The Farm Size-Productivity Relationship:
A Conceptual Review with Empirical Evidence from three African Countries

Jacques C. Julien*, Boris E. Bravo-Ureta**

* Ph.D. Student, Dept. of Agricultural and Resource Economics, University of Connecticut. Corresponding author jacques.julien@uconn.edu

** Professor, Department of Agricultural and Resource Economics, University of Connecticut, USA; and, Adjunct Professor, Agricultural Economics, University of Talca, Chile. boris.bravoureta@uconn.edu

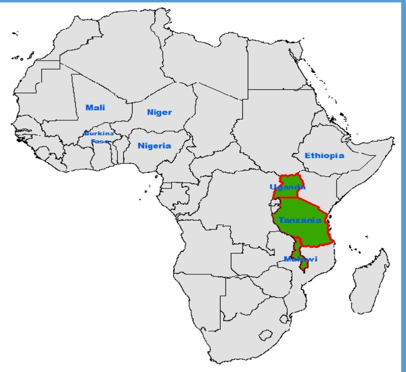
Selected Poster prepared for presentation at the 2016 Agricultural & Applied Economics Association Annual Meeting, Boston, MA, July 31- Aug. 2

The Farm Size-Productivity Relationship: A Conceptual Review with Empirical Evidence from three African Countries

Jacques C. Julien *, Boris E. Bravo-Ureta**

*Ph.D. Student, Dept. of Agricultural and Resource Economics, University of Connecticut.

** Professor, Department of Agricultural and Resource Economics, University of Connecticut, USA; and, Adjunct Professor, Agricultural Economics, University of Talca, Chile



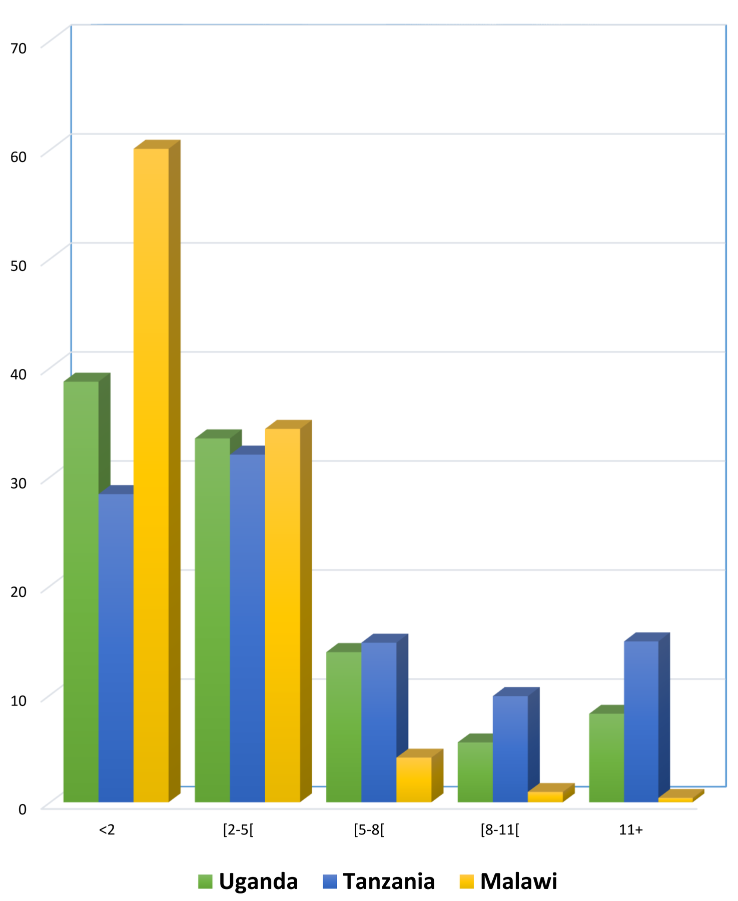
Motivation

- Governments and international agencies seek to increase farm efficiency as a strategy to promote the agricultural sector while contributing to poverty alleviation. This means increase agricultural productivity.
- Several factors impose challenges to agricultural productivity growth such as land availability and quality, labor and liquidity constraints, inadequate investment on research, infrastructure and human capital, and climate change (Hazell, 2007).
- Our focus here is Uganda, Tanzania and Malawi, three countries located in Sub-Saharan Africa (SSA), that share common geographic and climatic conditions, and agricultural features.
- Land area is a critical and prevalent variable in Country statistics and for agricultural policy. The imprecise measurement of farm size is of particular concern when examining the IR-H.
- Carletto et al. (2013), used GPS measures of the farm area and found that the IR-H is even stronger when compared with size estimates reported by farmers.
- Lamb (2003) finds that land quality and market failures explain much of the IR and farm size measurement error plays a role.

