Session 6: Panel Discussion on Going Forward: Conceptual and Data Issues

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GOING BEYOND AGRICULTURAL WATER PRODUCTIVITY

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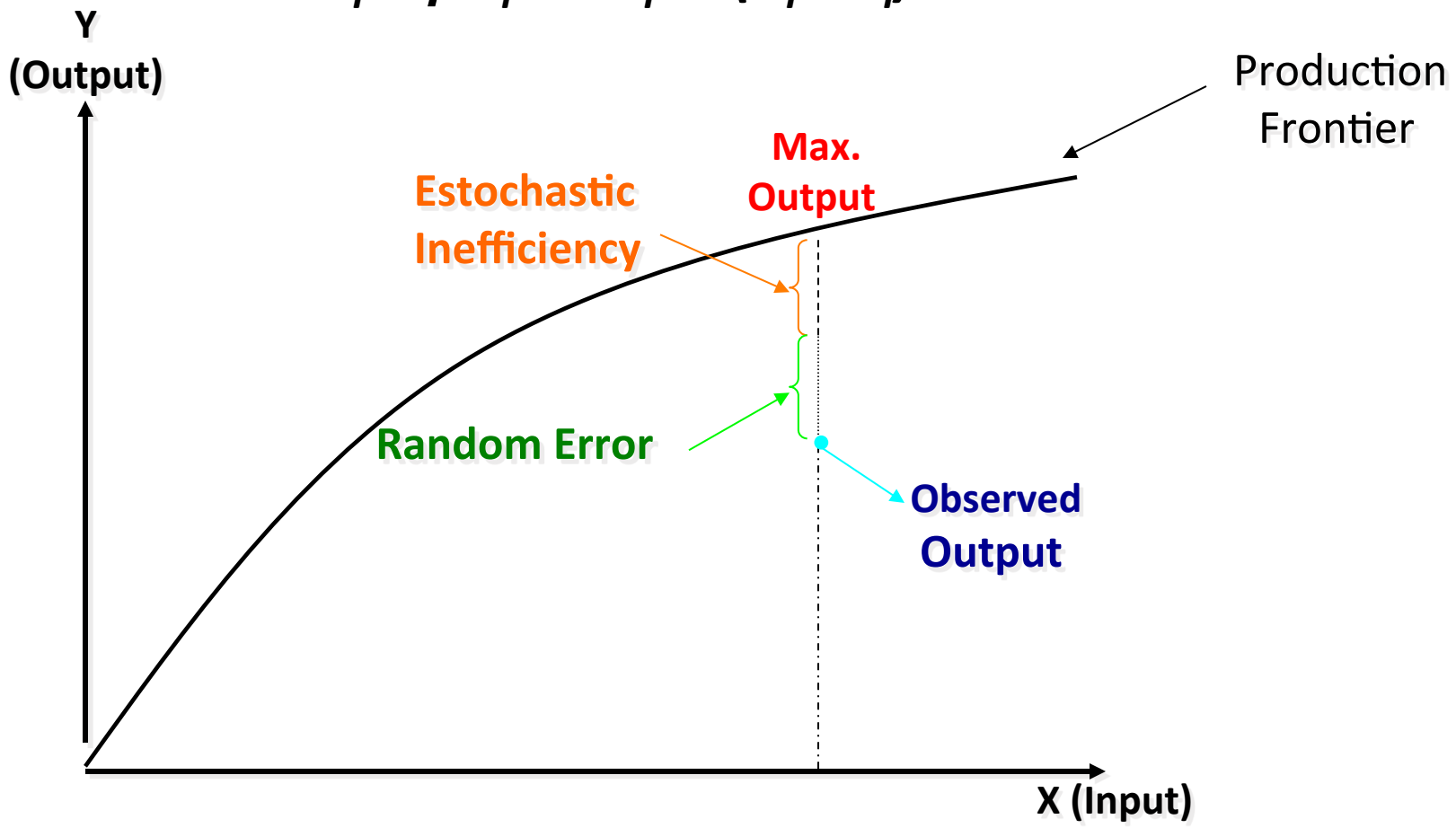
Frontier Methodologies: An Overview

$$Y_i = \beta X_i + \delta Z_i + (v_i - u_i)$$



Agricultural Productivity Growth in Latin America and the Caribbean (LAC): An Analysis of Climatic Effects, Convergence and Catch-up

