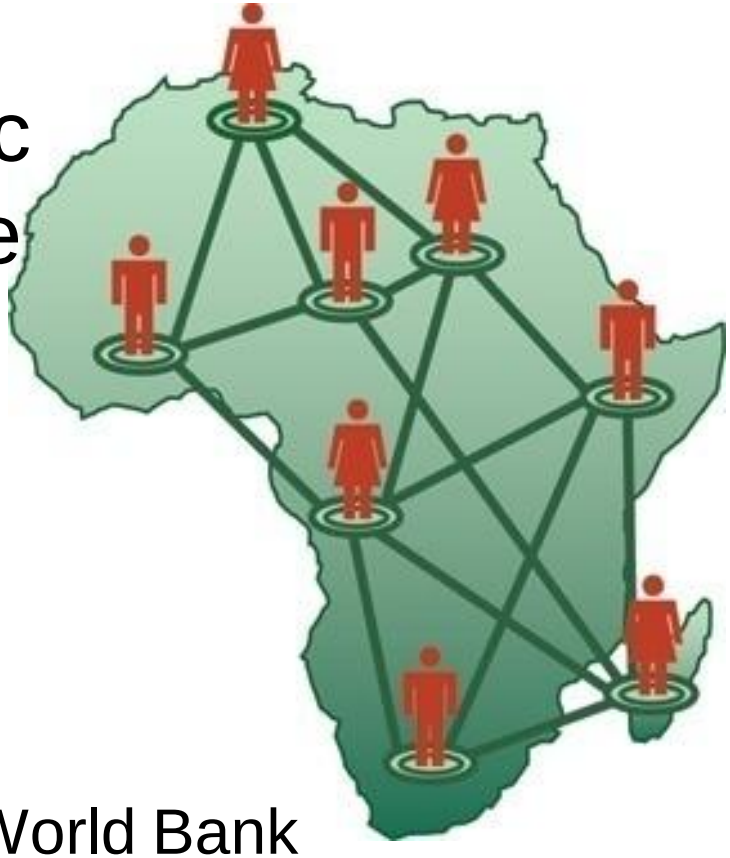
Using Global Static CGE to Assess the Effects of Climate Volatility



Presented by:

Amer Ahmed, World Bank

AGRODEP Workshop on Analytical Tools for Climate Change Analysis

June 6-7, 2011 • Dakar, Senegal

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Using Global Static CGE to Assess the Effects of Climate Volatility

Amer Ahmed

World Bank

June 7, 2011

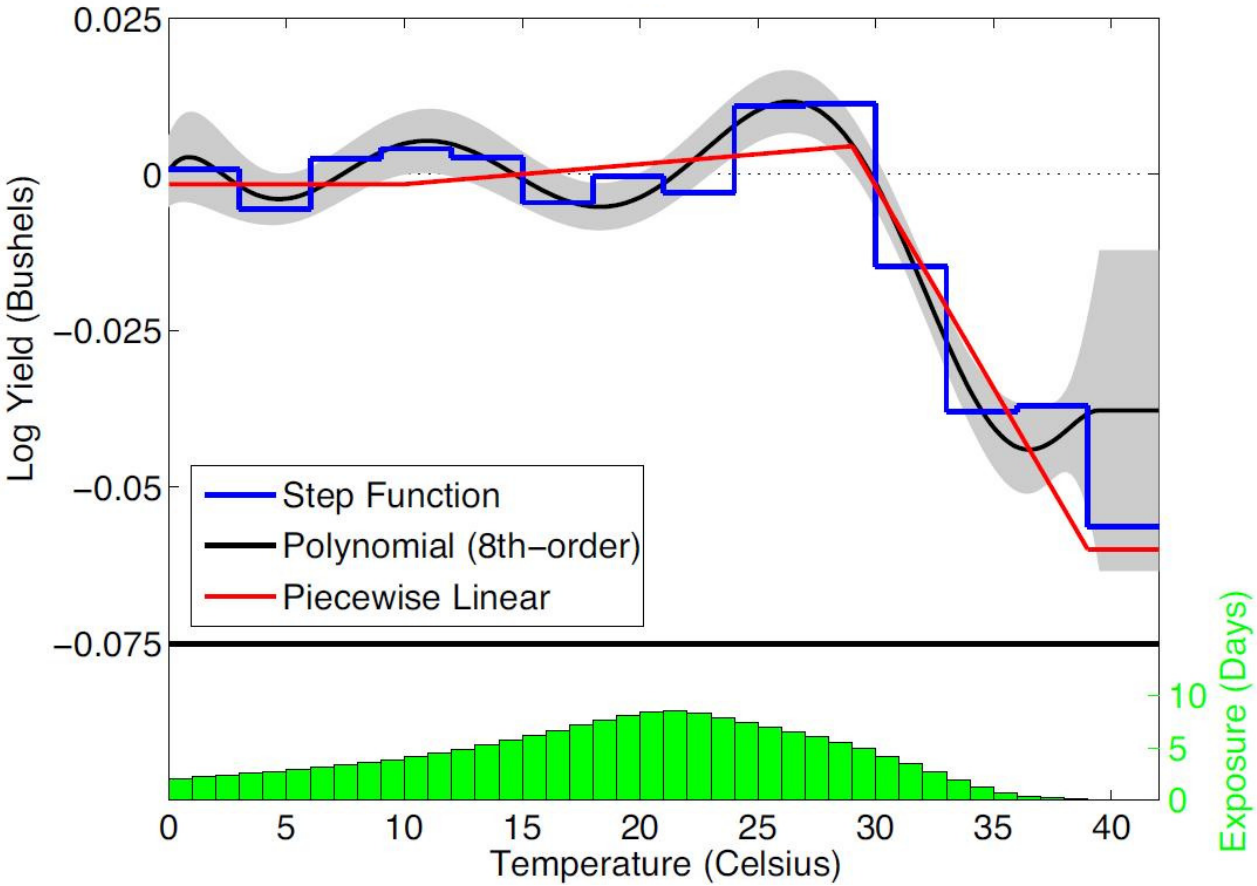
AGRODEP Members' Meeting and Workshop

Dakar, Senegal

Objectives

- Motivation: climate volatility, agricultural variability, & poverty
- Why CGE?
  - GE effects
  - Mechanisms that drive poverty impacts
- Implications of simulation design
- Illustrations from recent research

