Multivariate decomposition of yield difference

by Simone Pieralli, Ph.D. Candidate Department of Agricultural and Resource Economics at University of Maryland- College Park, U.S.A. and Research Associate at Department of Agricultural Economics at Humboldt University in Berlin, Germany

email: spieralli@arec.umd.edu

Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2013 AAEA & CAES Joint Annual Meeting, Washington, DC, August 4-6, 2013

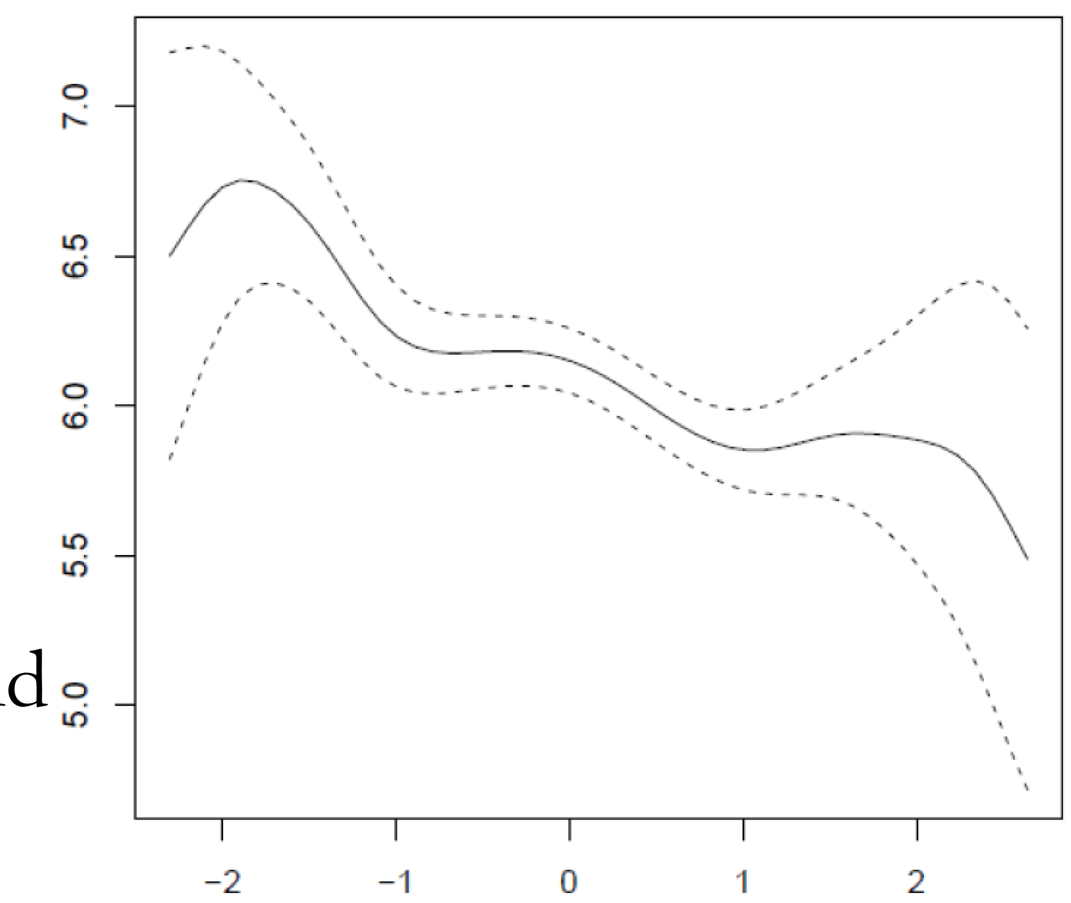
Multivariate decomposition of yield difference

QUESTION: Are smaller farmers more productive in Kenya?

