

Data Documentation

This note describes the index number procedures used to develop the series reported in Albert K. A. Acquaye, Julian M. Alston, and Philip G. Pardey. “Post-War Productivity Patterns in U.S. Agriculture: Influences of Aggregation Procedures in a State-Level Analysis” *American Journal of Agricultural Economics* (forthcoming).

Acquaye, Alston and Pardey report and discuss agricultural input and output price and quantity estimates for various spatial aggregates within the United States and a range of multi-factor productivity measures for the period 1949-1991. Laspeyres, Paasche, Fisher Ideal, and Törnqvist-Theil index number procedures (base year 1949 = 100) were used to develop their estimates, the formulas for which are presented below and elaborated further in Alston, Norton, and Pardey (1995).

An Excel spreadsheet file named <US state production and productivity indexes.xls> accompanies these notes. It contains the price and quantity input and output aggregates for each of the 48 contiguous states, 11 USDA production regions (with the Northeast region split into two sub-regions), and a 48-state (national) total for the period 1949-91. The data file also includes various input and output subaggregates (see table 1 from Acquaye, Alston, and Pardey, appended below, for details) and the value shares using prices from the current and past period that are required to reconstruct all these indexes for all the spatial units reported in the paper.

Documentation of the primary data files constructed by Craig, Pardey, and Acquaye is also available in the file named <Primary Data Documentation-US state, input, output, and MFP series.doc>

Index Number Construction

The Laspeyres and Paasche indexes are not chain-linked indexes—they use base-period and current prices and quantities, respectively in the calculation. The Laspeyres input (output) quantity index uses base period input (output) prices to weight both current and base-period input (output) quantities, and was calculated as

$$QI_t^L = QI_0^L \left(\frac{\sum_{i=1}^N P_{i0} Q_{it}}{\sum_{i=1}^N P_{i0} Q_{i0}} \right)$$

where P_{i0} is the price of input (output) i in the base-period, and Q_{i0} is the quantity of input (output) i in the base-period. N is the number of individual observations of input (output).

The Paasche input (output) quantity index, which uses current input (output) prices to weight both current and base-period input (output) quantities was calculated as

$$QI_t^P = QI_0^P \left(\frac{\sum_{i=1}^N P_{it} Q_{it}}{\sum_{i=1}^N P_{it} Q_{i0}} \right),$$

where P_{it} is the state-level price, and Q_{it} is the state-level quantity of input (output) i in period t . The Paasche quantity (price) index tends to understate the Divisia quantity (price) index. The Laspeyres and Paasche indexes provided an upper and lower bound for Divisia indexes.

The Fisher Ideal input (output) quantity index, which is a geometric mean of the chain-linked versions of the Laspeyres and Paasche indexes, was calculated as

$$QI_t^F = QI_{t-1}^F \left(\frac{\sum_{i=1}^N P_{i,t-1} Q_{it}}{\sum_{i=1}^N P_{i,t-1} Q_{i,t-1}} \right)^{1/2} \left(\frac{\sum_{i=1}^N P_{it} Q_{it}}{\sum_{i=1}^N P_{it} Q_{i,t-1}} \right)^{1/2}$$

Using nomenclature consistent with the accompanying Excel data file, an equivalent definition of the Fisher quantity index, QI_t , is

$$QI_t = QI_{t-1} \left(\sqrt{\frac{V(t,t)}{V(t-1,t)} \times \frac{V(t,t-1)}{V(t-1,t-1)}} \right) \text{ and } QI_{1949} = 100$$

where $V(s,u)$ is the value of output (input) in period s calculated with prices in period u .

In the case of the direct price index analogs of these quantity indexes, quantities were used to weight prices, rather than vice versa.

State abbreviations used in the accompanying Excel data file are presented in table 2.

The Törnqvist-Theil index was calculated as

$$QI_t^{TT} = QI_t^{TT} \prod_{i=1}^N \left(\frac{Q_{it}}{Q_{i,t-1}} \right)^{\bar{s}_{it}}$$

where $\bar{S}_{it} = 0.5(S_{it} + S_{it-1})$ and S_{it} is the input cost (output value) share of input (output) i in national input (output) in period t .

