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Multivariate decomposition of yield difference

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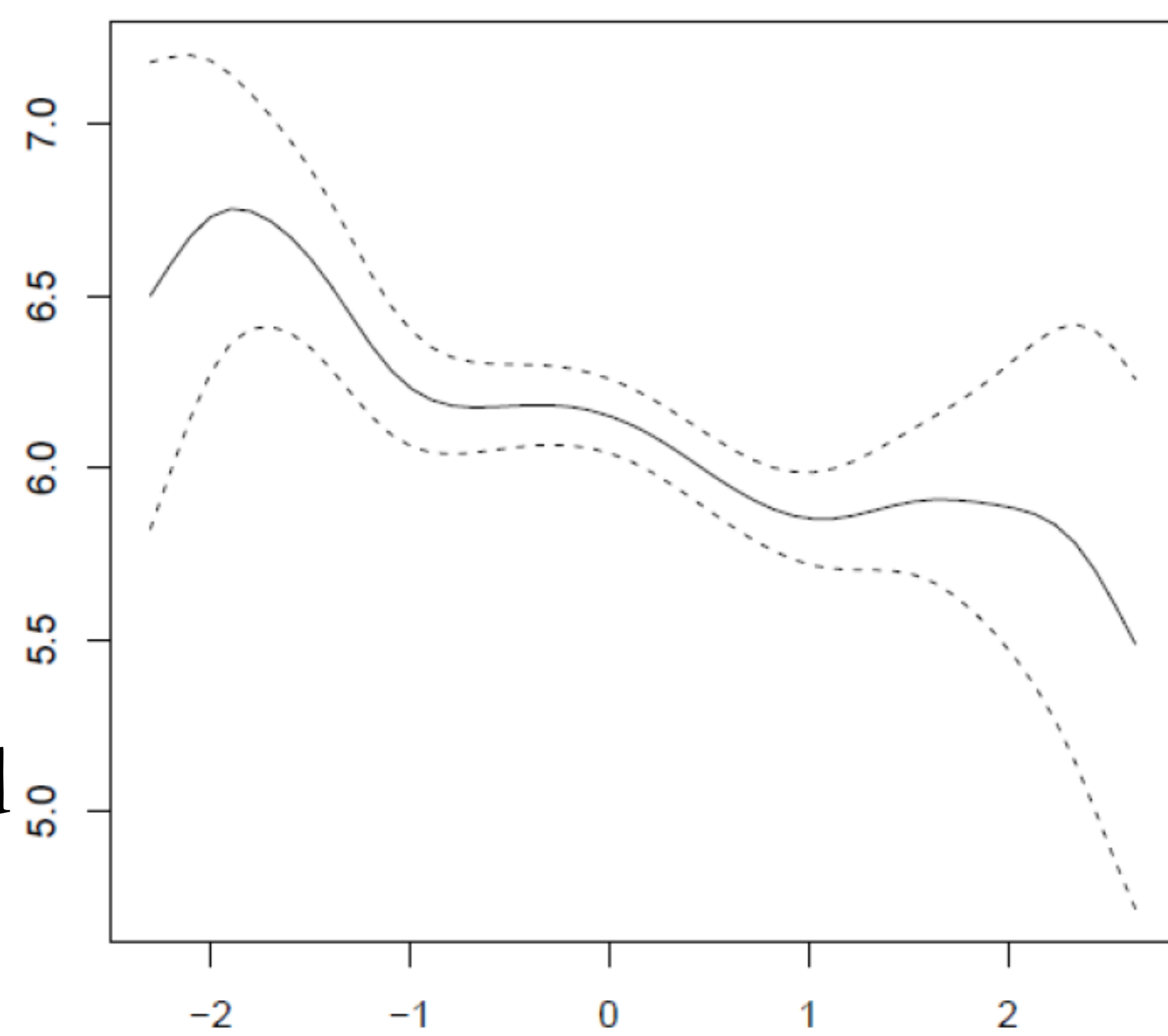
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Multivariate decomposition of yield difference

QUESTION: Are smaller farmers more productive in Kenya?