US Maize Yield Response to Temperature



Source: Schlenker and Roberts, 2008

Changing Climate Volatility

- Extreme outcomes may be particularly important for agriculture (White et al, 2006; Mendelsohn et al, 2007)
- Climate volatility is already changing (Easterling et al, 2000)
  - Higher temperature and precipitation extremes in the future (IPCC, 2007)

Implications for Poverty

- Extreme climate events will reduce agricultural output in the tropics and subtropics (Lobell et al, 2008; Battisti and Naylor, 2009)
  - Food insecurity
- Food insecurity influenced by forces that constrain people's access to food, not just availability (Sen, 1981)
- Income & price effects
  - 100 million additional poor due to global food price crisis between 2005-2008 (Ivanic & Martin, 2009)

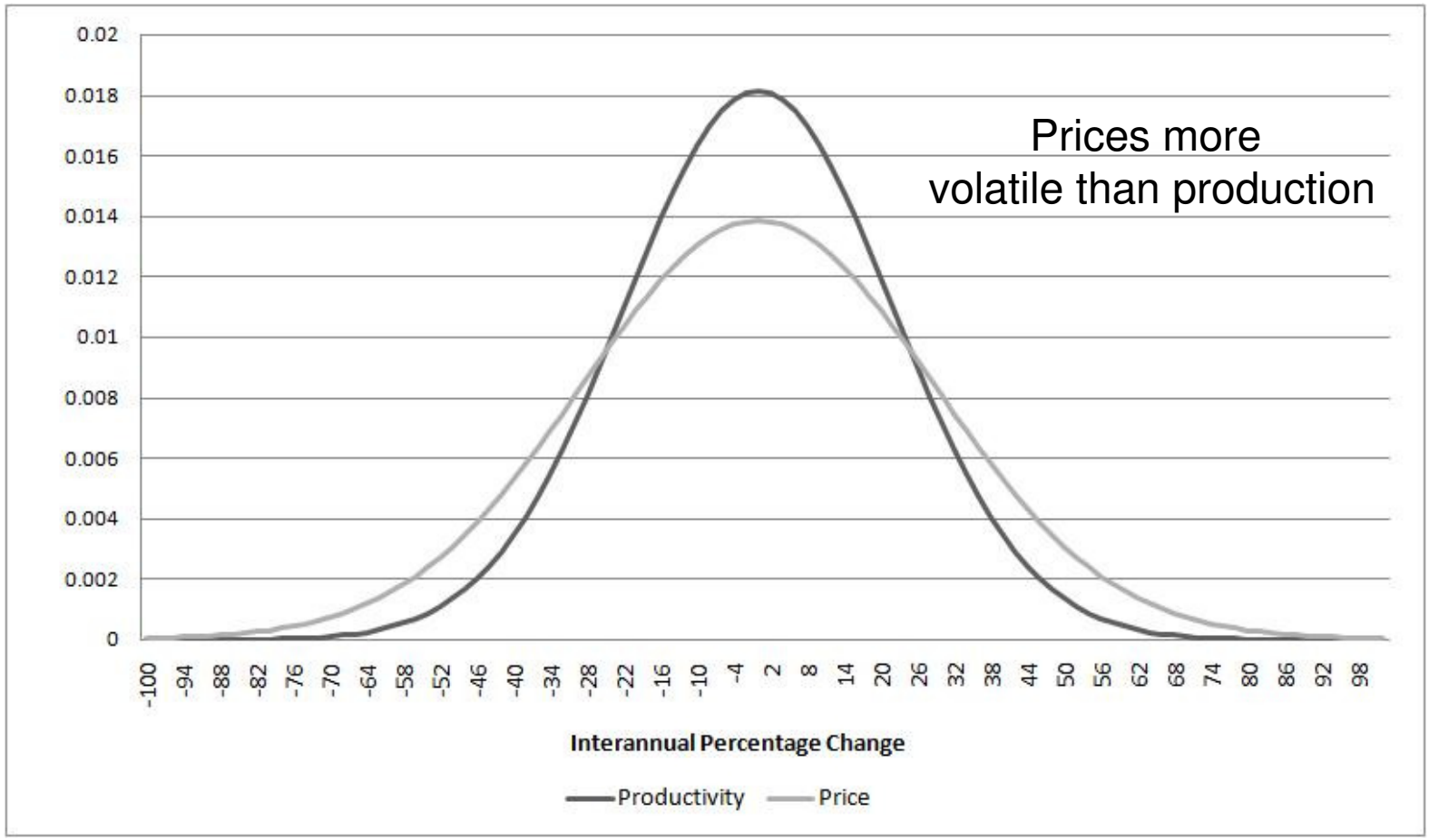
Income Effects

- Changes to household income depend on sources of income
- For many rural poor, main endowment is unskilled labor
- Agriculture is unskilled labor intensive
  - If output expands, unskilled wages rise; opposite for contraction
- Ambiguous impact of agricultural commodity price rise on non-farm rural households
  - depends on earnings diversification, impacts on farm factor returns, and unskilled wages

Price Effects

- Higher crop prices hurt all households, but hurt the poor relatively more due to large food budget share
- Lower crop prices may reduce incomes of rural net-sellers of crops
- Recent experience: 100 million additional poor due to global food price crisis between 2005-2008 (Ivanic & Martin, 2009)

Historical Volatility* in Grains Production and Prices in Tanzania



*Volatility = standard deviation of interannual % changes

Source: Ahmed , Diffenbaugh, & Hertel (2009)