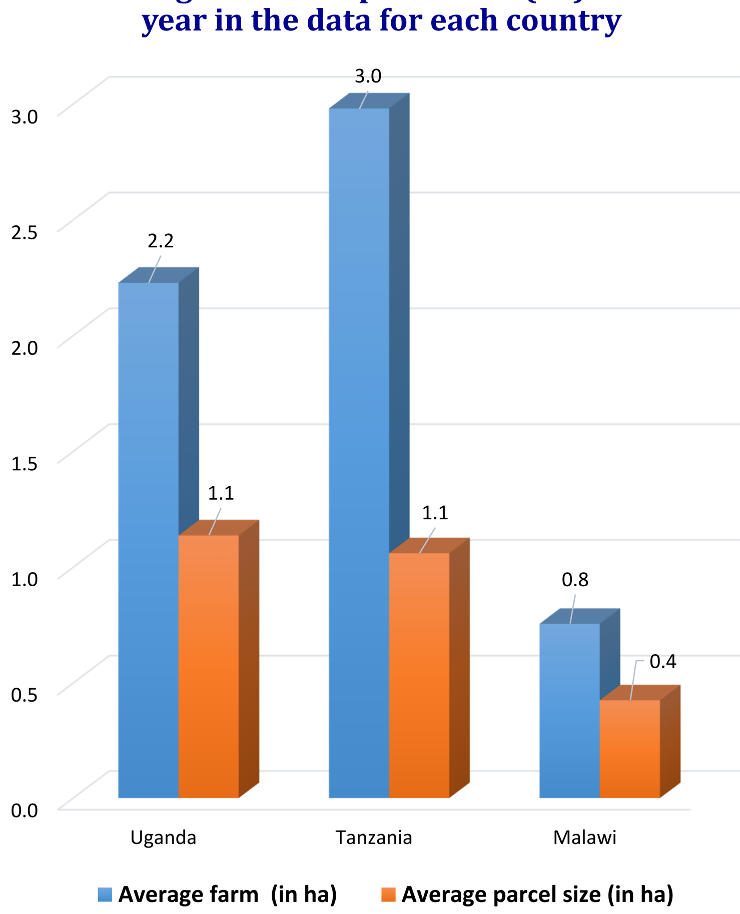
Objectives

- To test the effect of land area measurement on the IR-H using both farmer reported data and GPS data.
- To incorporate environmental variables (e.g., soil quality, climatic conditions) when testing for the Inverse Relationship Hypothesis (IR-H).
- To test alternative model specifications using stochastic production frontier methods in the analysis of the IR-H.

Land by Farm size class (acres)



Average farm and parcel size (ha): First year in the data for each country



Methodology

The empirical estimation relies on a Stochastic Production Frontier (SPF) model represented by a Cobb-Douglas function specified as follows:

$$\boldsymbol{ln(Y_i/A) = \alpha_0 + \alpha_1 lnA_i + \sum_{k=1}^{K} \beta_k lnX_{ik} + \sum_{m=1}^{M} \gamma_i lnQ_{im} + \delta_2 T_2 + \delta_3 T_3 + V_i - U_i}$$

Y_i : net agricultural revenues

A_i: total farm size in hectares

X_{ik} : vector of traditional inputs

Q_{im} : vector of climatic and soil quality variables

T_2 and T_3 : Time dummies are represented

V_i and U_i : conventional random error and the inefficiency terms

Table 1: Mean Difference test between Farm size collected by GPS device and Farm size reported by farmers for Uganda, Tanzania and Malawi

Survey Round	Uganda		Tanzania		Malawi	
	Mean Difference GPS – Farmer's SR	Mean test	Mean Difference GPS – Farmer's SR	Mean test	Mean Difference GPS – Farmer's SR	Mean test
1	-1.7 **	Difference	0.7	No Difference	0.06	No Difference
2	-0.35	No Difference	0.79	No Difference	0.32 *	Difference
3	0.25	No Difference	0.54	No Difference		
4	-0.53 ***	Difference				