TFP with a Cobb-Douglas Generalized **True Random Effects (GTRE) and Mundlak (GTREM) Production Frontier** (**Greene, 2005; Colombi et al., 2014; Tsionas and Kumbhakar, 2014; Filippini and Greene, 2014**)

$$y_{it} = \alpha_0 + \sum_{k=1}^{K} \beta_k x_{kit} + \xi T + \sum_{j=1}^{J} \eta_j z_{jit} + \alpha_i + v_{it} - u_{it} + A_i \quad (1)$$

$$\alpha_i = \sum_{k=1}^{K} \theta_k \bar{x}_k + \delta_i \quad (2)$$

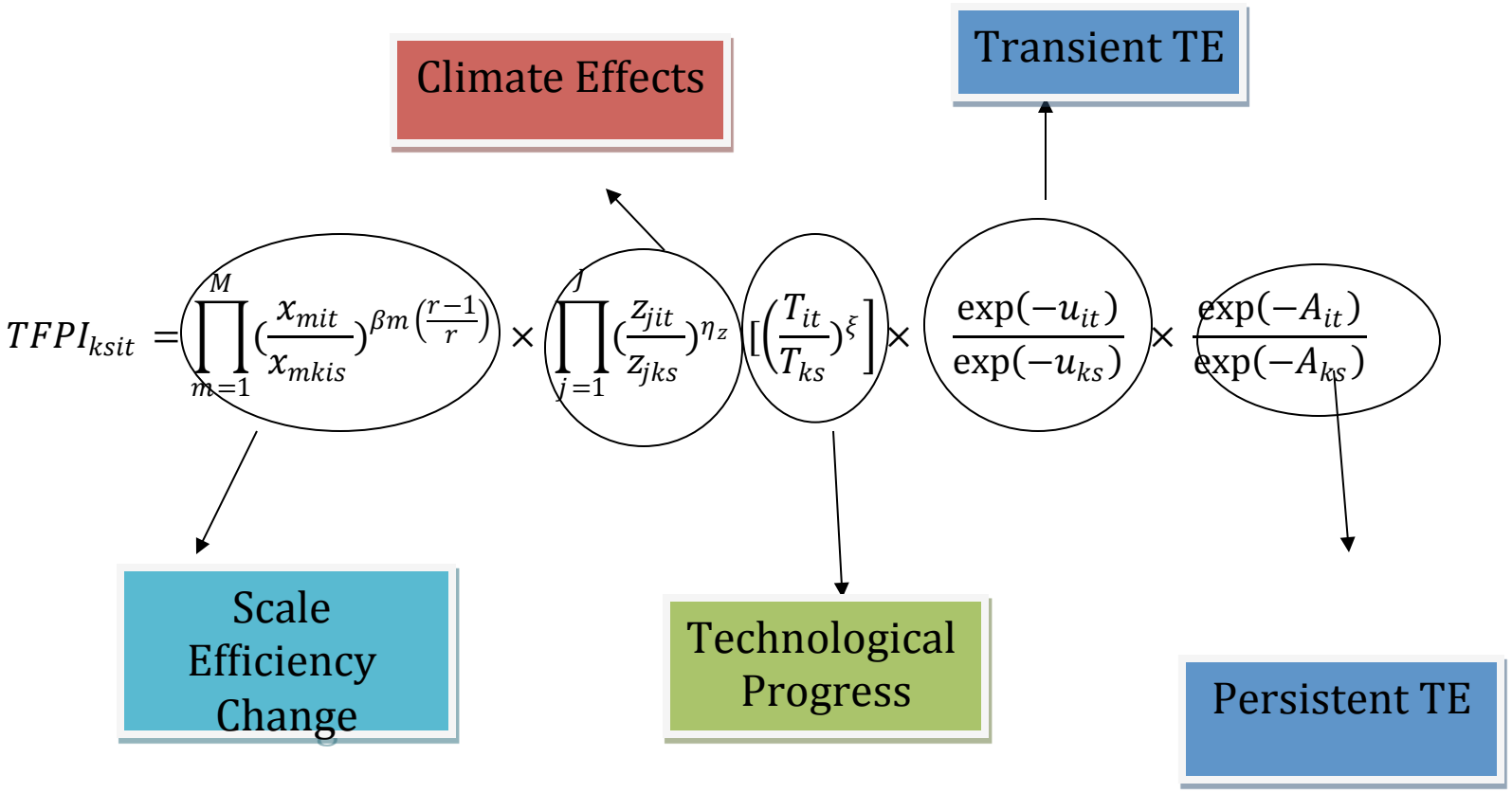
$$y_{it} = \alpha_0 + \sum_{k=1}^{K} \beta_k x_{kit} + \xi T + \sum_{j=1}^{J} \eta_j z_{jit} + \sum_{k=1}^{K} \theta_k \bar{x}_k + \delta_{it} + v_{it} - u_{it} + A_i \quad (3)$$

$$\boldsymbol{y_{it} \equiv lnq_{it}, \text{ and } X_{it} = (1, Z_{it}, T, \ldots, x_{kit})'}$$

