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The Sources of Measured Agricultural Productivity Growth

Robert G. Chambers

Selected Paper prepared for presentation at the International Agricultural Trade Research Consortium's (IATRC's) 2013 Symposium: Productivity and Its Impacts on Global Trade, June 2-4, 2013, Seville, Spain

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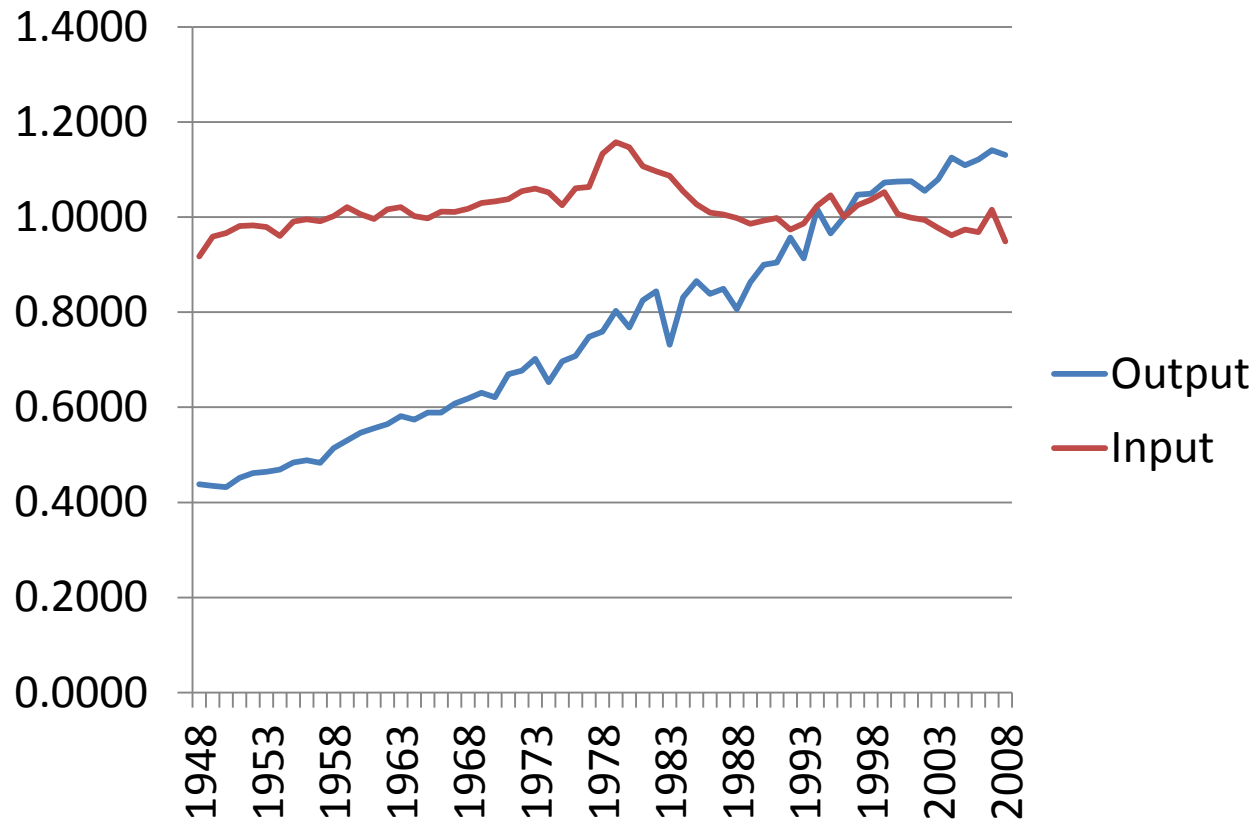
The Sources of Measured Agricultural Productivity Growth