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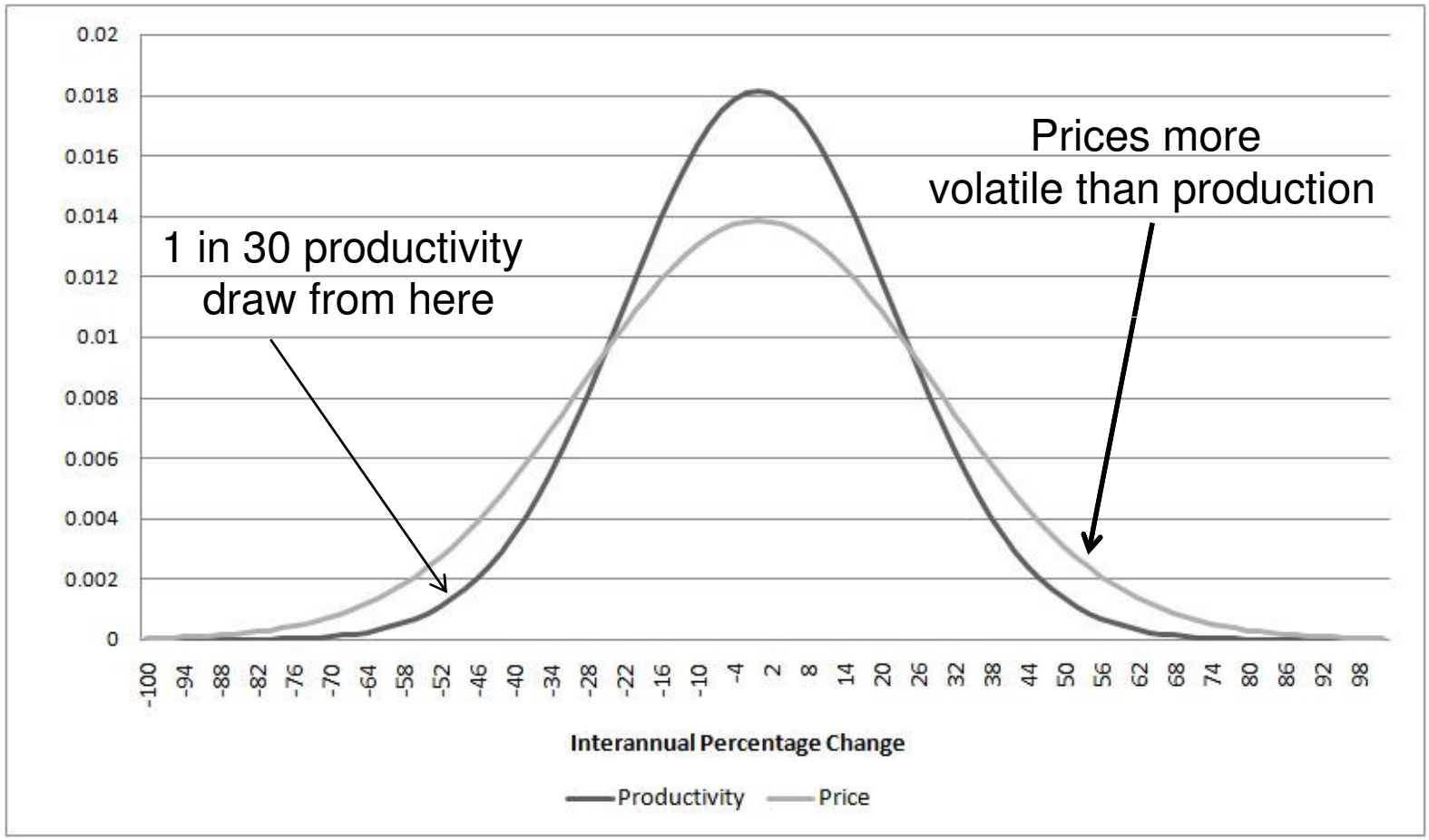

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Source: Ahmed , Diffenbaugh, & Hertel (2009)