Table 2: Model 1: Carletto's specification using SPF and Panel Data

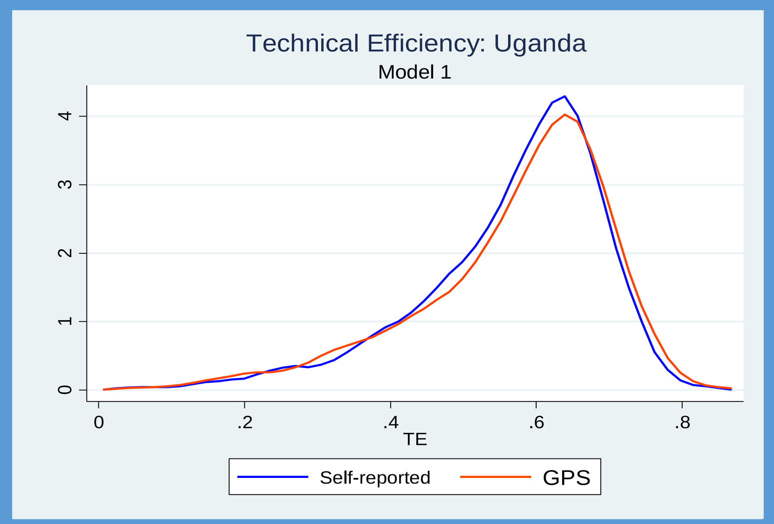
TVP	Uganda SR Coef.	Uganda GPS Coef.	Tanzania SR Coef.	Tanzania GPS Coef.	Malawi SR Coef.	Malawi GPS Coef.
Land	-0.520***	-0.585***	-0.542***	-0.591***	-0.487***	0.487***
Prod Input Exp	0.077***	0.050***	0.044***	0.047***	0.041***	0.179***
Hired Labor	0.029***	0.039***	0.018***	0.020***	0.043***	0.084***
Family Labor	0.195***	0.181***	0.119***	0.077***	0.042***	0.496***
Number of Plots	0.653***	0.658***	-0.035	0.093	0.597***	-0.398***
Poor Soil	-0.183**	-0.133	-0.258	-0.264**	-0.342***	-0.234***
Flat land	0.012	0.002	-0.180	-0.361***	-0.008	-0.021
Swamp/wet	0.051	-0.046			0.053	-0.037
Cropping Syst.	0.404***	0.341***	-0.585***	-0.618***	-0.156***	-0.261***
Rounding	-0.075		-0.022		0.065	
Gender	0.233***	-0.313***	0.082	-0.290***	0.275***	-0.220***
Age	-0.287***	0.001	-0.205***	0.040***	0.100	0.006
Education	0.001	0.203***	0.023***	0.160**	0.015**	-0.127*
T2	0.750***	0.872***	-0.218***	-0.279**	-1.344***	-0.866***
T3	0.854***	0.986***	-0.655***	-0.554***		
T4	1.018***	1.208***				
Cons	5.351***	5.242***	6.933***	7.527***	5.765***	4.956***

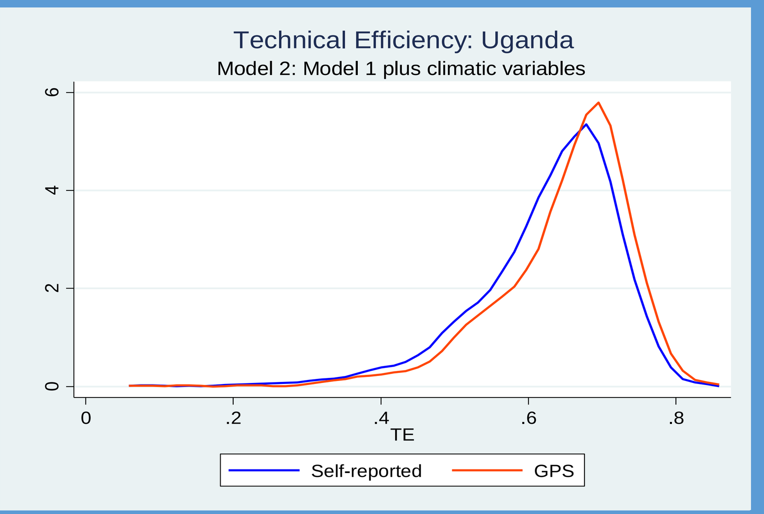
Table 3: Model 2: Model 1 plus climatic variables

