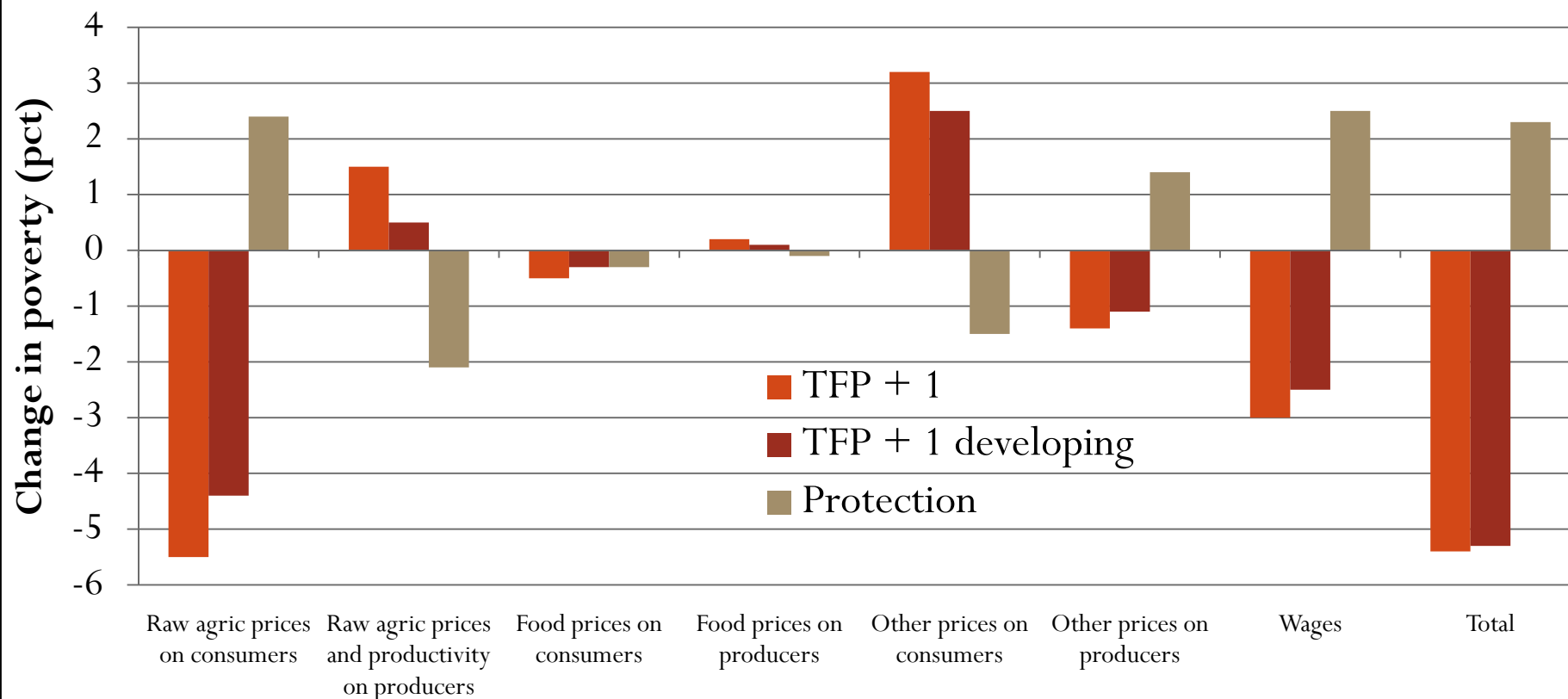
- Higher agricultural productivity lowers poverty mainly through favorable agricultural price and wage impacts
- Protection works in opposite direction, mainly