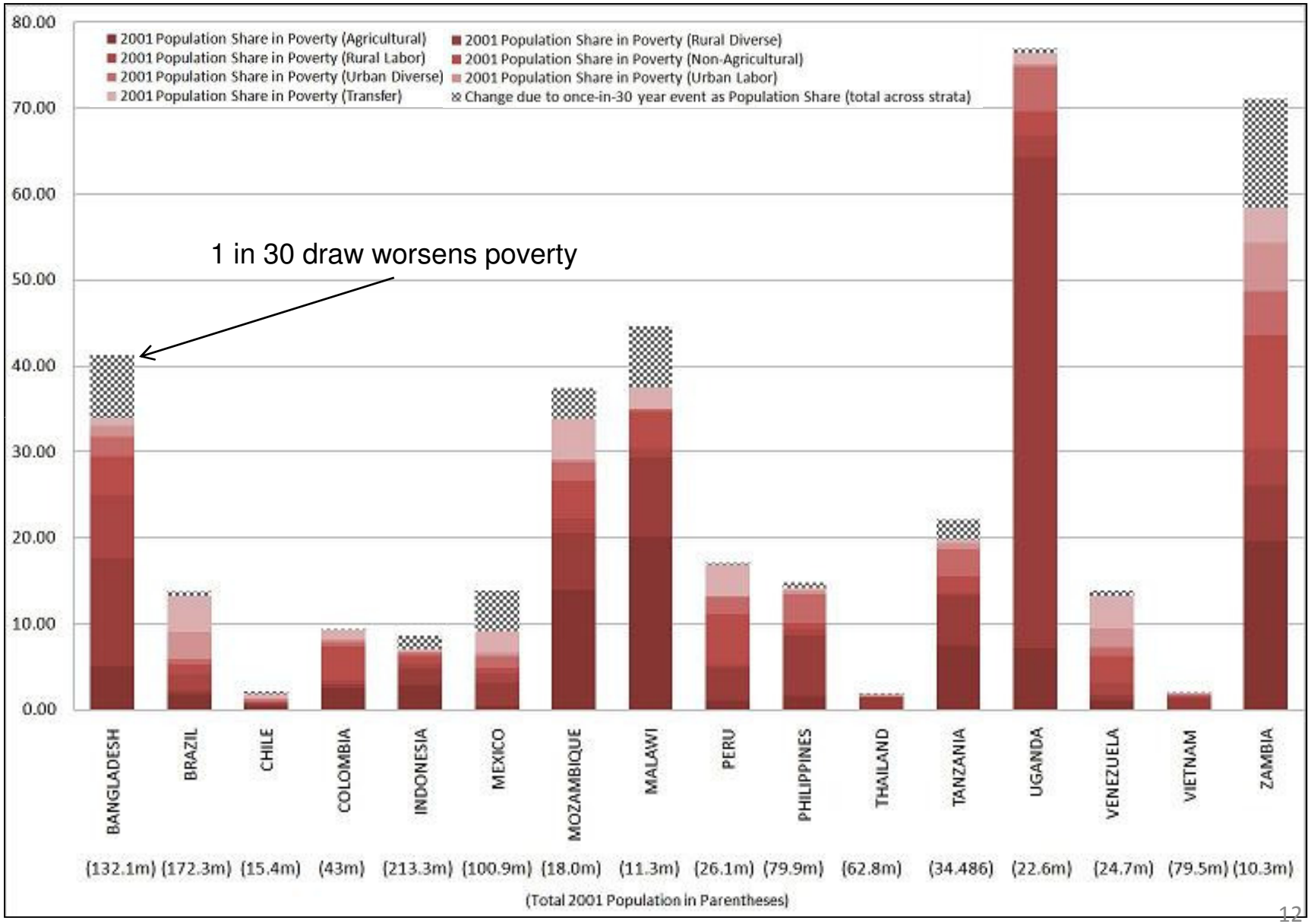
Computational Framework

- GTAP model used to elicit national price and earnings impacts of productivity shocks :
  - land use by Agro-Ecological Zone
  - factor market segmentation
- Micro-simulation module to evaluate household-level impacts at poverty line in 7 population strata across 16 countries in Asia, Latin America and Africa
- Survey data:
  - Estimate earnings shares and density around poverty line
  - Use estimated consumer demand system to predict consumption changes at poverty line
  - Estimate change in stratum poverty due to combination of factor earnings and consumption impacts
  - Combine into estimate of national poverty using shares of strata in national poverty headcount

Implications of Simulation Design

- What are we shocking?
- Time horizon of simulation
  - Long run vs short run
  - Factor market mobility
  - Closure (response of capital, technology)
- What kind of farmer behavior is characterized?
  - Ability to adapt
- Shocking one country or multiple?
- Sensitivity analysis or forecasting?

Impact on Poverty Rates of 1 in 30 Climate Extreme



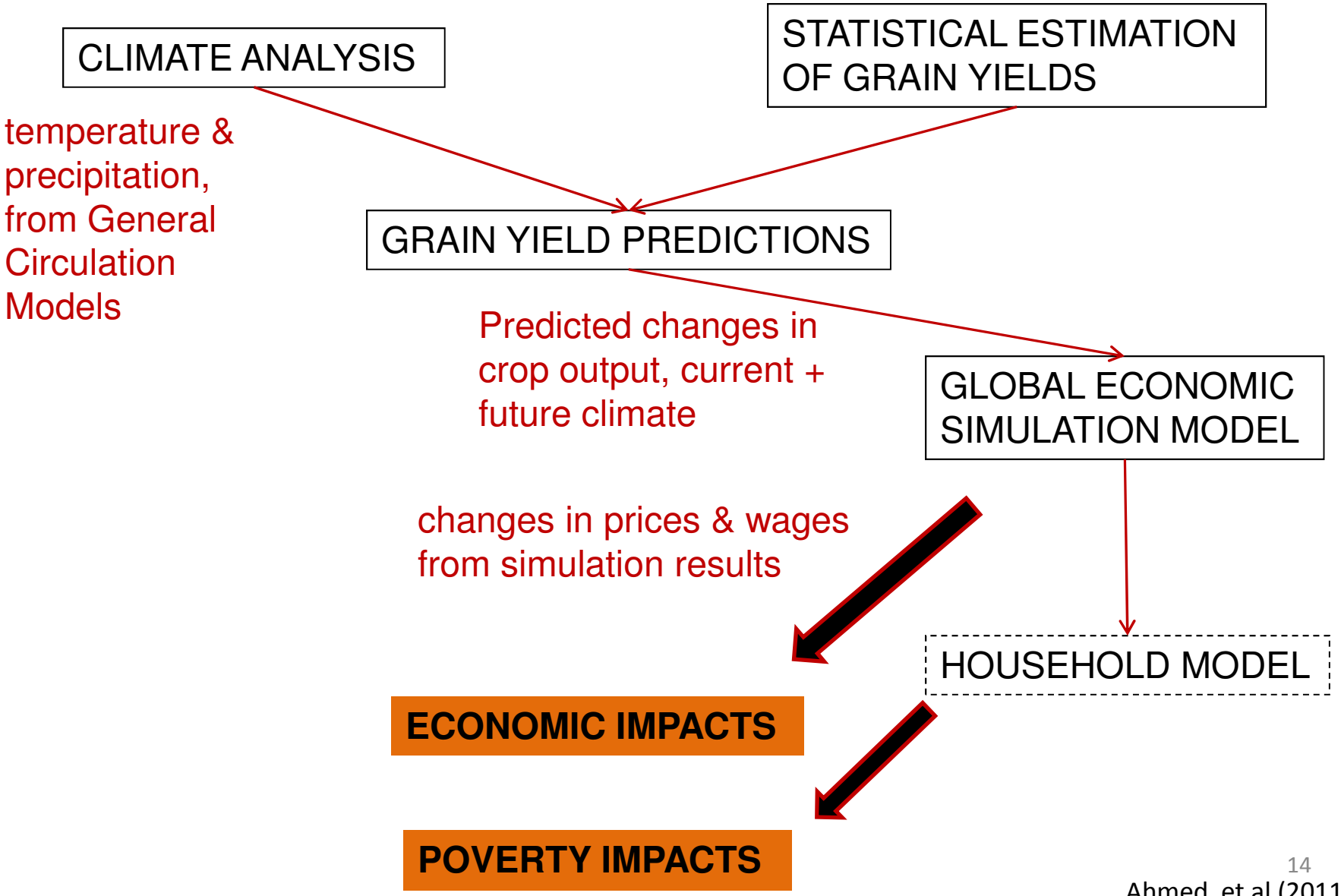
Source: Ahmed , Diffenbaugh, & Hertel (2009)