USUAL EMPIRICAL ANSWER: YES

Nonparametric regression of log maize yield on log of land area utilized

On average almost 1/4 decrease in yield per 1% increase in acreage

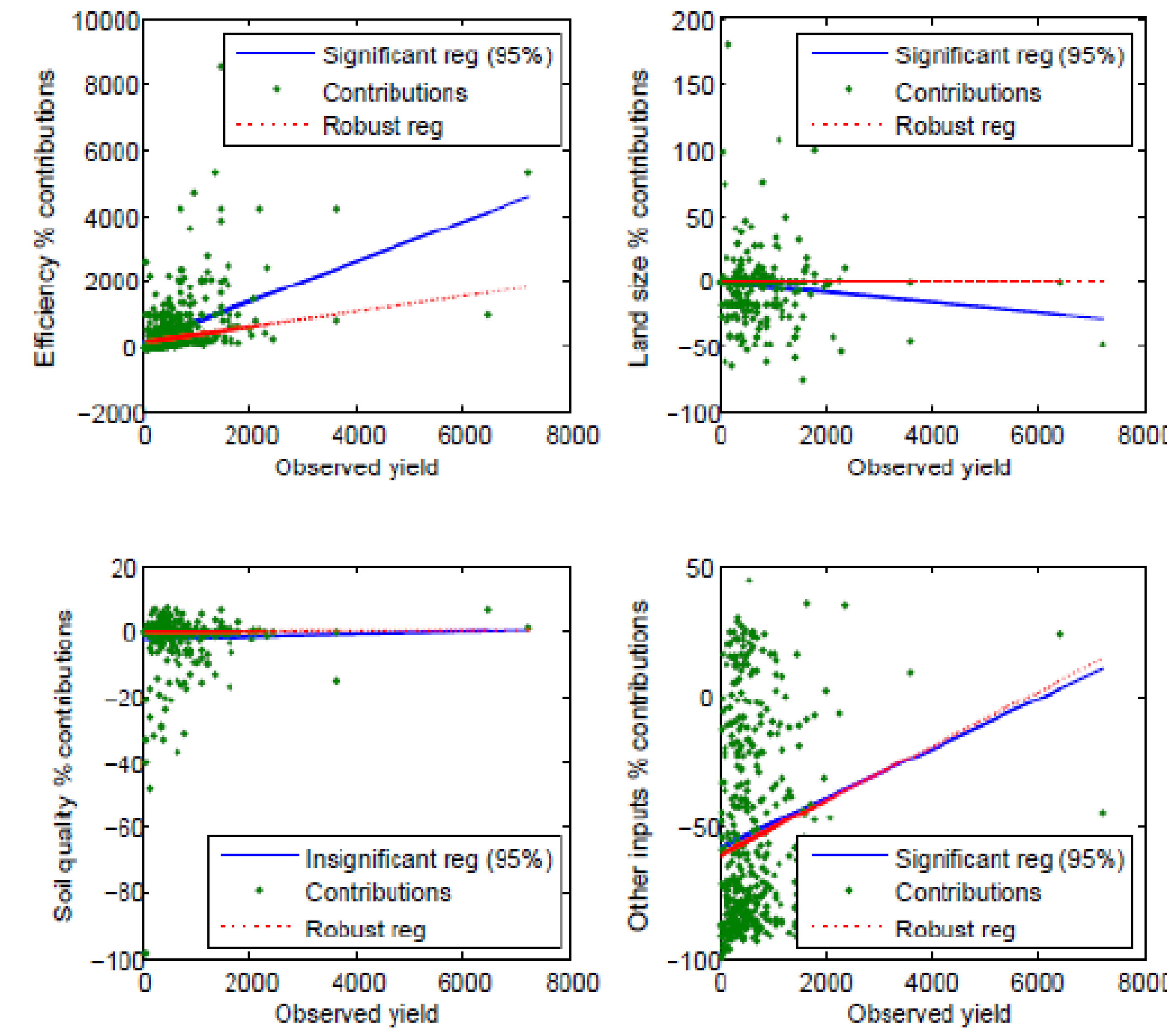


BUT

No relationship exists between land size contributions and yield if a univariate output nonparametric productivity accounting framework is used

Coefficient= -0.0000052

P-value=0.97



NONETHELESS: Farmers produce more than just maize

THIS PAPER DEVELOPS A MULTI-OUTPUT PRODUCTIVITY ACCOUNTING FRAMEWORK TO RECONSIDER THE INVERSE LAND SIZE-YIELD RELATIONSHIP

HOW

Generalizing Kumar and Russell (AER 2002) and applying Gini (ECTA 1937) formula to a three variable ideal Fisher index in a multiple output case

METHODOLOGY

$$T_t = \left\{(\mathbf{x}_t, l_t, q_t, \mathbf{y}_t) \in \mathbb{R}_+^{U+1+1+S} : (\mathbf{x}_t, l_t, q_t) \text{ can be used by households to produce } \mathbf{y}_t \text{ at time } t\right\}$$