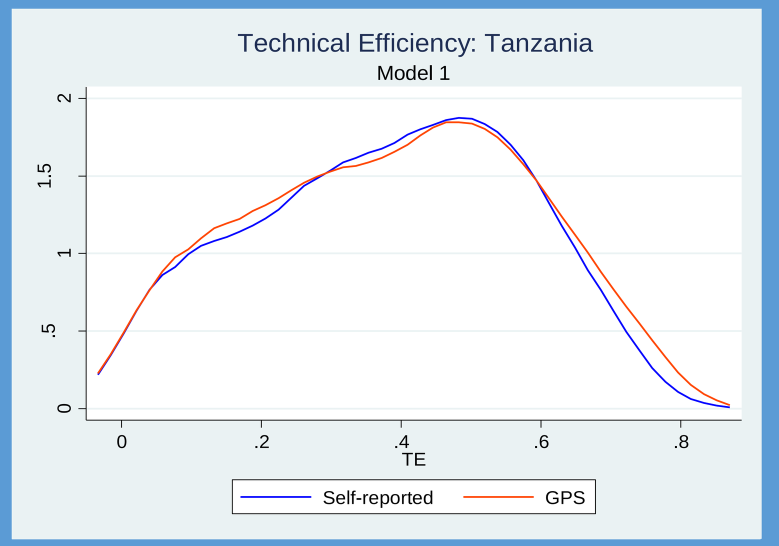
TVP	Uganda SR Coef.	Uganda GPS Coef.	Tanzania SR Coef.	Tanzania GPS Coef.	Malawi SR Coef.	Malawi GPS Coef.
Land	-0.451***	-0.564***	-0.581***	-0.624***	-0.472***	0.485***
Prod Input Exp.	0.098***	0.057***	0.044***	0.046***	0.040***	0.176***
Hired Labor	0.026***	0.031***	0.010*	0.017**	0.046***	0.084***
Family Labor	0.156***	0.131***	0.029***	0.012	0.057***	0.496***
Cropping Syst.	0.365***	0.349***	-0.597***	-0.610***	-0.073	-0.234***
Temperature C	-10.213***	-8.859***	0.154	0.885**	3.359***	1.363**
Precipitation (mm)	0.418**	0.311	-0.007	-0.007	-0.050	0.502***
Slope (percent)	-0.209***	-0.185**	-0.022	0.030	-0.072*	-0.043
Elevation (m)	-2.069***	-1.698***	0.057*	0.133***	1.002***	0.705***
Number of Plots	0.689***	0.762***	-0.032	0.074	0.521***	-0.424***
Oxygen	-0.124*	-0.107			0.496***	0.516***
Excess salts	-0.444***	-0.324*			-0.600***	-0.531***
Workability	0.393***	0.353***	0.056	0.129	0.098*	0.052
Rounding	0.027		-0.050		0.040	
Age	-0.327***	-0.332***	-0.246***	-0.306***	0.094	-0.217***
Education	-0.002	0.001	0.028***	0.049***	0.015**	0.004
Gender	0.214***	0.208***	0.126**	0.188***	0.300***	-0.080
T2	0.089	0.096	-0.195***	-0.292***	-1.347***	-0.846***
T3	0.346***	0.378***	-0.611***	-0.582***		
Cons	50.323***	43.813***	6.809***	4.334**	-10.858***	-7.511***