%Δ in Poverty by Household Stratum due to 1 in 30 Climate Extreme

	Socio-Economic Strata						
	Agricultural	Non-Agricultural	Urban Labor	Rural Labor	Transfer	Urban Diverse	Rural Diverse
Bangladesh	***32.1***	***37.8***	***30.7***	11.1	0.8	***29.5***	***17.2***
Brazil	0.1	4.1	5.5	6.2	1.0	9.6	7.0
Chile	7.7	13.8	12.7	9.5	14.7	12.6	14.9
Colombia	0.1	0.4	1.0	1.0	0.6	0.6	0.5
Indonesia	***29.5***	12.1	19.2	***23.9***	5.9	***17.9***	***19.0***
Mexico	***52.2***	***36.7***	***95.4***	***52.1***	***61.8***	***37.4***	***43.2***
Mozambique	4.3	***15.3***	***16.2***	12.4	7.2	***26.6***	***16.0***
Malawi	***15.8***	9.0	***110.5***	***91.0***	11.1	***30.8***	***23.0***
Peru	2.4	1.9	3.6	2.6	0.5	1.5	1.4
Philippines	-17.7	10.2	***32.3***	***25.9***	8.5	6.0	3.8
Thailand	4.9	5.8	7.1	5.8	6.4	5.6	5.8
Tanzania	7.2	11.0	14.9	5.3	6.6	***21.3***	11.9
Uganda	-0.1	1.6	***16.4***	2.9	0.1	1.0	0.6
Venezuela	4.0	5.1	12.1	10.1	0.0	7.2	6.6
Vietnam	5.1	7.0	0.0	0.0	3.9	6.3	6.4
Zambia	0.0	***17.7***	***102.0***	***32.5***	10.9	***41.1***	10.6
Average	9.2	11.8	30.0	18.3	8.8	16.0	11.7

Ahmed et al. (2009)

Tanzania Specific Analysis: Framework

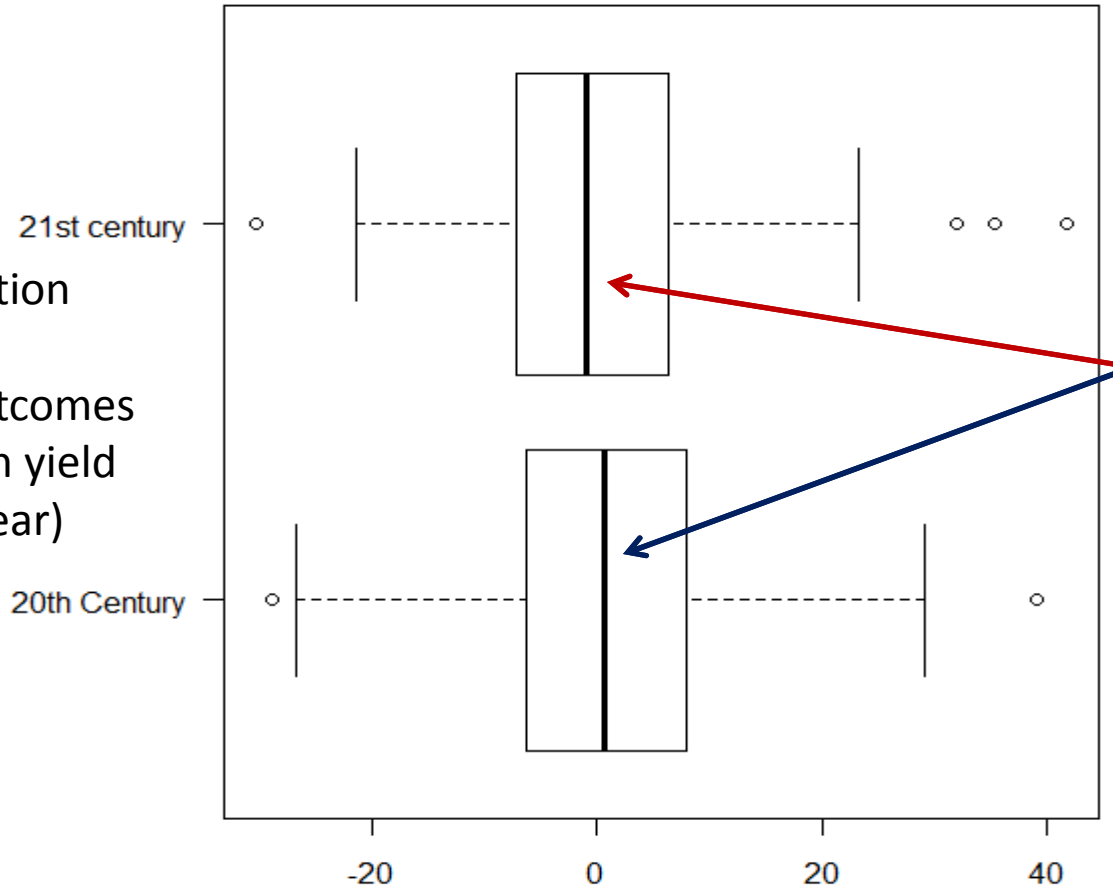


Ahmed et al (2011)

Sensitivity of Tanzanian Poverty to Climate Volatility

- Statistical analysis using data from 17 administrative regions: 1992-2005
  - Maize, rice, and sorghum yields (tonnes/ha)
  - Temperature (growing season mean in degrees C)
  - Precipitation (growing season mean in mm/month)
- Predictions using data from 22 global climate models
  - Yield variability increases in 10 cases out of 22
- Use yield equation to translate historical and future climate into output changes