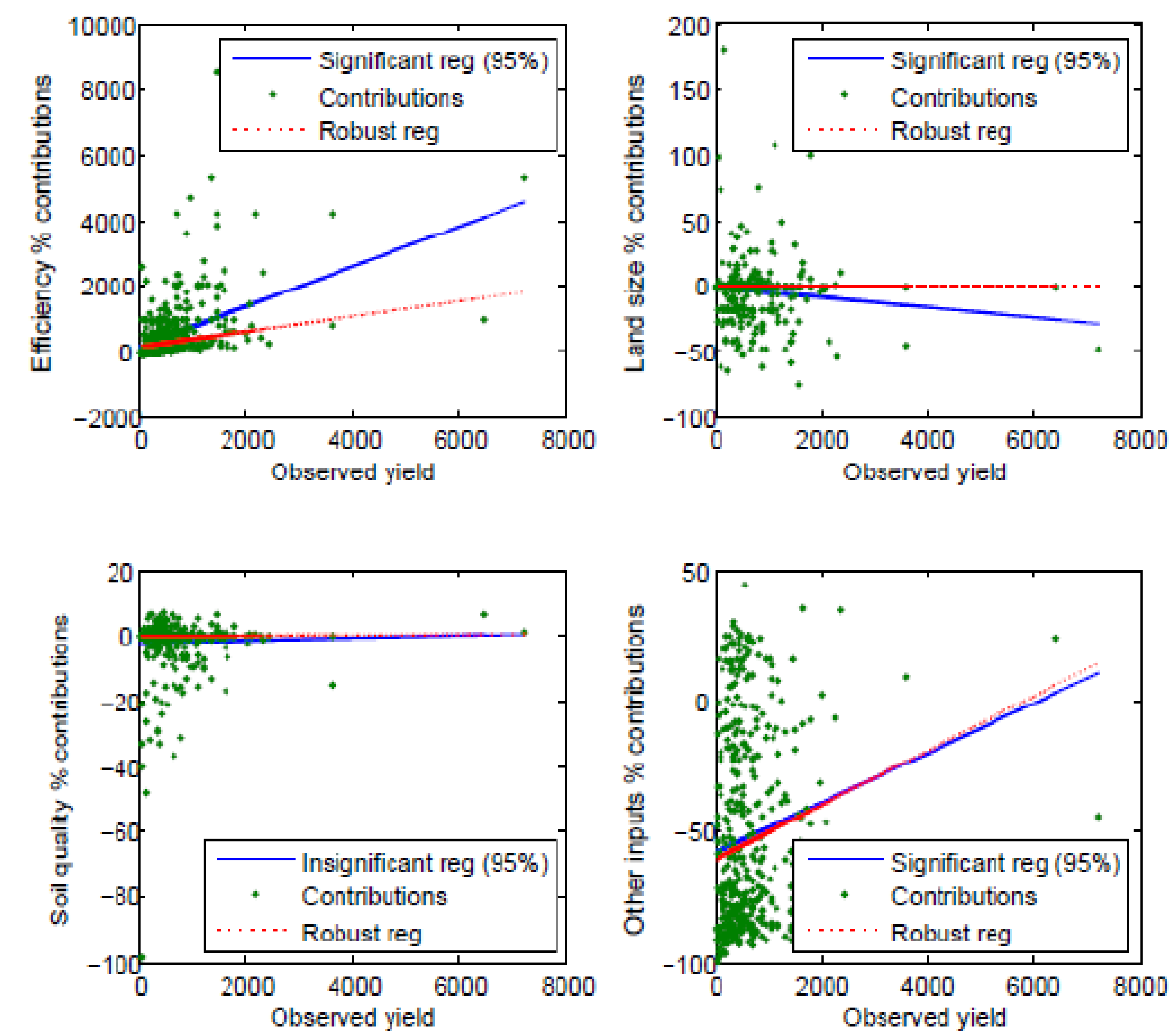
USUAL EMPIRICAL ANSWER: YES

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

MAIN RESULT through Data Envelopment Analysis

METHODOLOGY

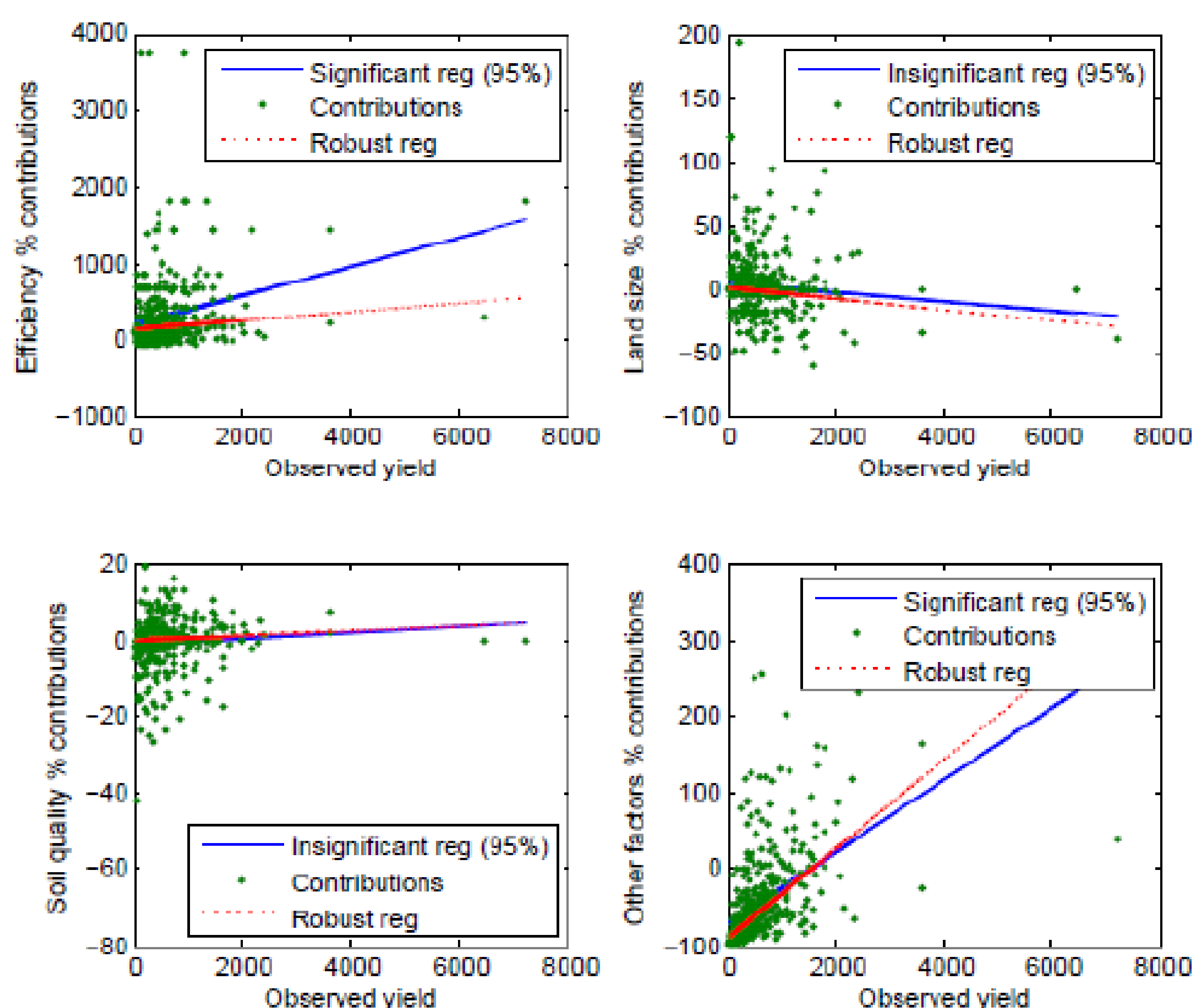
$$T_t = \left\{ (x_t, l_t, q_t, y_t) \in \mathbb{R}_+^{U+1+1+S} : (x_t, l_t, q_t) \text{ can be used by households to produce } y_t \text{ at time } t \right\}$$