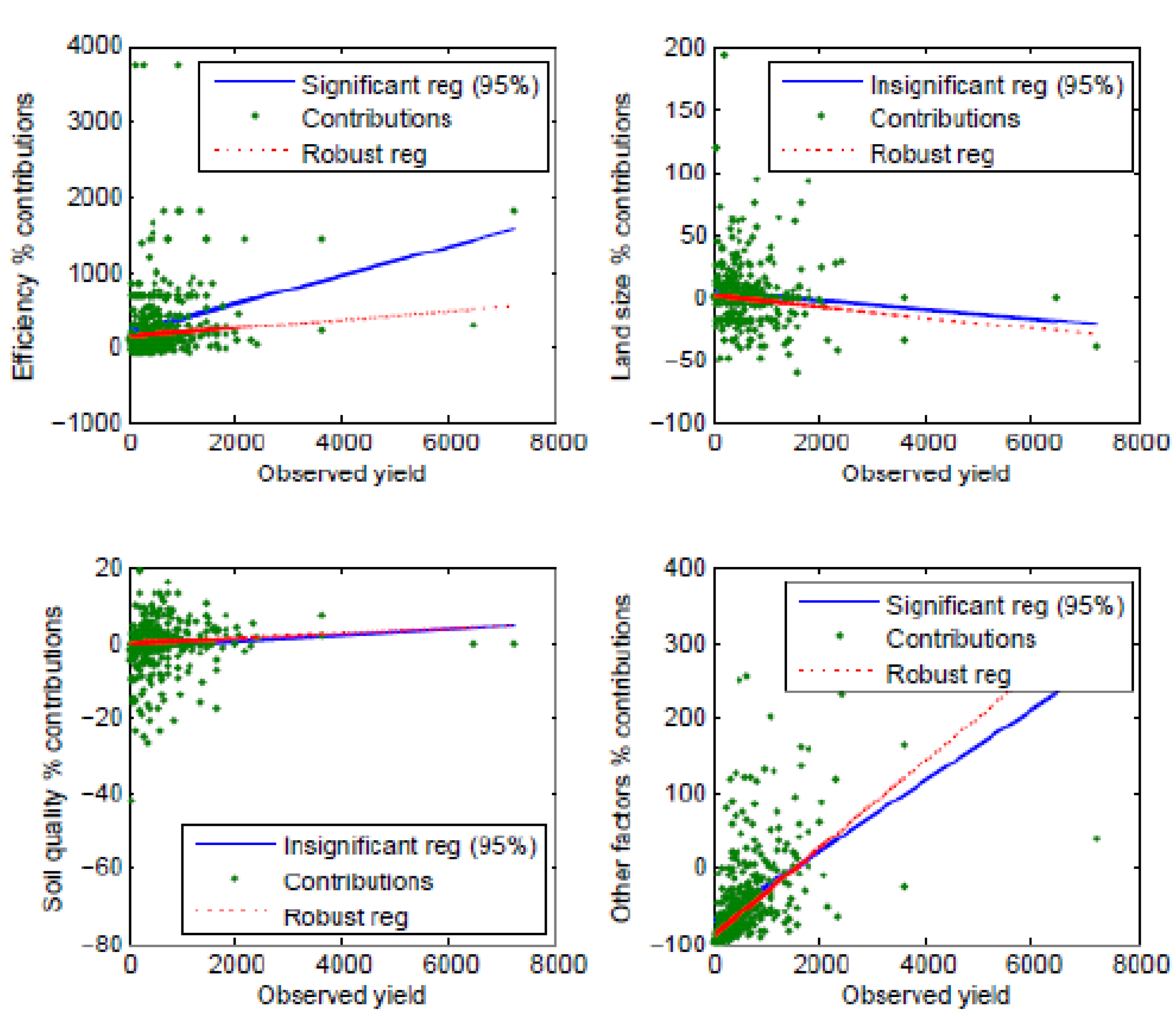
$$E(\mathbf{x}_t, l_t, q_t, \mathbf{y}_t) = \max\{e_t \in \mathbb{R}_+ : (\mathbf{x}_t, l_t, q_t, e_t\mathbf{y}_t) \in T_t\} \longrightarrow E(\mathbf{x}_t, l_t, q_t, \mu y_t^N, \mu y_t^M) = \mu^{-1} E(\mathbf{x}_t, l_t, q_t, y_t^N, y_t^M) \quad \mu > 0$$

$$E(\mathbf{x}_t, l_t, q_t, \frac{y_t^N}{y_t^M}, 1) = y_t^M E(\mathbf{x}_t, l_t, q_t, y_t^N, y_t^M) \quad y_t^M > 0 \longrightarrow \frac{y_1^M / l_1}{y_0^M / l_0} = \frac{E(\mathbf{x}_1, l_1, q_1, \frac{y_1^N}{y_1^M}, 1)/l_1}{E(\mathbf{x}_0, l_0, q_0, \frac{y_0^N}{y_0^M}, 1)/l_0} \frac{E(\mathbf{x}_0, l_0, q_0, y_0^N, y_0^M)}{E(\mathbf{x}_1, l_1, q_1, y_1^N, y_1^M)}$$