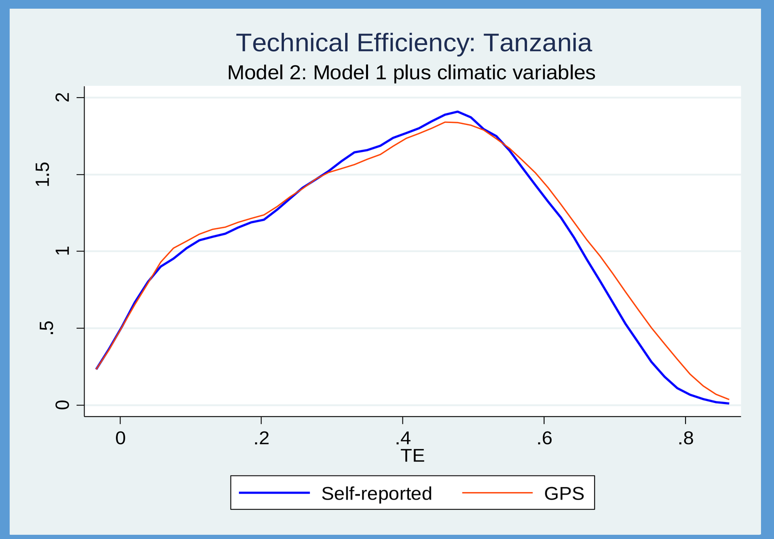
Model 1

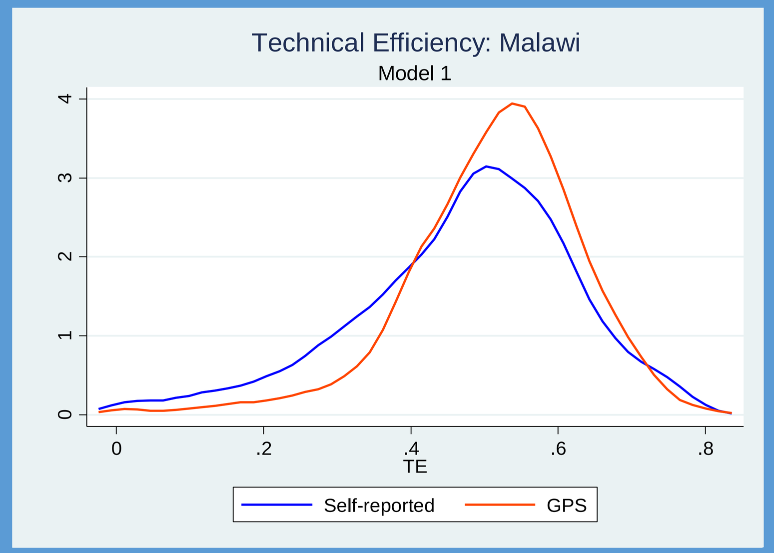
Model 2

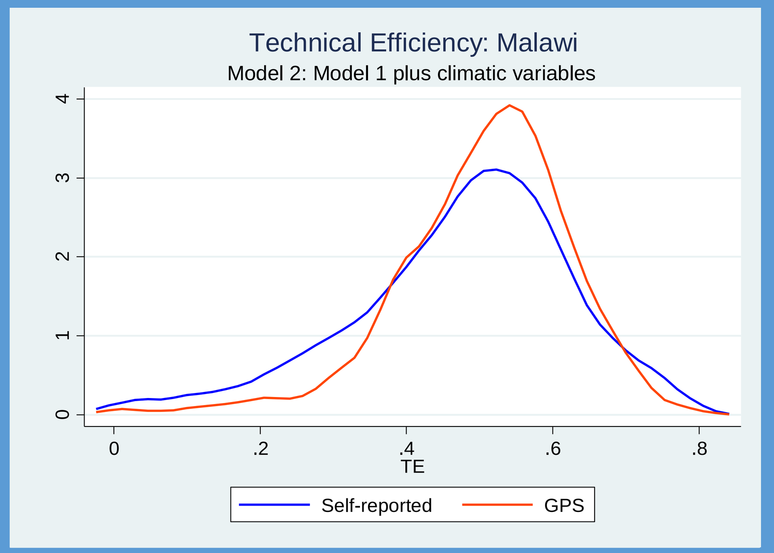












Conclusions

- Comparing Self-reported with GPS models: findings show that IR-H holds with both measures in all three countries.
- The IR-H is stronger in models with GPS for the three countries.
- The Time effect is negative for Tanzania and Malawi and positive for Uganda.
- Labor plays a key role in farm productivity, specially family Labor.
- Model 2 includes climatic variables that affect the production process.
  - Temperature is significant for Uganda (negative sign) and Malawi (positive sign)
  - Precipitation is significant only for the GPS data in Malawi
  - Slope of the land affects productivity only for Uganda (negatively).
- The findings concerning the IR-H imply that, on average, small farms are more productive than larger farms.
- The results suggest that policies promoting small farms and the subdivision of large farms would make economic sense. But, sub-dividing land from large to small farms is a major source of conflict in developing countries.
- Another consideration is the integration of small-scale farmers to commercial agriculture. Transaction costs associated with output commercialization could be costly. As labor continues to migrate to cities this might force mechanization and thus structural change toward larger farms.
- Can small-holder farmers feed the World?