Reference

Alston, J.M., G.W. Norton, and P.G. Pardey. *Science Under Scarcity: Principles and Practice for Agricultural Research Evaluation and Priority Setting*. Ithaca: Cornell University Press, 1995 (reprinted in soft cover by CAB International 1998).

Table 1: Input, Output, and Spatial Details

Inputs/Outputs	Subcategory	Examples (where applicable)
Inputs		
Land	Cropland	
	Irrigated cropland	
	Pasture and grassland	
Labor	Family labor	
	Hired labor	
	Operator labor	Thirty classes characterized by: Education—0–7 years; 8 years; 1-3 years of high school, 4 years of high school, 1-3 years of college, 4 years or more of college. Age—25-34, 35-44, 45-54, 55-64, or 65 or more years of age.
Capital	Physical capital	Automobiles, combines, mowers and conditioners, pickers and balers, tractors, and trucks.
	Biological capital	Breeding cows, chickens, ewes, milking cows, and sows.
Purchased inputs		Electricity, purchased feed, fuel, hired machines, pesticides, nitrogen, phosphorous, potash, repairs, seeds, and miscellaneous purchases.
Outputs		
Crops	Field crops	Barley, corn, cotton, flax, oats, peanuts, rice, rye, sugar beets, sugarcane, sorghum, soybeans, tobacco, tomatoes for processing, wheat.
	Fruits and Nuts	Almonds, apples, apricots, avocados, cherries, cranberries, grapefruit, grapes, lemon, oranges, pears, peaches, pecans, strawberries, walnuts.
	Vegetables	Beans, broccoli, carrots, cauliflower, celery, cucumber, fresh tomatoes, lettuce, onions, peas, potatoes, sweet corn (fresh, and for processing).
	Greenhouse and Nursery Products	
Livestock		Broilers, cattle, eggs, hogs, honey, milk, sheep, turkeys, wool..
Machines rented out		
Returns from CRP		
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Region	Name and abbreviation	States within region
	Northeast 1 (NE1)	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
	Northeast 2 (NE2)	Delaware, Maryland, New Jersey, New York, and Pennsylvania
	Cornbelt (CB)	Illinois, Indiana, Iowa, Missouri, and Ohio.
	Lake states (LS)	Michigan, Minnesota, and Wisconsin.
	Northern plains (NP)	Kansas, Nebraska, North Dakota, and South Dakota.
	Appalachian (AP)	Kentucky, North Carolina, Tennessee, Virginia, and West Virginia.
	Southeast (SE)	Alabama, Florida, Georgia, and South Carolina.
	Delta states (DS)	Arkansas, Louisiana, and Mississippi.
	Southern plains (SP)	Oklahoma, and Texas.
	Mountain (M)	Arizona, Colorado, Idaho, Montana, New Mexico, Nevada, Utah, and Wyoming
	Pacific (P)	California, Oregon, and Washington.

Source: Acquaye, Alston, and Pardey

Table 2: U.S. State Abbreviations

Region	State	Abbreviation
Northeast 1	Connecticut	CT
	Maine	ME
	Massachusetts	MA
	New Hampshire	NH
	Rhode Island	RI
	Vermont	VT
Northeast 2	Delaware	DE
	Maryland	MD
	New Jersey	NJ
	New York	NY
	Pennsylvania	PA
Cornbelt	Illinois	IL
	Indiana	IN
	Iowa	IA
	Missouri	MO
	Ohio	OH
Lake states	Michigan	MI
	Minnesota	MN
	Wisconsin	WI
Northern plains	Kansas	KS
	Nebraska	NE
	North Dakota	ND
	South Dakota	SD
Appalachian	Kentucky	KY
	North Carolina	NC
	Tennessee	TN
	Virginia	VA
	West Virginia	WV
Southeast	Alabama	AL
	Florida	FL
	Georgia	GA
	South Carolina	SC
Delta	Arkansas	AR
	Louisiana	LA
	Mississippi	MS
Southern plains	Oklahoma	OK
	Texas	TX
Mountain	Arizona	AZ
	Colorado	CO
	Idaho	ID
	Montana	MT
	New Mexico	NM
	Nevada	NV
	Utah	UT
Wyoming	WY	
Pacific	California	CA
	Oregon	OR
	Washington	WA