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University of Maryland

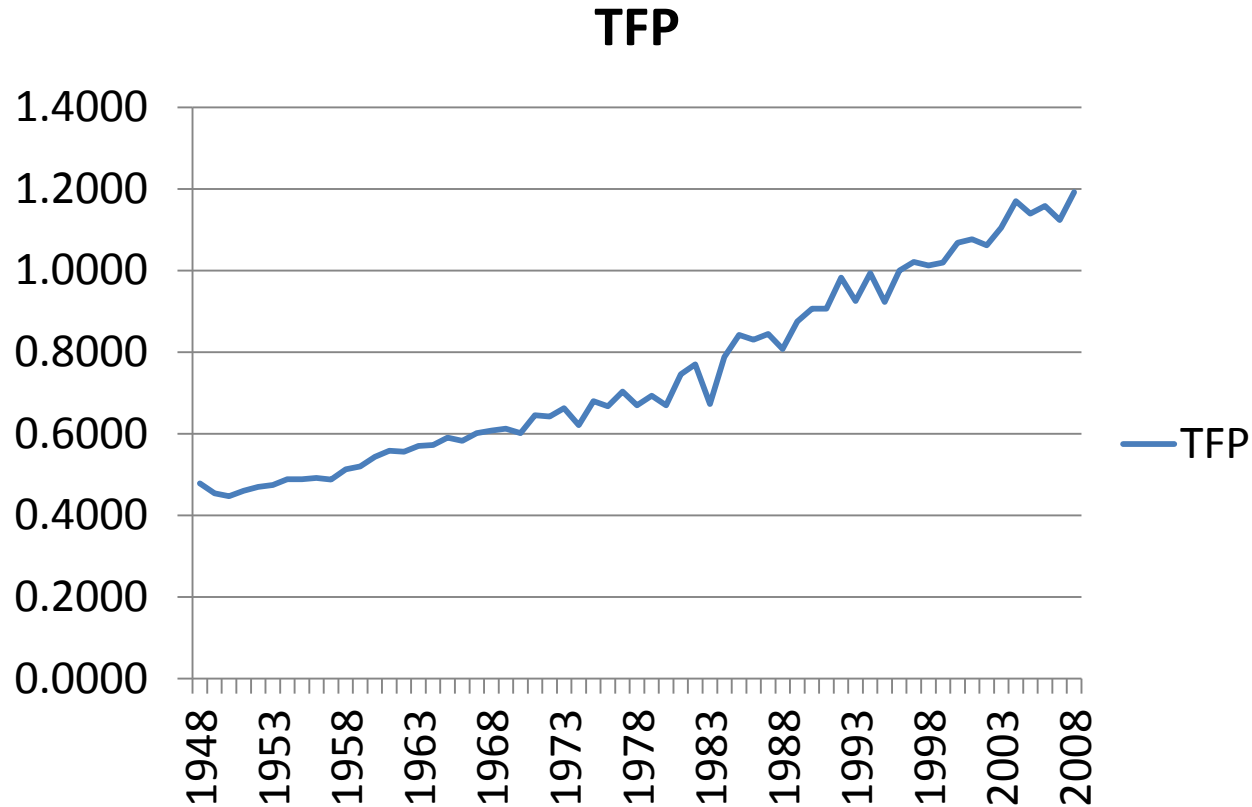
May 31, 2013

Fact 1: Aggregate US Agricultural Input and Output (1948-2008)



