The Sources of Measured Agricultural Productivity Growth

Robert G. Chambers

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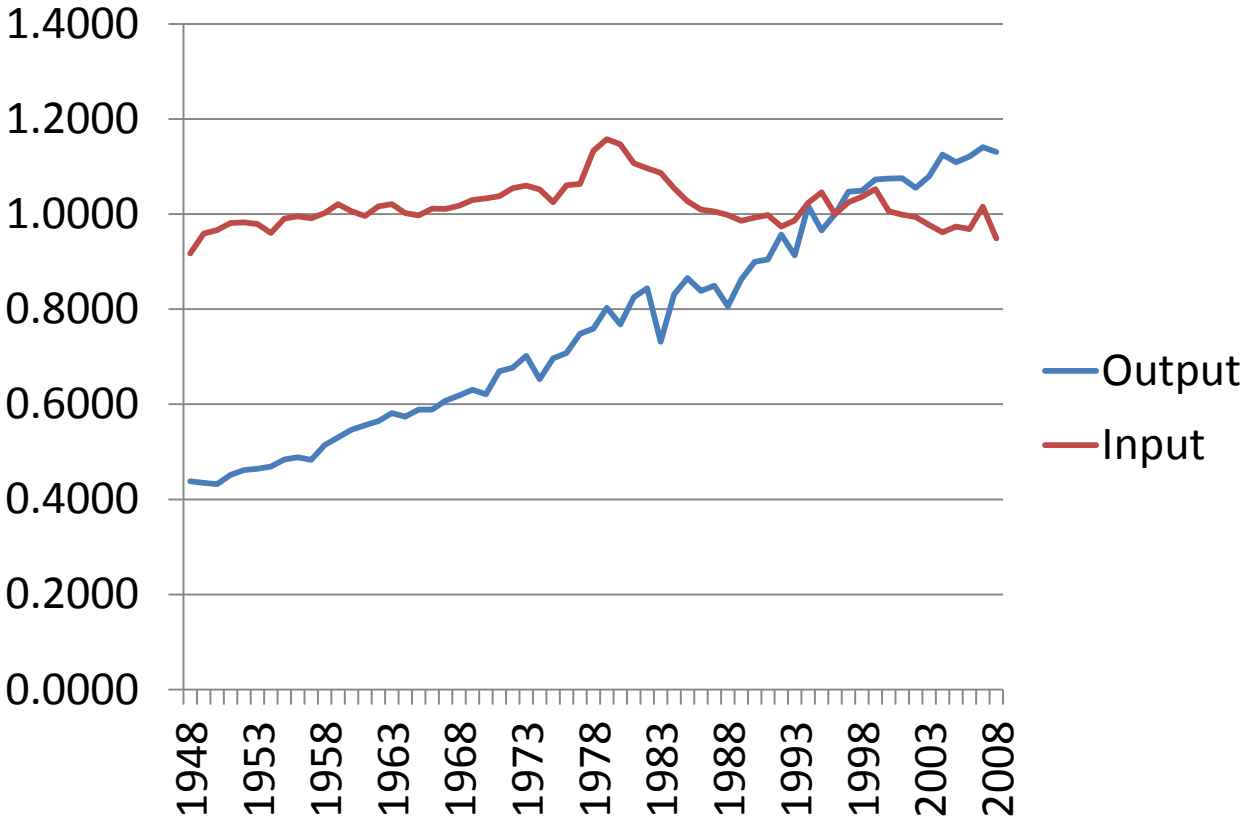
University of Maryland