Reference unit is the median

$$\frac{y_1^M / l_1}{y_0^M / l_0} = \frac{E(\mathbf{x}_1, l_1, q_1, \frac{y_1^N}{y_1^M}, 1)}{E(\mathbf{x}_0, l_0, q_0, \frac{y_0^N}{y_0^M}, 1)} \frac{E(\mathbf{x}_0, l_0, q_0, y_0^N / l_0, y_0^M / l_0)}{E(\mathbf{x}_1, l_1, q_1, y_1^N / l_1, y_1^M / l_1)}$$

MAIN RESULT through Data Envelopment Analysis



The robust regression shows the presence of a negatively significant relationship between land size contributions to productivity and observed yield

Coefficient=-0.00436

P-value=0.0001

$$\frac{h(\mathbf{z}_1, l_1, q_1)}{h(\mathbf{z}_0, l_0, q_0)} = I_m^{(\mathbf{z}_1, \mathbf{z}_0)}(l_0, q_0; l_1, q_1) * L_m^{(l_1, l_0)}(\mathbf{z}_0, q_0; \mathbf{z}_1, q_1) * Q_m^{(q_1, q_0)}(\mathbf{z}_0, l_0; \mathbf{z}_1, l_1)$$

$$\left(\frac{h(\mathbf{z}_1,l_0,q_0)}{h(\mathbf{z}_0,l_0,q_0)}\frac{h(\mathbf{z}_1,l_1,q_1)}{h(\mathbf{z}_0,l_1,q_1)}\frac{h(\mathbf{z}_1,l_0,q_0)}{h(\mathbf{z}_0,l_0,q_0)}\frac{h(\mathbf{z}_1,l_1,q_1)}{h(\mathbf{z}_0,l_1,q_1)}\frac{h(\mathbf{z}_1,l_1,q_0)}{h(\mathbf{z}_0,l_1,q_0)}\frac{h(\mathbf{z}_1,l_0,q_1)}{h(\mathbf{z}_0,l_0,q_1)}\right)^{1/6}$$

$$\left(\frac{h(\mathbf{z}_1,l_1,q_0)}{h(\mathbf{z}_1,l_0,q_0)}\frac{h(\mathbf{z}_0,l_1,q_1)}{h(\mathbf{z}_0,l_0,q_1)}\frac{h(\mathbf{z}_1,l_1,q_1)}{h(\mathbf{z}_1,l_0,q_1)}\frac{h(\mathbf{z}_0,l_1,q_0)}{h(\mathbf{z}_0,l_0,q_0)}\frac{h(\mathbf{z}_0,l_1,q_0)}{h(\mathbf{z}_0,l_0,q_0)}\frac{h(\mathbf{z}_1,l_1,q_1)}{h(\mathbf{z}_1,l_0,q_1)}\right)^{1/6}$$

$$\left(\frac{h(\mathbf{z}_1,l_1,q_1)}{h(\mathbf{z}_1,l_1,q_0)}\frac{h(\mathbf{z}_0,l_0,q_1)}{h(\mathbf{z}_0,l_0,q_0)}\frac{h(\mathbf{z}_1,l_0,q_1)}{h(\mathbf{z}_1,l_0,q_0)}\frac{h(\mathbf{z}_0,l_1,q_1)}{h(\mathbf{z}_0,l_1,q_0)}\frac{h(\mathbf{z}_1,l_1,q_1)}{h(\mathbf{z}_1,l_1,q_0)}\frac{h(\mathbf{z}_0,l_0,q_1)}{h(\mathbf{z}_0,l_0,q_0)}\right)^{1/6}$$

WHILE THE INVERSE LAND SIZE-YIELD RELATIONSHIP IS NOT AN AGRICULTURAL REALITY PER SE, IT APPEARS IN THE MULTIVARIATE OUTPUT VERSION OF THE TECHNOLOGY

by Simone Pieralli, Ph.D. Candidate at University of Maryland College Park and Humboldt University in Berlin