Source: Economic Research Service, United States Department of Agriculture

Fact 2: US Agricultural TFP



Thinking about Facts 1 and Fact 2

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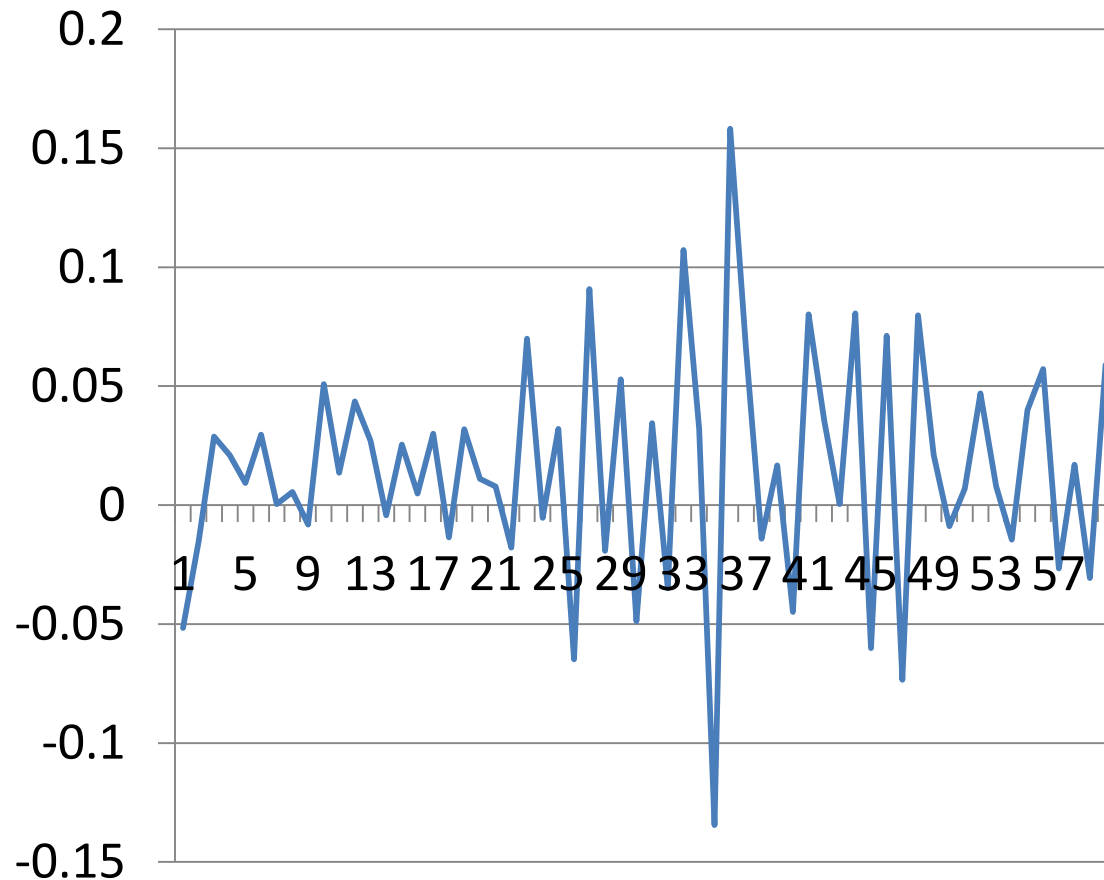
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- Residual remains

Fact 3: US Agriculture TFP Change (1949-2008)



Source: Computed from ERS/USDA official statistics

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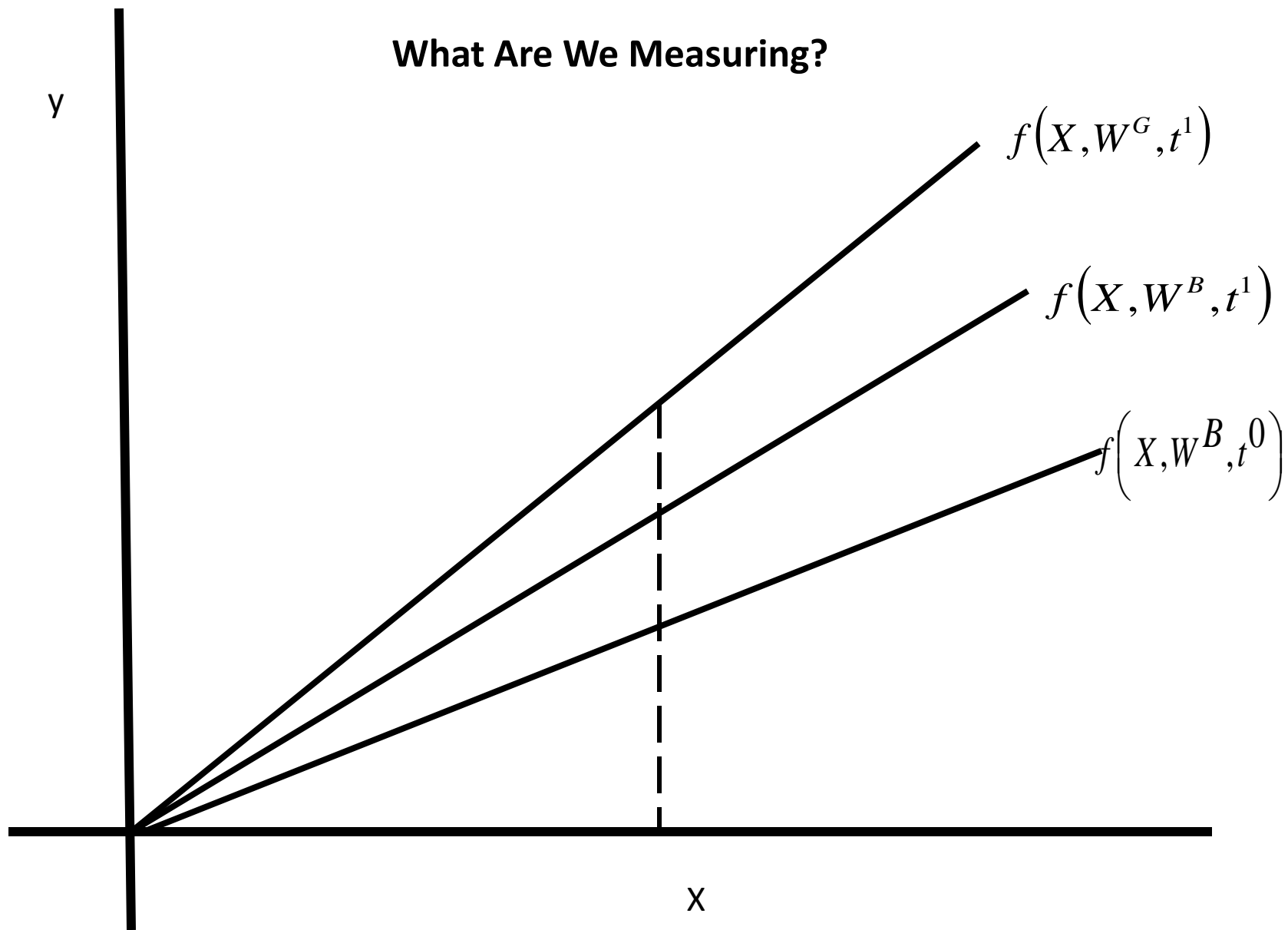
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- Instead we get:

What Are We Measuring?



- Incorporate stochastic nature of agriculture into productivity measurement, while allowing for inefficiency.

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$$T^\Omega(t) = \{(\tilde{z}, x) : z(s) \leq g(x, s, t), s \in \Omega\}$$

$g : \Omega \rightarrow \mathbb{R}_+$, $\tilde{g} = (g(x, s_1, t), g(x, s_2, t), \dots) \in \mathbb{R}_+^\Omega$ is a random variable.

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- Huge number of conceptual problems (Chambers and Quiggin, *ad nauseam*) but does have advantages:
Implementable and easily comparable

- Standard Malmquist-type productivity index:

$$\left(\frac{z^0}{g(x^0, s^1, t^1)} \frac{g(x^1, s^1, t^1)}{z^1} \right)^{\frac{1}{2}} \left(\frac{z^0}{g(x^0, s^0, t^0)} \frac{g(x^1, s^0, t^0)}{z^1} \right)^{\frac{1}{2}},$$

easily decomposes as

$$E^{s^0, s^1, t^0, t^1}(z^0, x^0; z^1, x^1) H^{s^0, s^1, t^0, t^1}(z^0, x^0; z^1, x^1),$$

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- $H^{s^0, s^1, t^0, t^1}(z^0, x^0; z^1, x^1)$ is a combination of technical change and state of Nature change. Its decomposition is path dependent (standard problem, but see Henderson and Russell (2005))

Heterogeneity Decomposed (but not simply)

$$H^{s^0, s^1, t^0, t^1} = \Omega^{s^0, s^1} (x^0, x^1, t^0, t^1) \times T^{t^0, t^1} (x^0, s^0, x^1, s^1),$$

where $T^{t^0, t^1} (x^0, s^0, x^1, s^1)$ is technical change of the form

$$\left(\tilde{T}^{t^0, t^1} (x^0, s^1) \tilde{T}^{t^0, t^1} (x^0, s^0) \tilde{T}^{t^0, t^1} (x^1, s^1) \tilde{T}^{t^0, t^1} (x^1, s^0) \right)$$

and $\Omega^{s^0, s^1} (x^0, x^1, t^0, t^1)$ is state-contingent effect of the form

$$\left(\tilde{\Omega}^{s^0, s^1} (x^0, t^0) \tilde{\Omega}^{s^0, s^1} (x^0, t^1) \tilde{\Omega}^{s^0, s^1} (x^1, t^0) \tilde{\Omega}^{s^0, s^1} (x^1, t^1) \right)^{\frac{1}{2}}$$