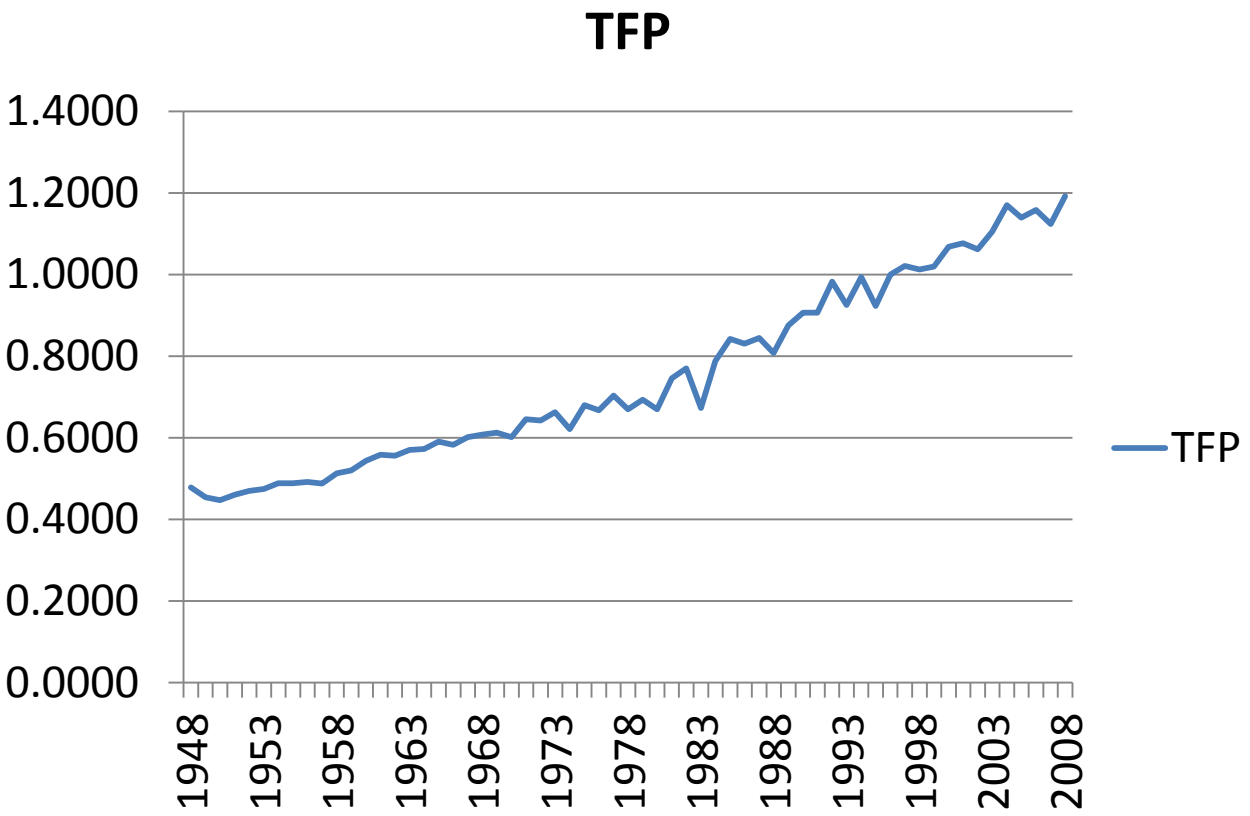
May 31, 2013

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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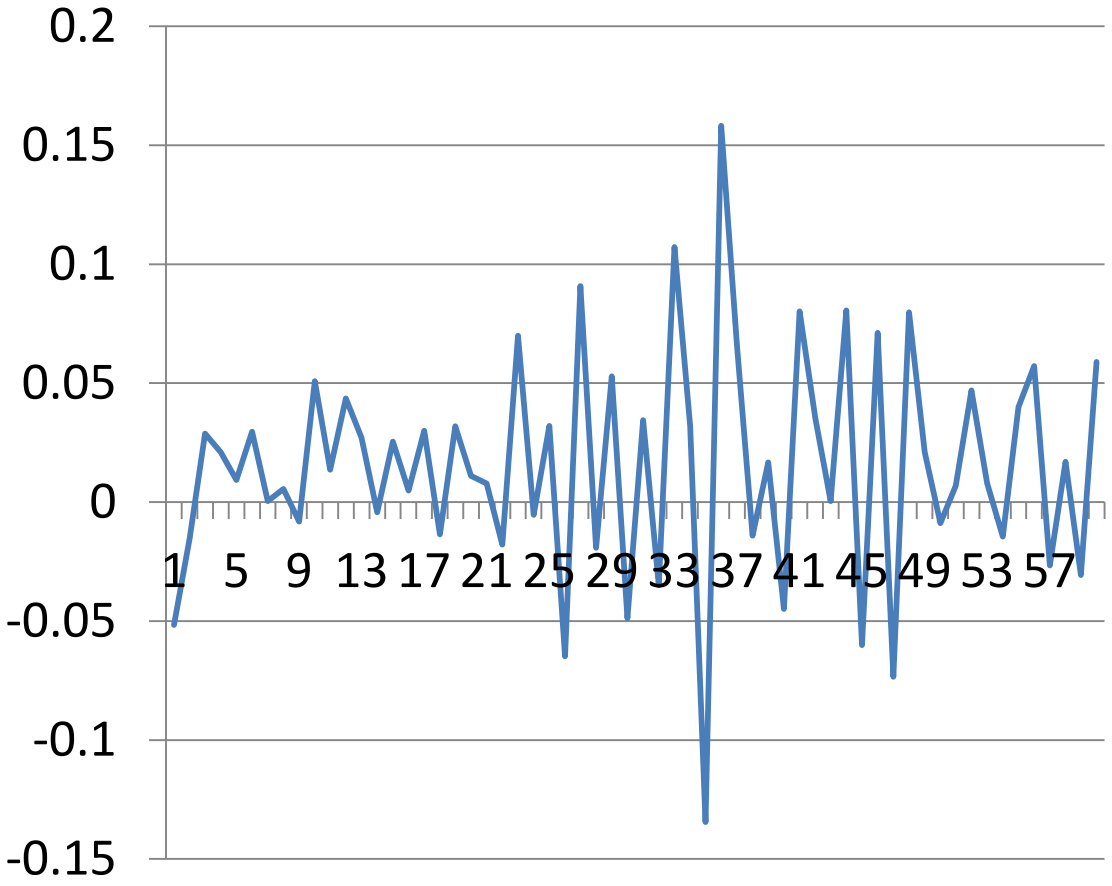
- Residual remains