Distribution of Interannual % Changes in Tanzanian Grains Yield due to Climate



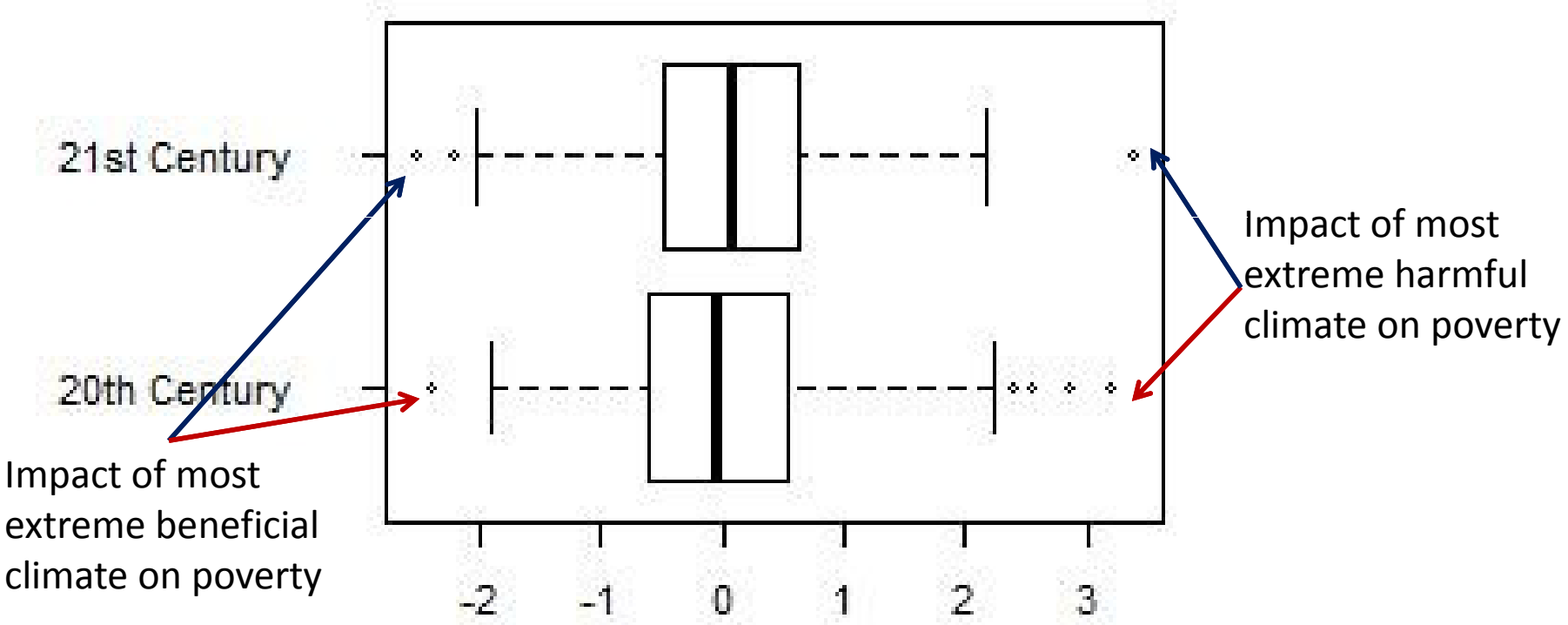
Mass of distribution shifting left (more/larger outcomes with % decline in yield from previous year)

median yield change

Outcomes within box represent 75% of all predicted outcomes

Ahmed et al (2011)

Sensitivity of Poverty in Tanzania to Climate Outcomes: Distribution of % Point Changes in National Poverty Rate



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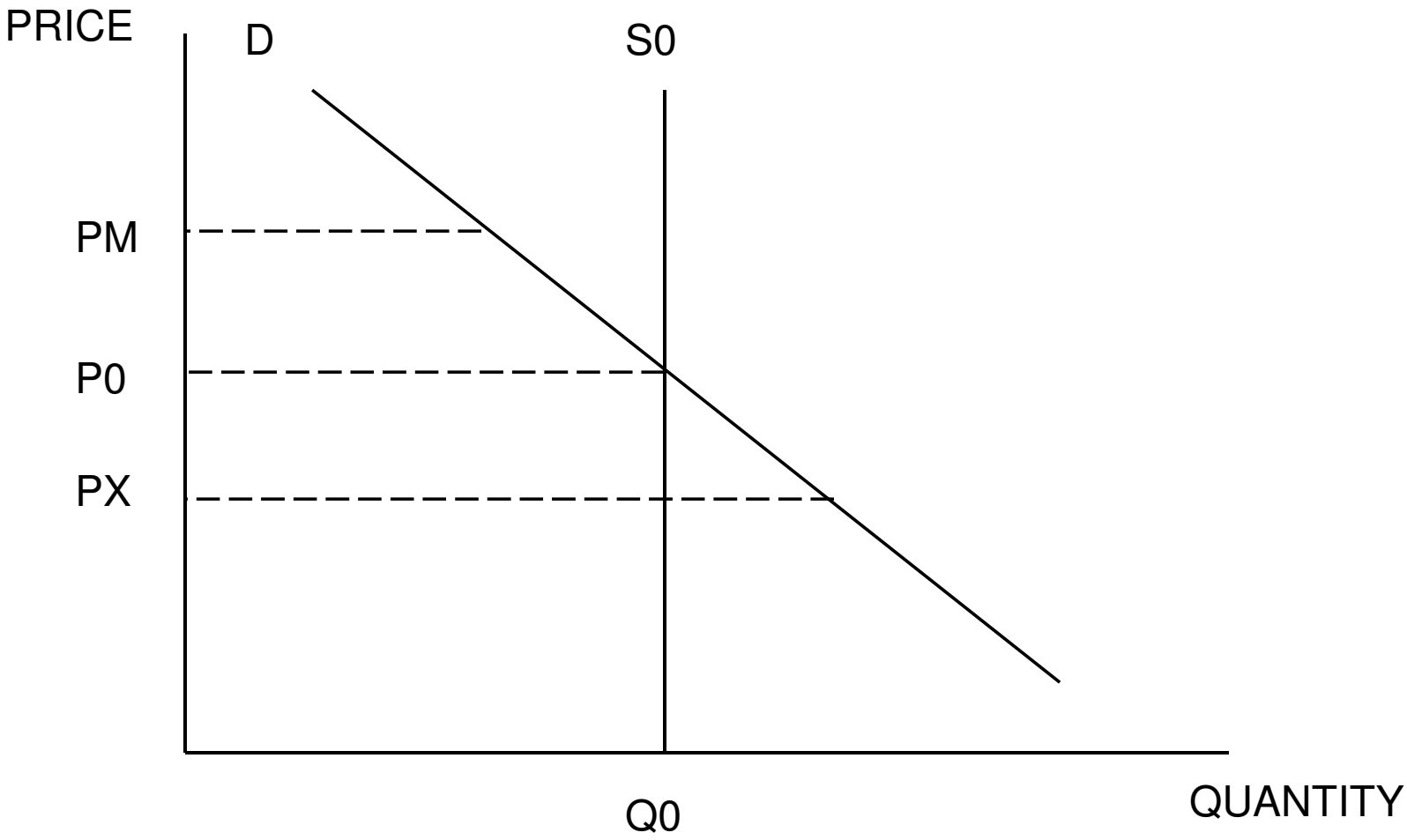
Ahmed et al (2011)

Illustration: Examining Trade Policy

- Concerns about greater trade & food security
- World price instability as a source of domestic price instability, price transmission
  - e.g. Special Safeguard Mechanisms
- Export bans during food price crisis 2005-2008
  - May block supply responses to higher international prices in long run (Mitra & Josling, 2009)
  - Higher price volatility
- Tanzania had export ban on maize & other grains