hurting poor through lower wages
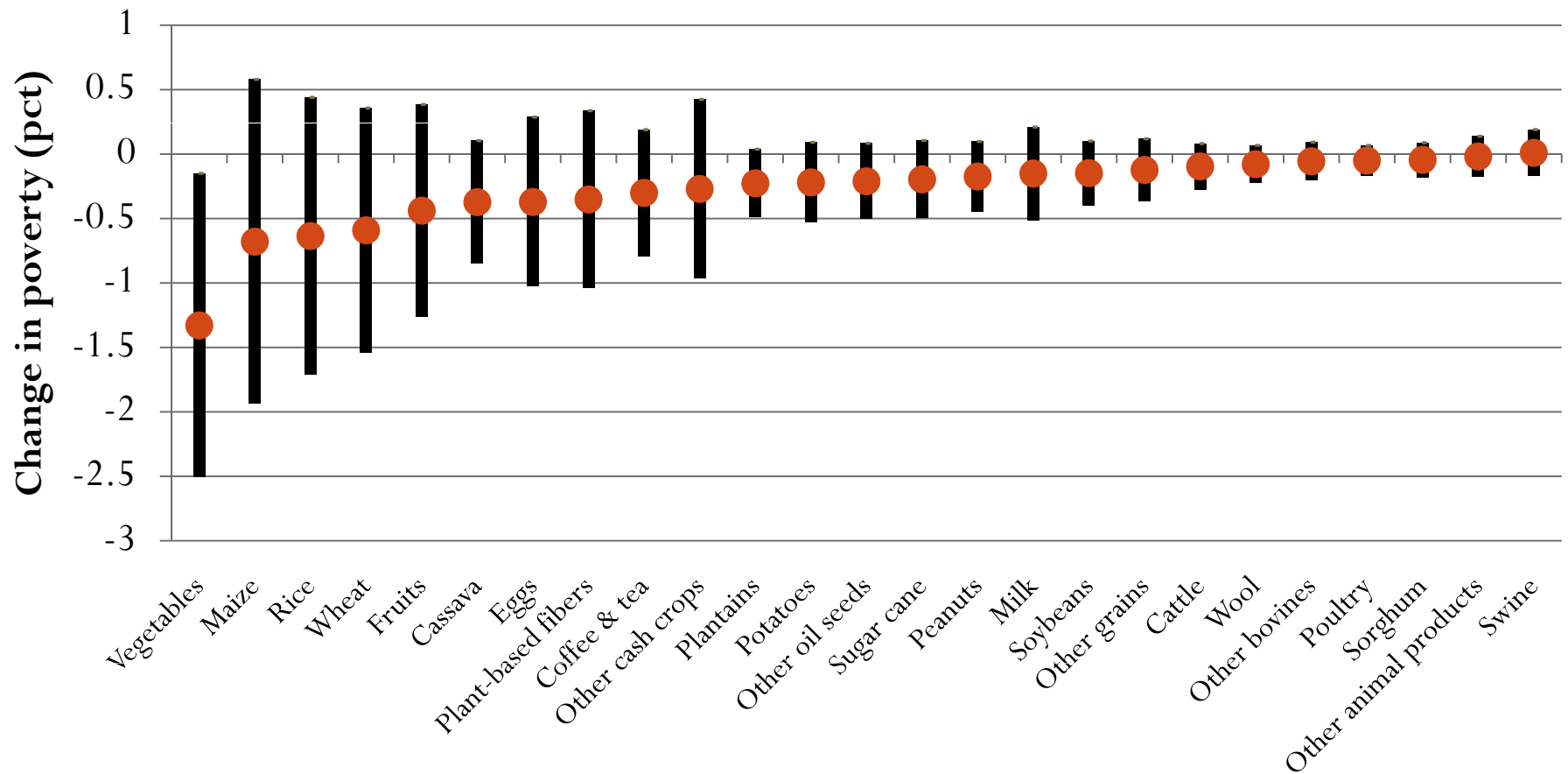
Comparison of regional poverty impacts
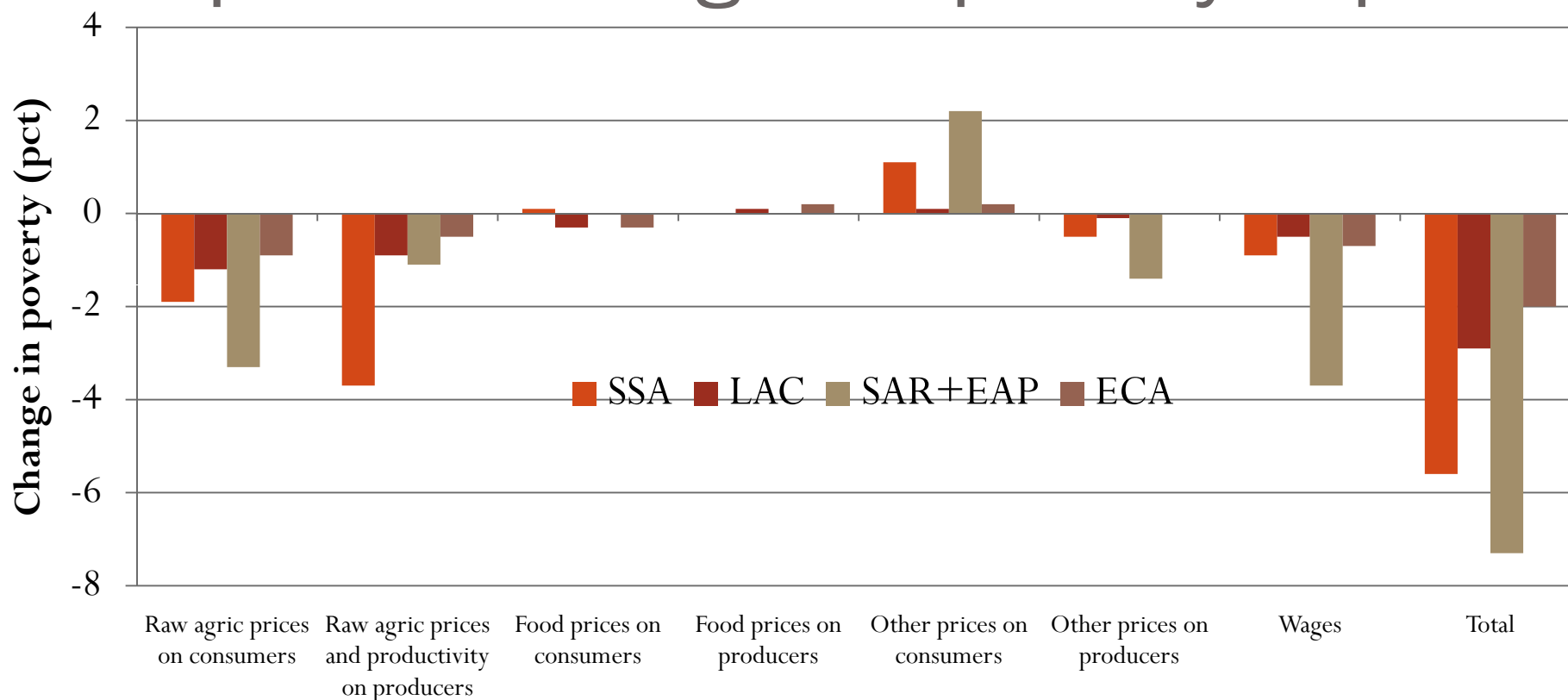
- Simulation: 1 pct additional agric growth by region
