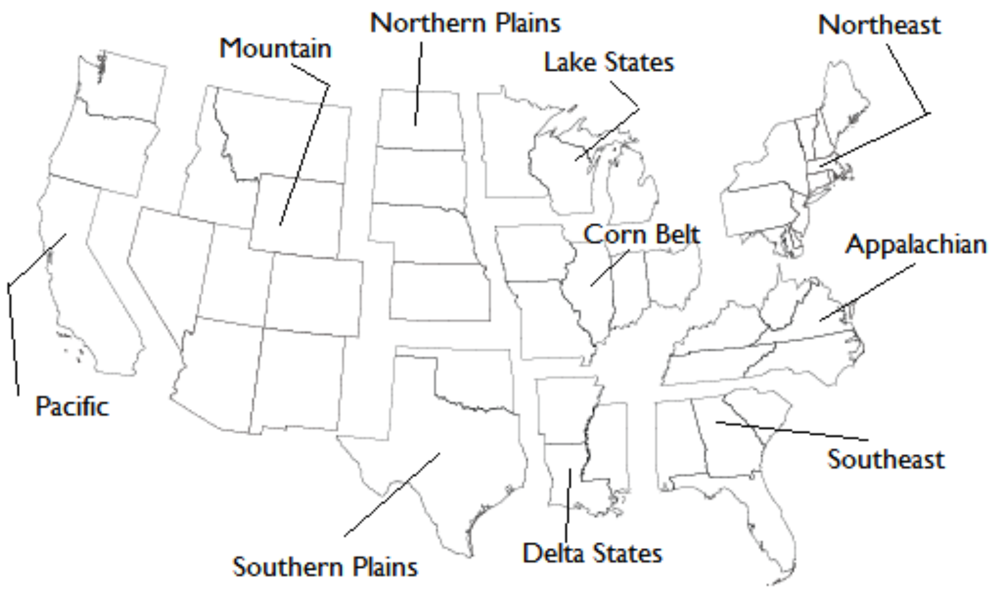
Online Appendix

Moving Matters: The Effect of Location on Crop Production

APPENDIX TABLE 1
INDEX VALUES

	Simple		Paasche			Laspeyres		
Year	I_O^S	I_A^S	I_Y^P	I_A^P	I_R^P	I_Y^L	I_A^L	I_R^L
			(index value, 1909=100)					
1879	69	63	101	67	106	102	68	107
1889	83	73	110	77	105	108	75	103
1899	104	96	107	97	101	107	98	102
1909	100	100	100	100	100	100	100	100
1919	92	89	104	89	100	103	89	99
1924	71	84	86	83	99	87	83	99
1929	83	85	99	86	102	97	84	100
1934	46	63	74	76	120	60	62	98
1939	91	79	113	83	106	109	80	102
1944	109	86	120	93	109	117	91	106
1949	109	76	128	83	109	131	85	111
1954	102	68	132	85	125	121	78	114
1959	145	71	170	82	116	176	85	120
1964	132	55	194	67	122	198	68	124
1969	174	53	260	66	124	263	67	125
1974	171	62	221	72	117	237	77	125
1978	266	71	302	88	123	303	88	124
1982	294	71	328	83	117	355	90	126
1987	263	60	355	70	117	376	74	125
1992	340	70	389	78	111	438	88	124
1997	341	72	387	82	114	416	88	122
2002	337	69	395	84	121	401	85	123
2007	499	88	472	101	116	491	106	121

Source: Calculated using the data described in the text.



APPENDIX FIGURE 1

REGION DEFINITIONS

Source: Recreated based on USDA (1998, p. 18).

EQUIPROPORTIONAL VERSUS RELATIVE CHANGES IN A LASPEYRES AREA INDEX

Consider the Laspeyres area index, defined as

$$I_A^L = \frac{\mathbf{y}_b{}'\mathbf{a}_t}{\mathbf{y}_b{}'\mathbf{a}_b}.$$

Suppose that each county changes its area by the same (decimal) percentage, say p percent, so that $a_t = a_b(1+p)$. This equi-proportional increase in area will generate an index value of $(1+p) = A_t / A_b$. However, the same *total* area change can generate a different index value if the new (or deleted) areas are not distributed across counties in proportion to their base-period areas. Suppose the increase was not equi-proportional, and that county *N* increased its area by some other amount, α percent, but that the overall increase in area remained the same. For this condition to hold, one must derive the percentage by which the other counties increased their area. Let that parameter be called γ. Then, the total area increase will be maintained if:

$$(1+\gamma)\sum_{i=1}^{N-1} a_{bi} + (1+\alpha)a_{bN} = (1+p)\sum_{i=1}^{N} a_{bi}$$

Solving for γ reveals:

$$\gamma = p + \frac{a_{bN}(p-\alpha)}{\sum_{i=1}^{N-1} a_{bi}}$$

The goal is to determine how much the index value differs when a change in national area is distributed evenly across counties from its value when the total area changes by the same amount, but is not equally distributed across counties. The numerator of the index will be:

$$\sum_{i=1}^{N-1}(1+\gamma)a_{bi}y_{bi} + (1+\alpha)a_{bN}y_{bN}\ .$$

Subtracting the numerator for a proportional change in area and manipulating the expression yields:

$$a_{bN}(p-\alpha)\sum_{i=1}^{N-1}s_{bi}y_{bi} - a_{bN}y_{bN}(p-\alpha)\,,$$

where s_{bi} is county *i*'s share of the total acreage in counties 1...(*N*–1). Finally, the numerator of the index for the unequal redistribution will be equal to the numerator of the proportional increase plus the following term:

$$a_{bN}(p-\alpha)\left(\sum_{i=1}^{N-1}s_{bi}y_{bi} - y_{bN}\right).$$

Thus, the non-proportional increase in acreage alters the calculated index value by

$$\frac{a_{bN}(p-\alpha)\left(\sum_{i=1}^{N-1}s_{bi}y_{bi} - y_{bN}\right)}{\sum_{i=1}^{N}a_{bi}y_{bi}}\ .$$

Notice that the bracketed term is equal to the area weighted average yield of counties whose acreage increased by γ percent (hereafter denoted μ_{-N}.) less the yield for the county whose area increased by α percent.[1] Thus, there are several possible scenarios:

1. If $\alpha > p$, county *N* took more than its area weighted share of the new acres and the first bracketed term will be negative. In this case,

[1] Note that the conclusions apply to the more general case in which several counties change at different rates since the "N^{th} county" and its associated area, growth percentage and yield in both periods could represent a weighted average of any arbitrary aggregation of counties.

   a. if $y_{bN} < \mu_{-N}$, the yield in county N is less than the area-weighted average of yields in other counties. The second bracketed term will therefore be positive. The index will decrease since a low-yielding county increased its share of area.

   b. If $y_{bN} > \mu_{-N}$, the yield in county N is higher than μ_{-N}. The second bracketed term is also negative and the index will increase since a high-yielding county increased its area share.

   c. If $y_{bN} = \mu_{-N}$, the second bracketed term is equal to zero, and there is no effect on the index.

2. If $\alpha < p$, county N took less than its share of the new acres, and the first term is positive.

   a. If in addition, $y_{bN} < \mu_{-N}$, the second term will be positive and the index will show an increase since acres were allocated away from a low-yielding county.

   b. If $y_{bN} > \mu_{-N}$, the overall effect will be negative.

3. If $\alpha = p$, county N increased its area in the same relative proportion as the other counties. The first term will equal zero and there will be no effect on the index.

REFERENCE

USDA. *Agriculture Fact Book 1998*. Washington, DC: United States Department of Agriculture, 1998.