SR Supply Shocks and Price Changes: Small Open Economy



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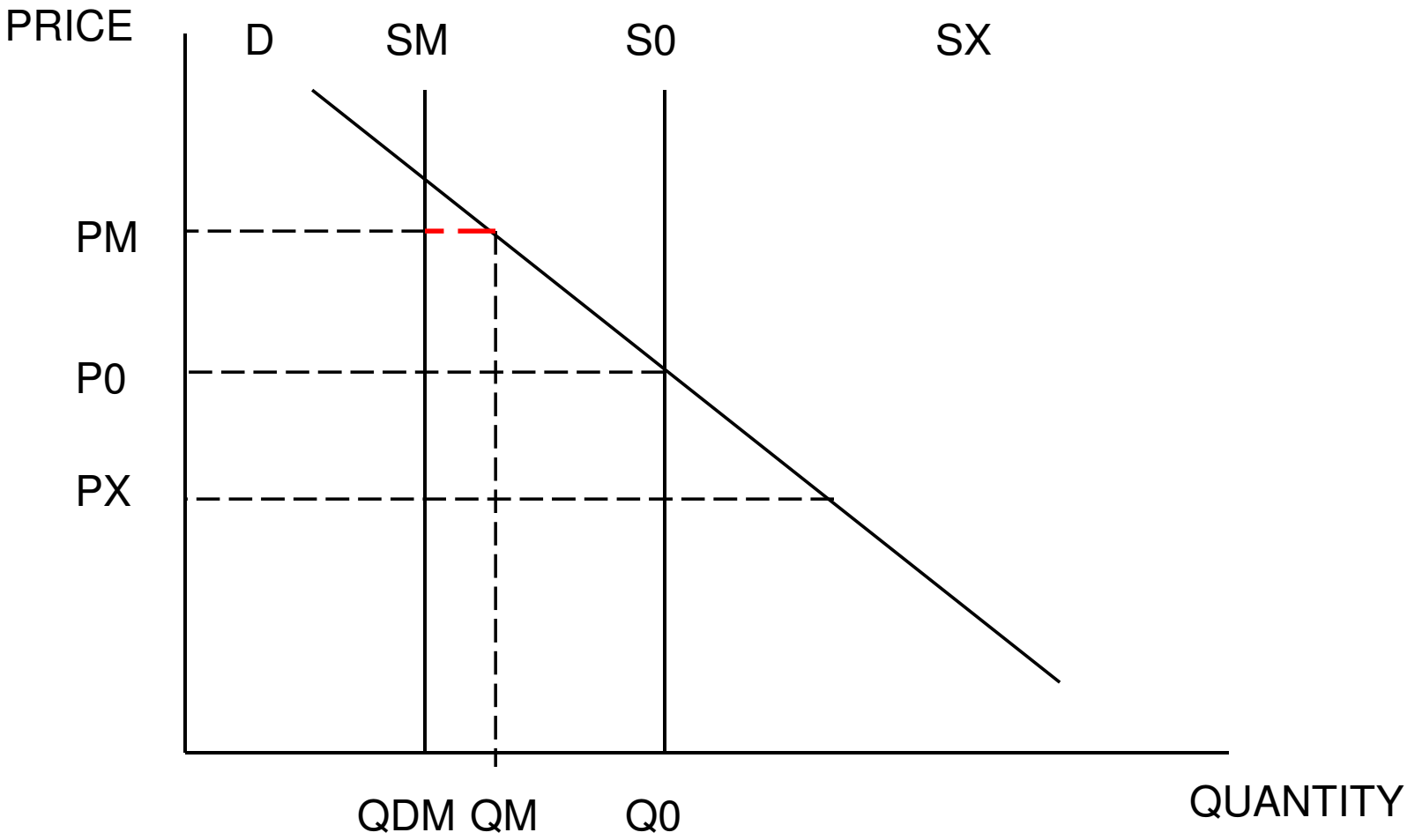