- Significant regional differences appear:
    - Africa benefits mainly from direct impacts on the price of agriculture
    - Asia benefits manly from wages
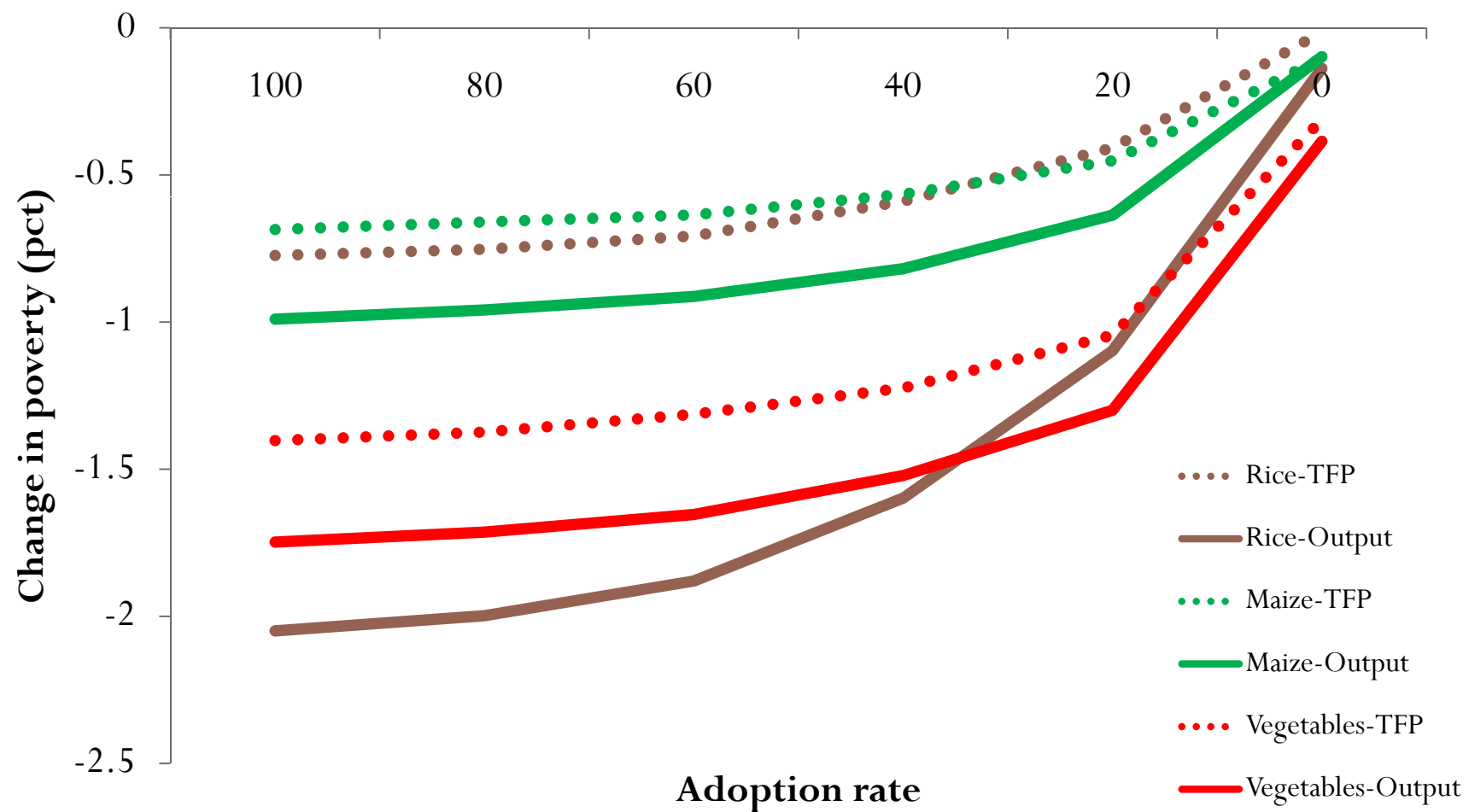   - Latin America and Eastern Europe benefit more equally

Impact of higher productivity on poverty by commodity (1pct TFP)

Adoption rates & poverty impacts of total **factor** productivity (1pct p.a.)