And the TFP Index is $\boldsymbol{TFP_{it} = \frac{Q_{it}}{X_{it}}}$

TFPG Decomposition theoretically consistent (O'Donnell (2010, 2012): LAC, and for US States but there we include *Irrigation* (Z) from USGS.

$$\boldsymbol{TFPI_{ksit} = \frac{TFP_{it}}{TFP_{ks}} = \frac{QI_{ksit}}{XI_{ksit}}}$$



FAO and Climatic and Research Unit (CRU) Datasets

Table 1: Description of Variables

Variables	Definition
Agricultural Production (Y)	Value of production in Thousans of constant 2004-2006 international dollars
Tractors (TR)	Thousand of agricultural tractors used in the production process
Fertilizer (FE)	Quantity of nitrogen, phosphorous and potassium in thousand metric tons
Animal Stock (AS)	Million of cattle, sheep, goat, pigs, and so forth in livestock unit (LU) equivalents
Land (LA)	Arable land and permanent crops expressed in thousands of hectares
Labor (LB)	Total economically active population in agriculture expressed in thousands
Temperature (TEMP)	**Annual mean maximum temperature**
Precipitation (PRECIP)	**Annual mean precipitation**
Precipitation Anomaly (PA)	**Standard deviation of PRECIP**
Precipitation Frequency (PF)	**Number of rainy days**

Results

Table 2: GTREM estimates for Agricultural Production Frontier Models

Models	GTREM (n=1352)		GTRE (n=1352)	
	Coeff.	S.E.	Coeff.	S.E.
Intercept	6.971***	0.093	6.971***	0.093
TR	0.086***	0.001	0.123***	0.004
FER	0.072***	0.001	0.125***	0.004
AS	0.215***	0.005	0.288***	0.007
LA	0.173***	0.002	0.172***	0.008
LB	**0.404*** **	**0.006**	0.229***	0.006
T	0.010***	0.000	0.007***	0.000
TEMP	**-0.213*** **	**0.061**	**-0.075*** **	**0.028**
PRECIP	**0.021*** **	**0.007**	**0.070*** **	**0.020**
ANOM	**-0.240*** **	**0.016**	**-0.215*** **	**0.048**
WD	**-0.088*** **	**0.013**	**-0.155*** **	**0.017**
Mean (TR)				
Mean (FER)	0.096***	0.002		
Mean (AS)	0.091***	0.005		
Mean (LA)				
Mean (LB)	-0.204***	0.006		
Mean (TEM)	0.207***	0.061		
Mean (PRECIP)				
Mean (ANOM)				
Mean (WD)	-0.069***	0.014		
λ	59.32***	17.13	1.941***	0.203
σ	0.165***	0.005	0.165***	0.005
σ_u	0.191		0.147	n/a
σ_v	0.003		0.076	
A_i	1.957		2.330	
α_i	0.026		0.019	
α_α	1.957***	0.037	2.330***	0.082
RTS	0.935		0.935	
Log-likelihood	21.56		-14.07	

Notes:*,**,*** are 10%, 5%, and 1% level of significance respectively
S.E.: Standard error. Variables are measured in natural log.
n/a: non-available