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



Source: Computed from ERS/USDA official statistics

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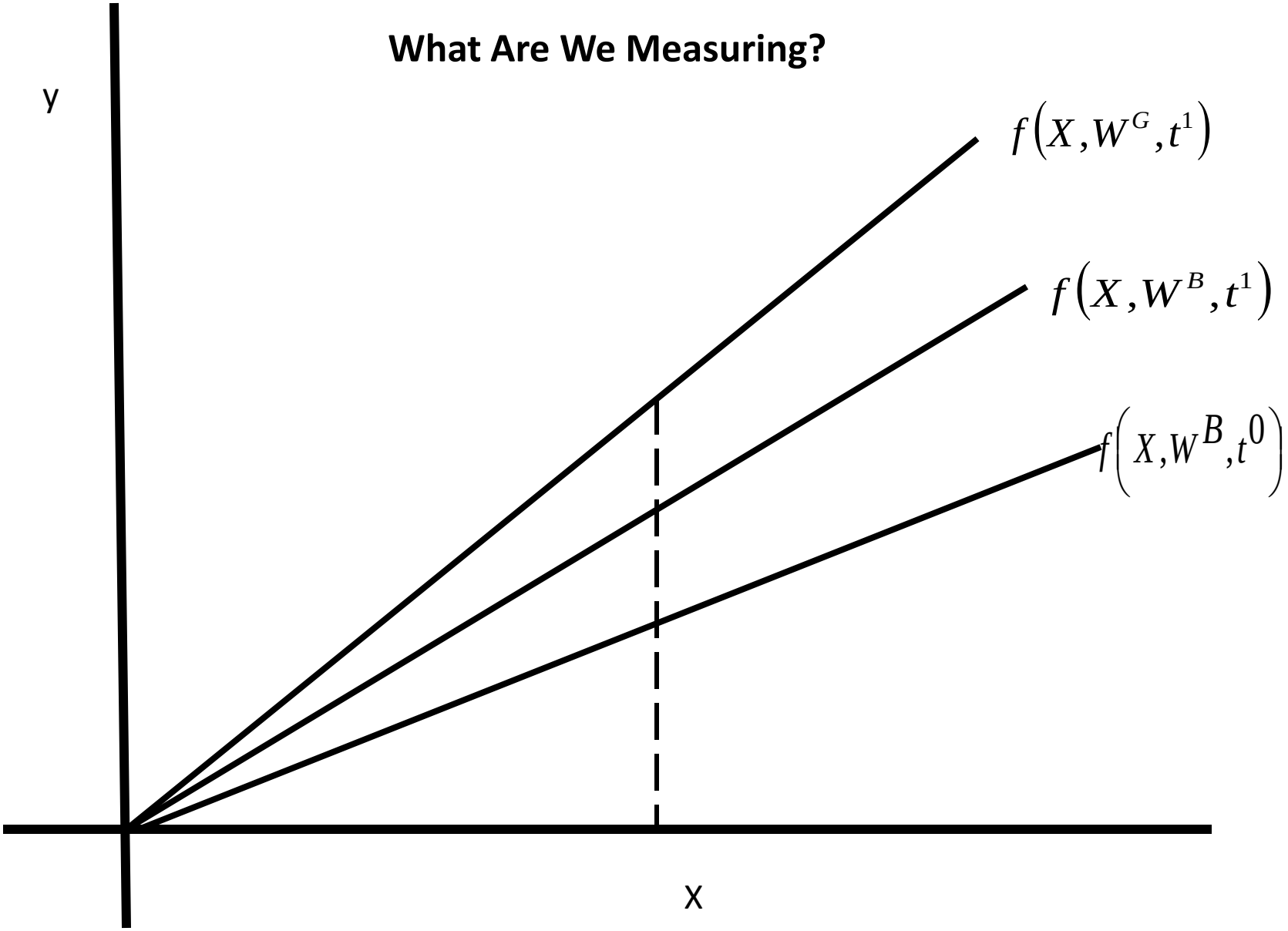
- Instead we get:

What Are We Measuring?



Simple Goal

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

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- Approximate it with

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

$g : \Omega \to \mathbb{R}_+$, $\tilde{g} = (g(x, s_1, t), g(x, s_2, t), ...) \in \mathbb{R}_+^{\Omega}$ 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

Productivity Index

- Standard Malmquist-type productivity index:

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

  easily decomposes as

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

  and $E^{s^0,s^1,t^0,t^1}\left(z^0,x^0;z^1,x^1\right)$ is a standard Färe et al. (1994) efficiency change index..

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- $H^{s^0,s^1,t^0,t^1}\left(z^0,x^0;z^1,x^1\right)$ 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)

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

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

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

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

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

Operationally speaking

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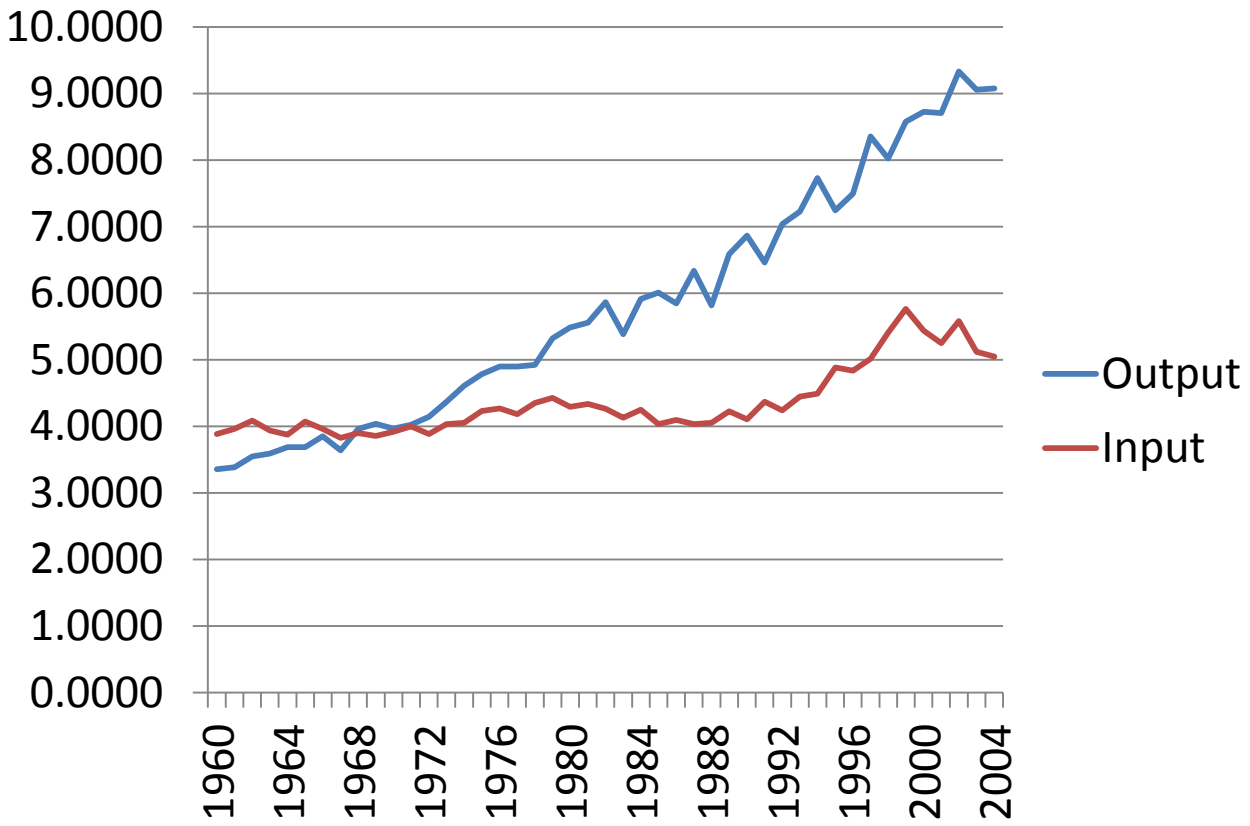
- Follow Banker and Morey (1986) and (implicitly) O'Donnell and Griffiths (2006) and approximate $\hat{T}^{\Omega}(t)$ with CRS hull