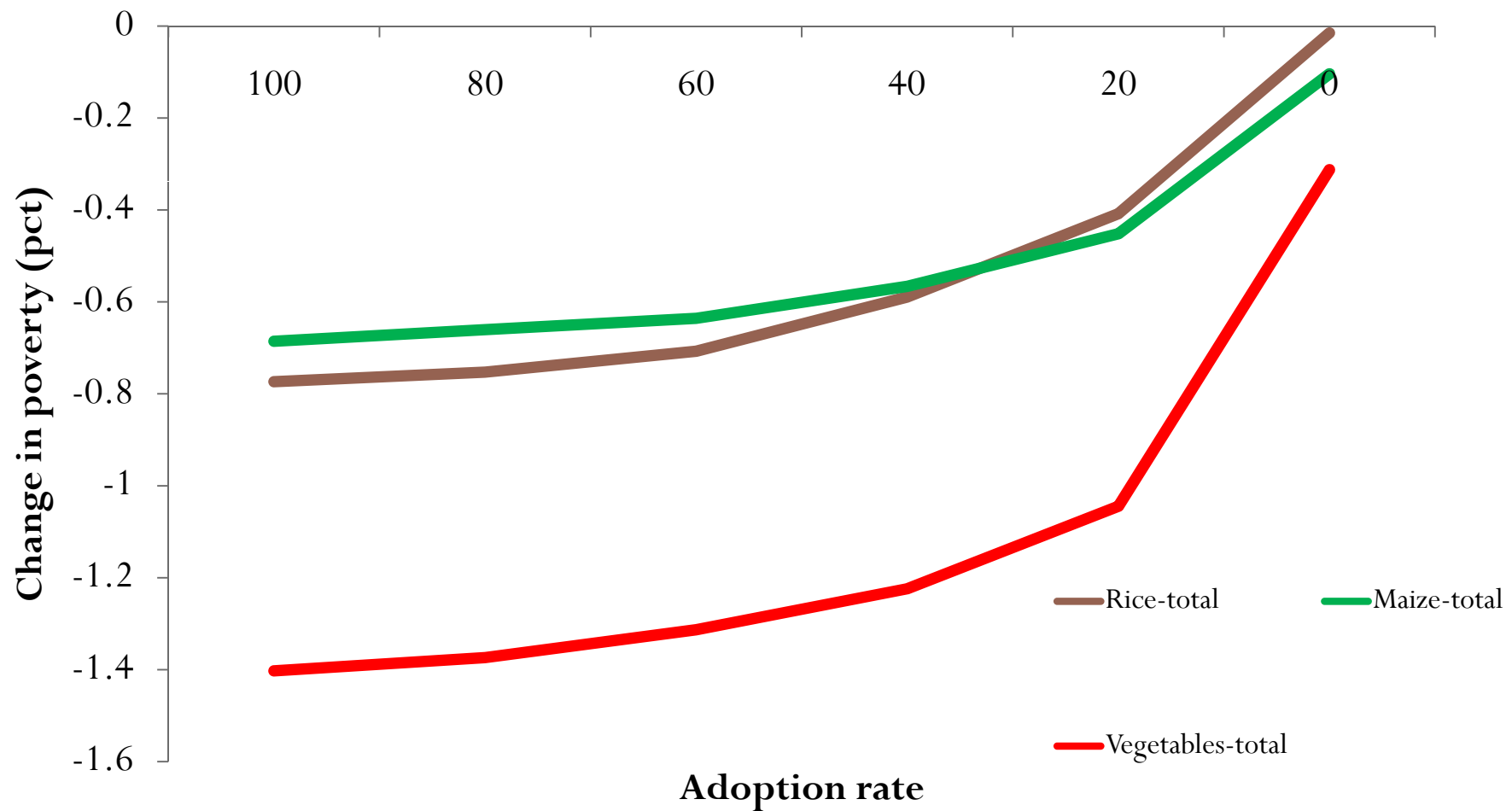
Adoption rates & total **output** productivity impacts on poverty (1pct p.a)

Conclusion

- Micro and micro tools are extremely useful in analyzing the likely poverty impacts of significant food price shocks
  - Simple scenarios can often be answer satisfactorily and quickly using simple methodology (household survey studies)
  - Complex and ex ante research questions may require the use of a CGE model
    - Long-run projections
    - Impact of unobservable variables (wages)
- Merging CGE with micro-simulations is not necessary as long as we assure broad consistency
- Data remains the greatest stumbling block of the analysis
  - Not enough household surveys
  - Not enough timely and comprehesive price information