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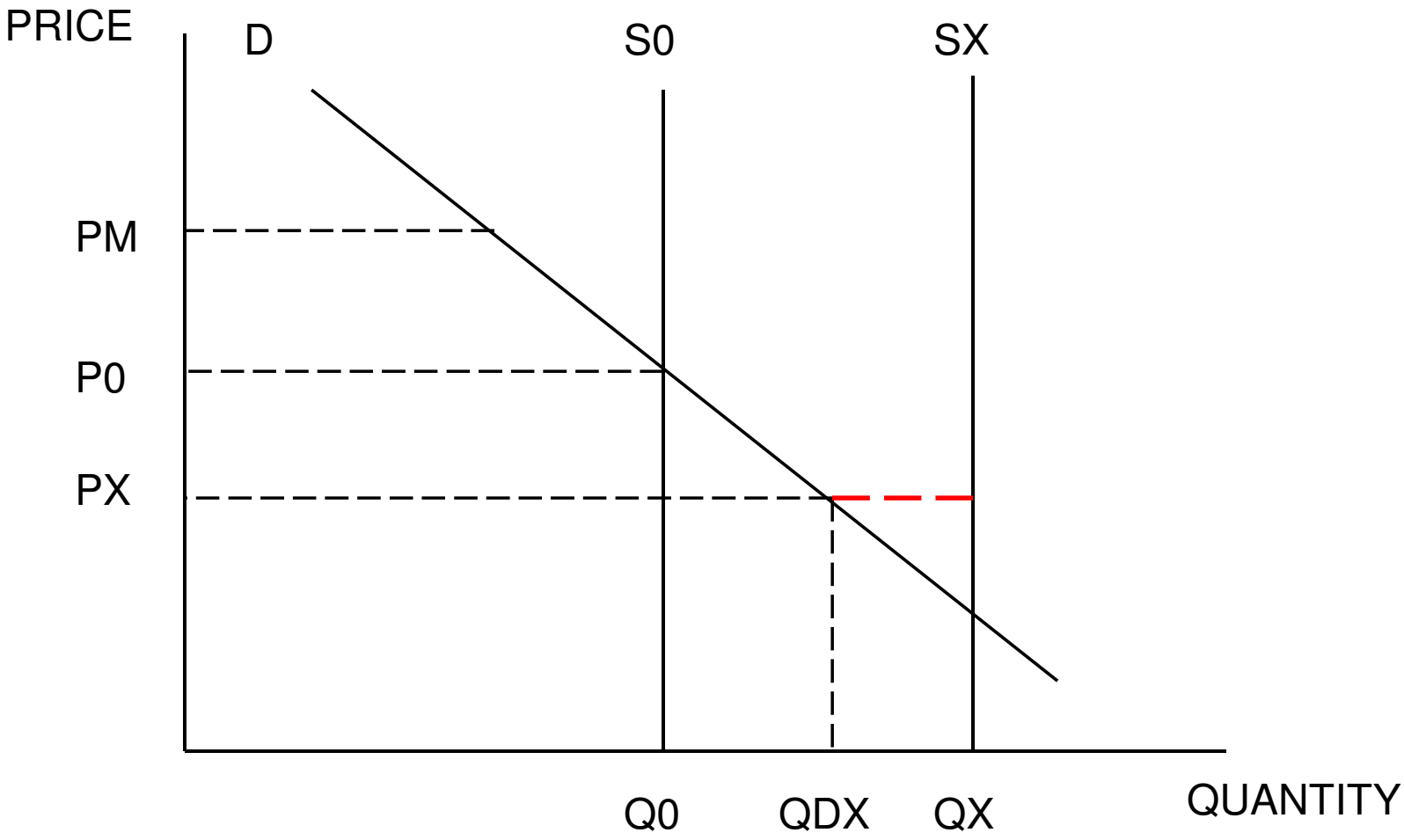
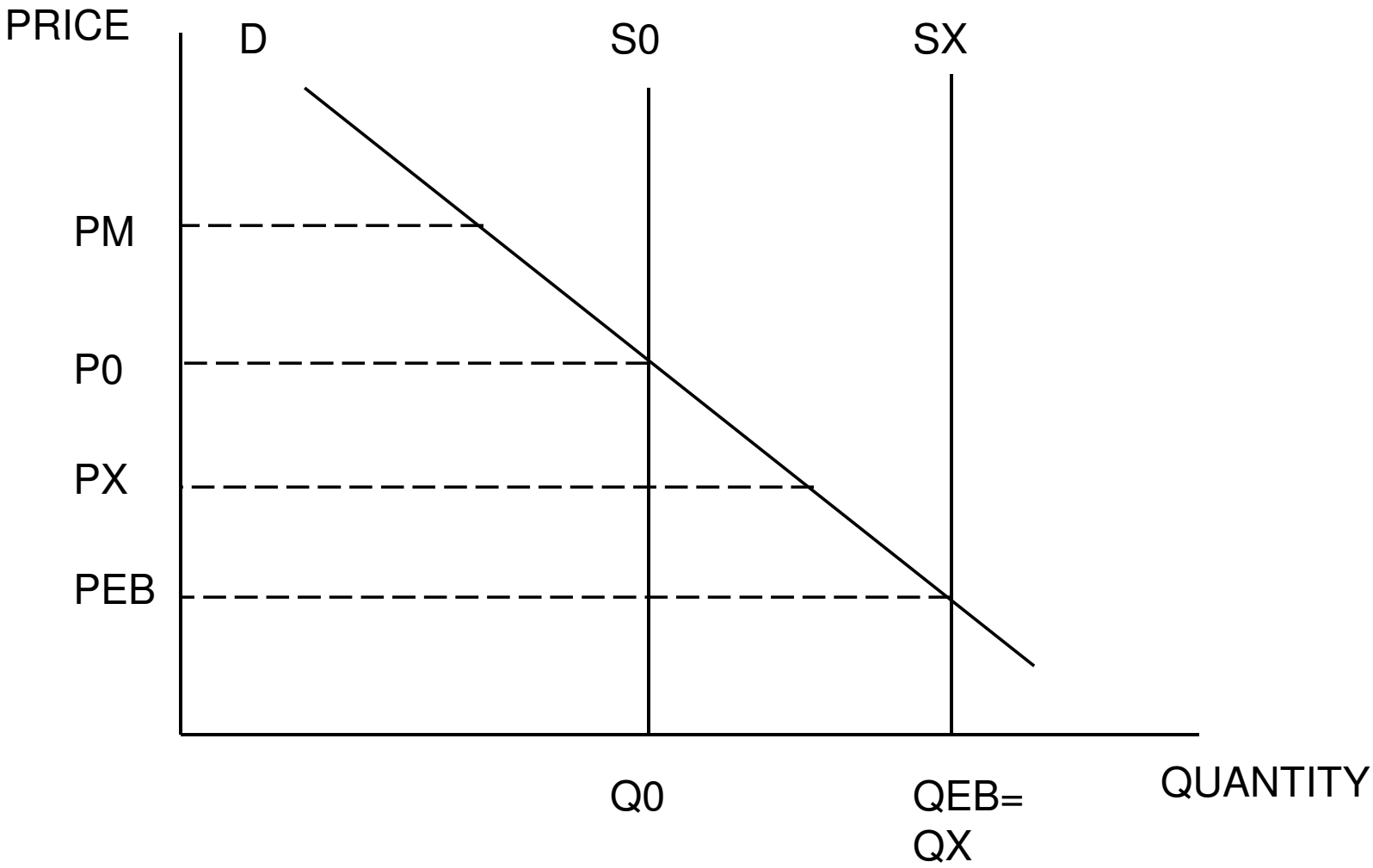


SR Supply Shocks and Price Changes: Export Ban



Export Ban on Maize Depresses Tanzanian Maize Prices

Year	Direction of Tanzania's Production Deviation from Trend	Under 2001 World Trade Policy Framework	Under 2001 World Trade Policy Framework + Export Ban in Tanzania	Additional Effect of Export Ban (Regime 2 - Regime 1)
		I	II	III
1995	Tanzania +	-22.56	-24.97	-2.41
1971		-21.11	-22.22	-1.11
1980	Tanzania 0	0.67	0.45	-0.22
1982	Tanzania -	27.67	27.67	0.00
1983		42.19	41.97	-0.23

General Take Homes

- Agriculture a key linkage between climate volatility & poverty vulnerability
- Income and price effects determine who is affected
- Future impacts are likely to be complex across countries, with great uncertainty in climate predictions
  - Lessons to be learned from historical volatility
- Need to consider climate interactions with existing policies (e.g. trade policies) to exacerbate impacts