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

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)



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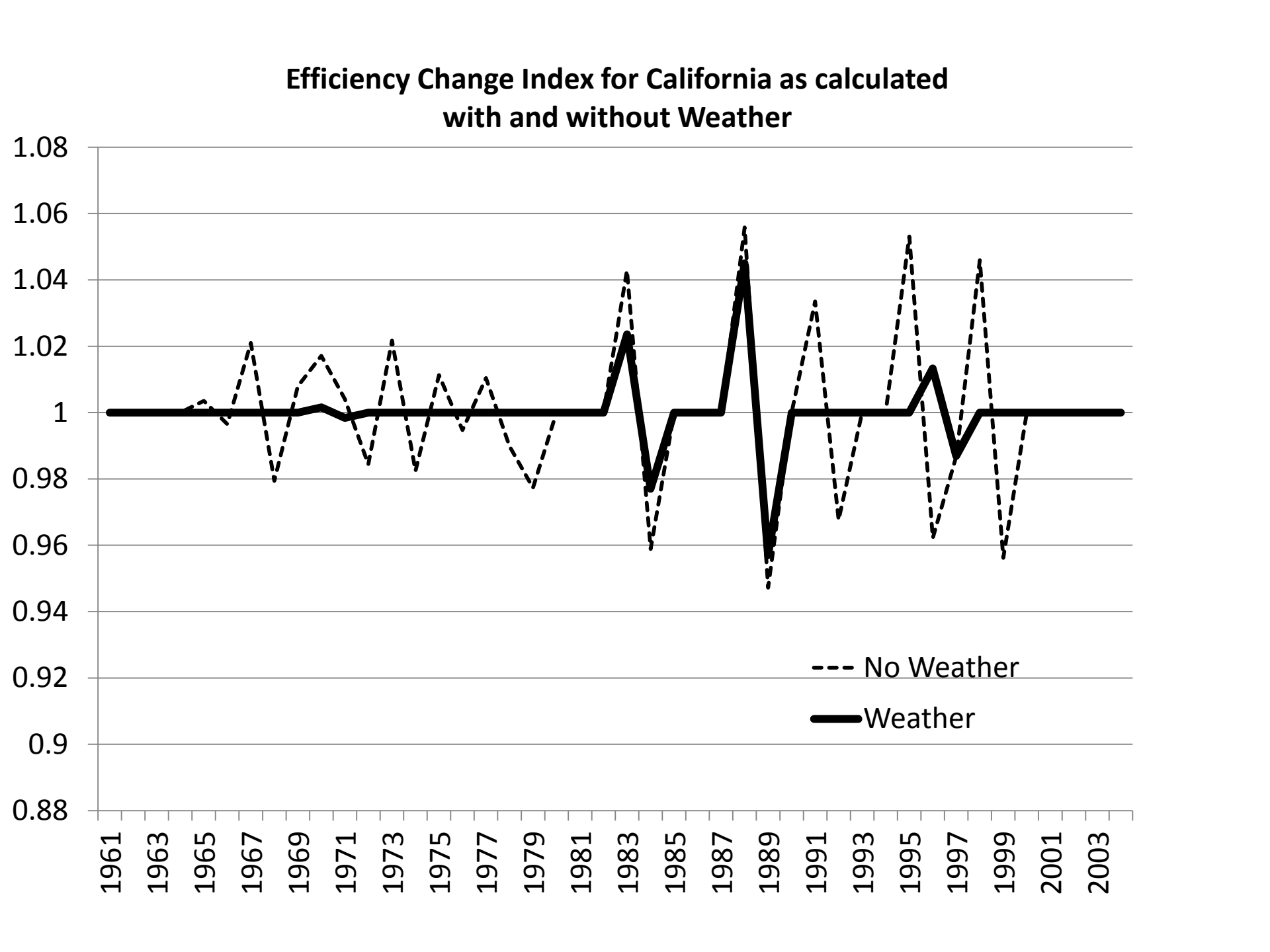
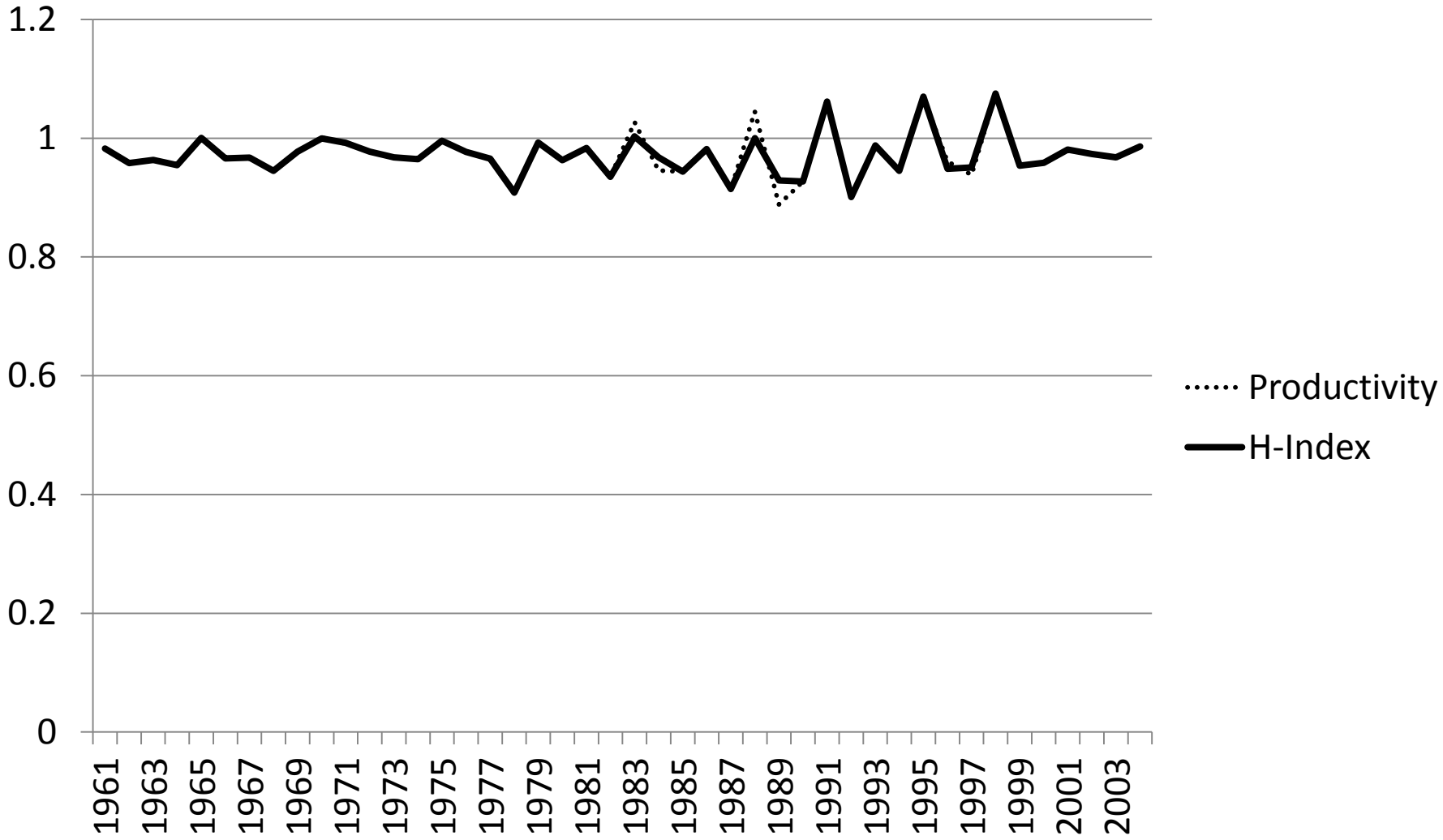

Efficiency Change Index for California as calculated with and without Weather
1.08
1.06
1.04
1.02
1
0.98
0.96
0.94
0.92
0.9
0.88
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
No Weather
Weather


California Productivity and H-Index: The Efficiency Residual Disappears
1.2
1
0.8
0.6
0.4
0.2
0
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
Productivity
H-Index

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- Too simple minded?
- For sure, but that's why I'm trying to raise the issue for the experts.