- $\Omega \subset \mathbb{R}_+^2$ defined empirically by observations on degree days between 8° and 32° C and precipitation

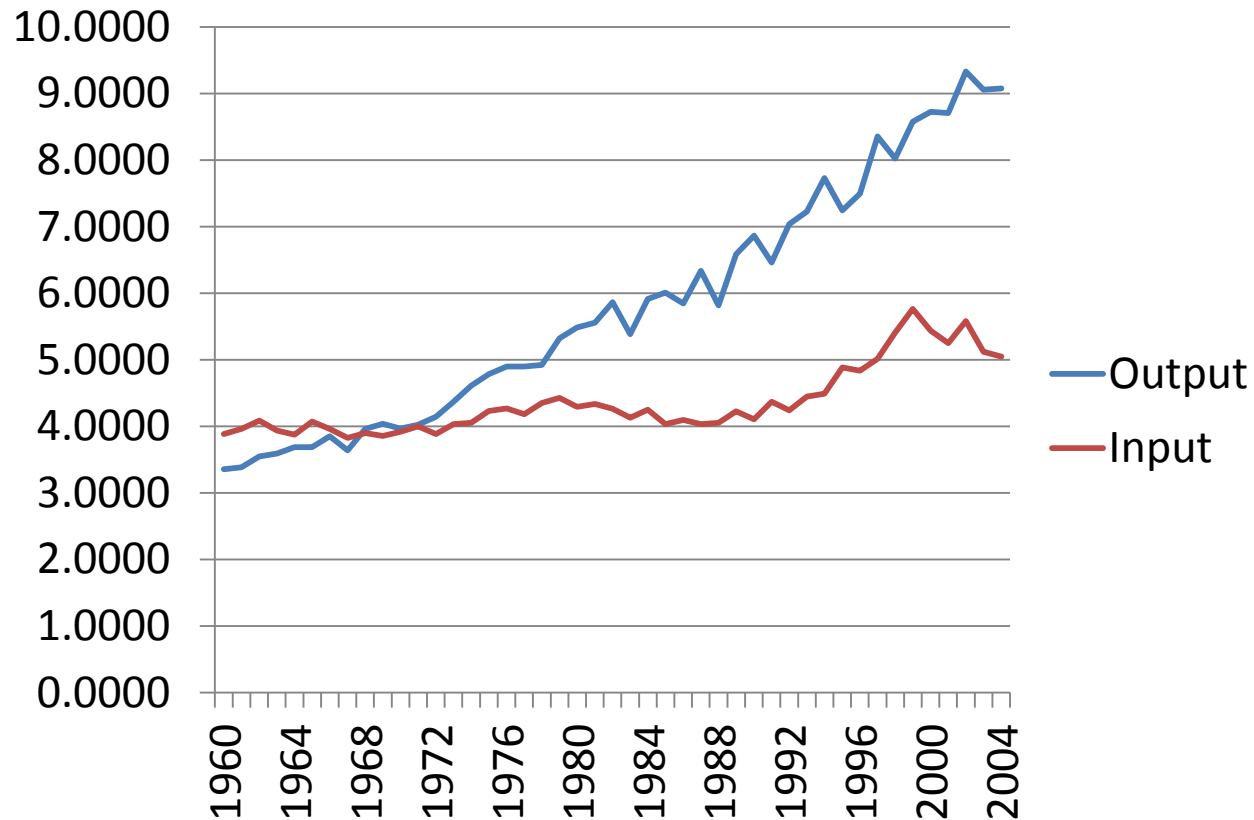
Operationally speaking

- $\Omega \subset \mathbb{R}_+^2$ defined empirically by observations on degree days between 8° and 32° C and precipitation
- Follow Banker and Morey (1986) and (implicitly) O'Donnell and Griffiths (2006) and approximate $\hat{T}^\Omega(t)$ with CRS hull

$$\hat{T}^\Omega(t) = \left\{ \begin{array}{l} (z, x, s) : z \leq \sum_{k=1}^{48} \sum_{v=1}^t \lambda_{kv} z^{kv}, \\ x \geq \sum_{k=1}^{48} \sum_{v=1}^t \lambda_{kv} x^{kv}, \\ s = \sum_{k=1}^{48} \sum_{v=1}^t \lambda_{kv} s^{kv}, \\ \lambda_{kv} \geq 0 \end{array} \right\},$$