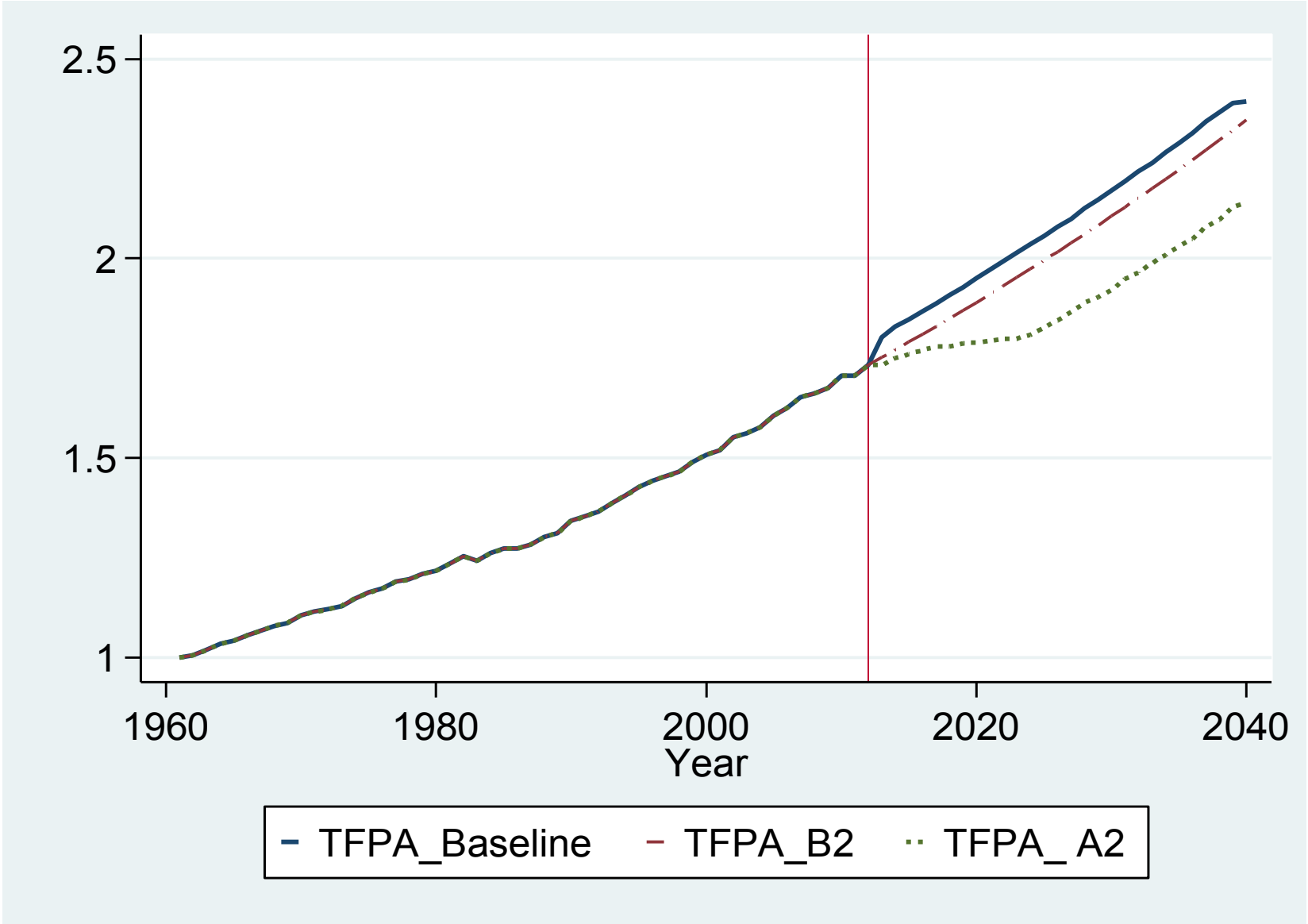
TFP Forecasting Scenarios

- **Baseline** (1982-2012)

- **Scenario A2** (IPCC, 2014)
  - High GHG emissions
  - Increasing population
  - Slow technological progress

- **Scenario B2** (IPCC, 2014)
  - Relatively low emissions
  - Certain level of economic development
  - Focus on local socio-economic development

Cumulative Projected TFPA across LAC Countries (2013-2040)



Economic Costs Forecasts

Table B: Economic Cost of Climatic Variability (Discount Rate= 12%)

	Economic Costs of Climatic Variability			
	TFPGA (%)		Present Value Losses (billion $)	
	A2	B2	A2	B2
Average LAC w.r.t Baseline				
	-10.73	-2.35	4.34	1.64

“From Cold to Hot: A Preliminary Analysis of Climatic Effects on the Productivity of Wisconsin Dairy Farms”

Comments/Thoughts

No super Econometric Model (David's comment)

CGE models could be helpful but you need parameters (Claudia Ringler's comment, I think)

Farm level: Take advantage of Spatial and overtime variability => panel data.

World Bank LSMS and LSMS-ISA (Integrated Surveys on Ag.)

What are we trying to do & define relevant indicators:

Designing impact evaluation plan for water projects
Understanding profitability of water use
Role of water in improving nutrition
Role of water in poverty reduction
TFPG, TE, RTS, profitability, investment analysis

Integration of Models (econometric and Math. Prog. Which are deterministic) to do detailed farm level analysis.

Comments/Thoughts…

Interaction between **climatic variability and irrigation**: Econometric estimates and simulations

Interaction/substitutability across inputs (Morishima elasticities of substitution needs consideration of functional form TL?)

Very little evidence **across systems** and of B/C analysis based on actual farm level data.

Christopher Neal: Can ET data be used with input- output data in econometric models, say at the County level in the US, to undertake TFP decompositions?

Volumetric metering in Australia, seems to quite unique? Is it?