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

$$E(x_t, l_t, q_t, \frac{y_t^N}{y_t^M}, 1) = y_t^M E(x_t, l_t, q_t, y_t^N, y_t^M) \quad y_t^M > 0 \rightarrow \frac{y_1^M/l_1}{y_0^M/l_0} = \frac{E(x_1, l_1, q_1, \frac{y_1^N}{y_1^M}, 1)/l_1}{E(x_0, l_0, q_0, \frac{y_0^N}{y_0^M}, 1)/l_0} \frac{E(x_0, l_0, q_0, y_0^N, y_0^M)}{E(x_1, l_1, q_1, y_1^N, y_1^M)}$$

Reference unit is the median

$$\frac{y_1^M/l_1}{y_0^M/l_0} = \frac{E(x_1, l_1, q_1, \frac{y_1^N}{y_1^M}, 1)}{E(x_0, l_0, q_0, \frac{y_0^N}{y_0^M}, 1)} \frac{E(x_0, l_0, q_0, y_0^N, y_0^M/l_0)}{E(x_1, l_1, q_1, y_1^N, y_1^M/l_1)}$$



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

$$\frac{h(z_1, l_1, q_1)}{h(z_0, l_0, q_0)} = I_m^{(z_1, z_0)}(l_0, q_0; l_1, q_1) * L_m^{(l_1, l_0)}(z_0, q_0; z_1, q_1) * Q_m^{(q_1, q_0)}(z_0, l_0; z_1, l_1)$$

$$\left(\frac{h(z_1, l_0, q_0)}{h(z_0, l_0, q_0)} \frac{h(z_1, l_1, q_1)}{h(z_0, l_1, q_1)} \frac{h(z_1, l_0, q_0)}{h(z_0, l_0, q_0)} \frac{h(z_1, l_1, q_1)}{h(z_0, l_1, q_1)} \frac{h(z_1, l_1, q_0)}{h(z_0, l_1, q_0)} \frac{h(z_1, l_0, q_1)}{h(z_0, l_0, q_1)} \right)^{1/6}$$

$$\left(\frac{h(z_1, l_1, q_0)}{h(z_1, l_0, q_0)} \frac{h(z_0, l_1, q_1)}{h(z_0, l_0, q_1)} \frac{h(z_1, l_1, q_1)}{h(z_1, l_0, q_1)} \frac{h(z_0, l_1, q_0)}{h(z_0, l_0, q_0)} \frac{h(z_0, l_1, q_0)}{h(z_0, l_0, q_0)} \frac{h(z_1, l_1, q_1)}{h(z_1, l_0, q_1)} \right)^{1/6}$$

$$\left(\frac{h(z_1, l_1, q_1)}{h(z_1, l_1, q_0)} \frac{h(z_0, l_0, q_1)}{h(z_0, l_0, q_0)} \frac{h(z_1, l_0, q_1)}{h(z_1, l_0, q_0)} \frac{h(z_0, l_1, q_1)}{h(z_0, l_1, q_0)} \frac{h(z_1, l_1, q_1)}{h(z_1, l_1, q_0)} \frac{h(z_0, l_0, q_1)}{h(z_0, l_0, q_0)} \right)^{1/6}$$

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