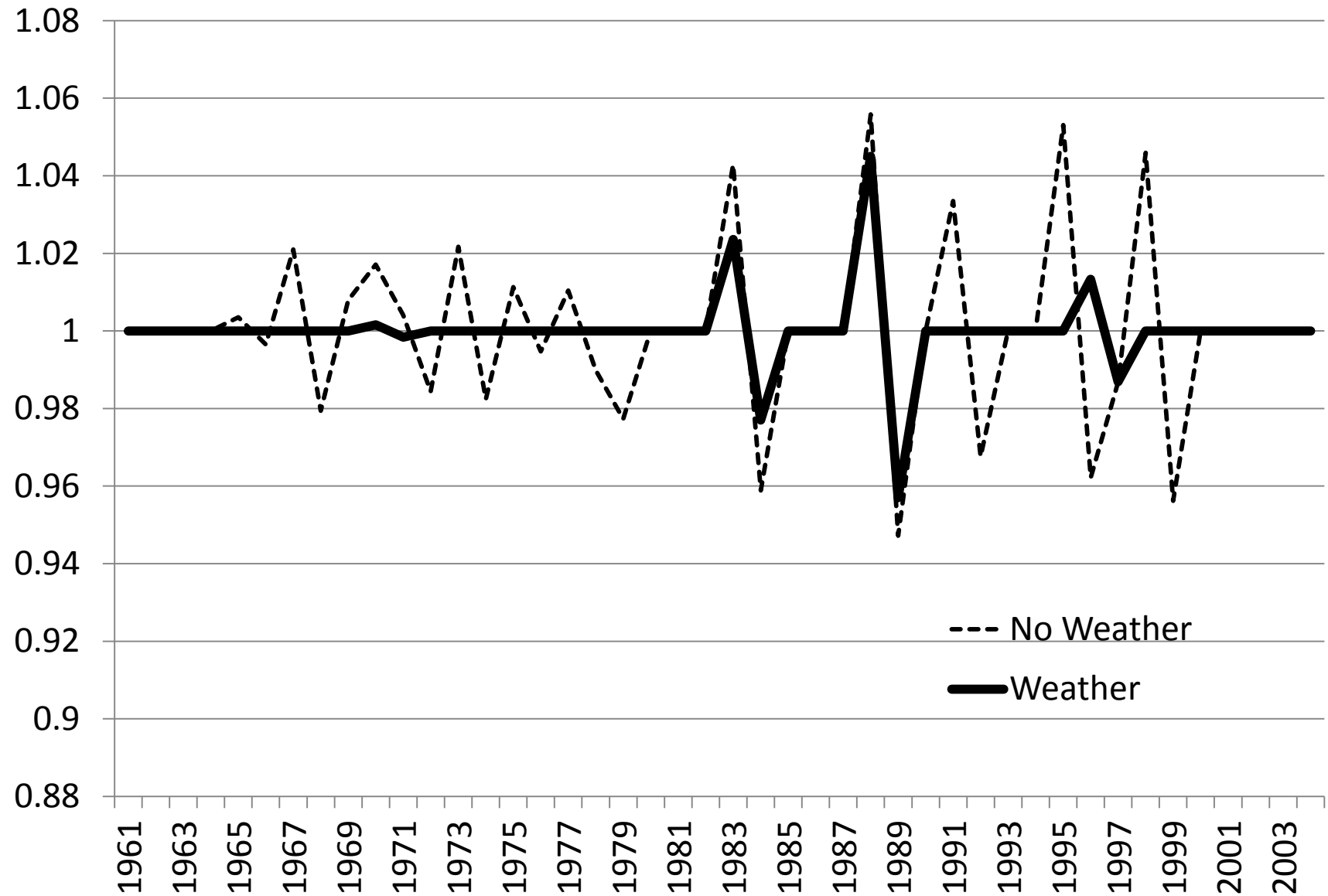
where the $(x, z)'$ s are taken from V. Eldon Ball's state panel (1960-2004) and the s 's from Schlenker and Roberts (2005)

California Aggregate Output and Input (1960-2004)

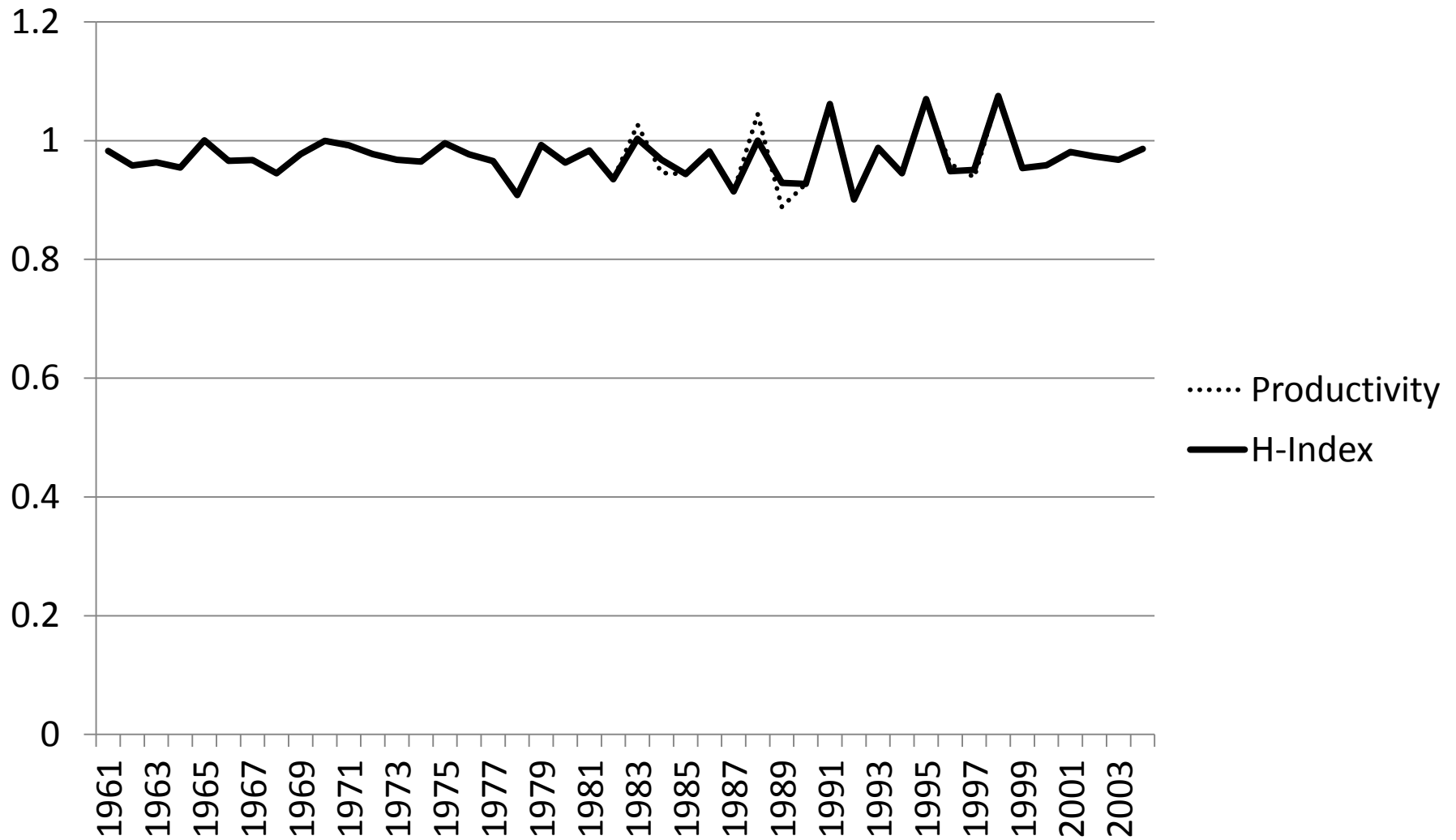


Source: ERS/USDA

Efficiency Change Index for California as calculated
with and without Weather



California Productivity and H-Index: The Efficiency Residual Disappears



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- Do we learn anything from trying to relax that premise?
- Maybe, maybe not! But we should definitely check.
- Too simple minded?
- For sure, but that's why I'm trying to raise the issue for the experts.