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Is There a Link between the Changing Skills of Labor Used in U.S. Processed Food Trade and Rural Employment?

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Between the 1970s and the 1990s, processed food exports switched from using more skilled labor per unit of output than imports to the opposite. Processed food trade also expanded during this period. More meat and poultry products in processed food trade could explain this switch in skill intensity. Growing meat trade paralleled an urban-to-rural shift in meat processing. Although this could have been a win-win situation for rural areas, many of the jobs related to expanded meat trade benefited commuter and migrant workers because late-1990s jobs slaughtering livestock and processing meat did not appeal to domestic rural workers.

Key Words: consolidation in the meat industry, factor content of trade, input-output analysis, international meat trade, processed food trade, rural development, rural labor demand, skill intensity

JEL Classifications: C67, D24, F14, F16, J61, L66, O18, Q17, R15

Every major farm bill since the 1985 Farm Bill has included policies to emphasize increasing value-added American agricultural exports.[1] In addition, the 1995 and 2002 Farm Bills provided funding for value-added agriculture enterprises to support more processing of farm products in rural areas. At the same time, rural area planners have looked to international markets for new destinations for their resource-based products. The 1990s saw a gain in processed agricultural products trade and a gain in rural manufacturing employment. The gain in rural manufacturing employment was led by food processing (Drabenstott, Henry, and Mitchell; Ghelfi), and in

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[1] In the 2002 Farm Bill, Congress's request for annual reports on program activities emphasized their continuing interest:

> Sec. 3105. Foreign Market Development Co-operator Program, (c) Report to Congress.—The Secretary shall annually submit to the Committee on Agriculture and the Committee on International Relations of the House of Representatives and the Committee on Agriculture, Nutrition, and Forestry of the Senate a report on activities under this section describing the amount of funding provided, the types of programs funded, the value-added products that have been targeted, and the foreign markets for those products that have been developed.

the Great Plains the gain in food processing employment was led by meat processing (McGranahan), raising the possibility that the trade policy had borne fruit and the hopes of the rural planners may be realized.

Is this a realistic possibility? Can a higher demand for low-skilled workers in rural areas be linked to a changing international trade environment? For the recent expansion of meat trade, it can. But are the linkages strong enough and policy sensitive enough to support a rural development policy? Rural development is complex and complicated. An analysis like that in this paper, which attempts to identify the effects of one economic force on rural development, has a difficult task. Nonetheless, this paper faces this difficulty by presenting evidence that expanded trade in processed food products and expanded employment opportunities in some rural areas have occurred at the same time and that there is a demonstrative economic linkage between the two events. Expanded processed food trade, however, was but one of a number of economic forces favorable to expanded employment opportunities in some rural areas. The paper concludes with a discussion of the economic environment that allowed such a strong economic linkage to be expressed.

The discussion explores the changes in the economic environment leading to the late 20th century status of rural processed food employment. Our assessment of the skill intensity of U.S. processed food trade led to finding a switch in skill intensity toward low-skilled labor. This switch could be traced to the expanded meat trade. Finally, we explore if the circumstances surrounding expanded meat trade and a shift of meat processing to rural areas are likely to fulfill the dreams of those rural area planners who have looked to international markets for new destinations for their resource-based products.

Theoretical Considerations

> A central objective of international economic research has been to account for the factor content of trade. . . . [E]conomists want to trace the effects of international influences on relative and absolute factor prices within a country. The Heckscher-Ohlin model and its variants, with their emphasis on trade arising from differences in the availability of productive factors, provide a natural setting for such investigations. (Davis and Weinstein, p. 1423)

The Heckscher-Ohlin-Vanek (HOV) theorem states that each country will export the commodity that uses its relatively abundant factor the most intensely. Most empirical studies of the HOV model, starting with the Leontief paradox, have focused on testing predictions of the factor content of trade. Nobel Laureate Wassily Leontief used input-output (I/O) analysis to estimate the economy-wide factor commitment to a particular internationally traded bill of goods (Leontief). Using I/O analysis, Leontief found the counter-intuitive result that contrary to expectations based upon the nation's factor endowments, U.S. exports were relatively more labor intensive than its imports. This finding, Leontief's paradox, characterized by Davis and Weinstein as "the first blow against the empirical validity of the factor proportions theory" (p. 1423), puzzled economists for some time.

Since Leontief's seminal study, factor content of trade research has followed at least two paths. One path pursued explanations of why the HOV did not have a better record for predicting actual trade flows. The persistence of interest in HOV in the face of its less than stellar performance as a predictor of actual trade flow is likely due to its dominant role in the explanation of comparative advantage, which was characterized by Eatwell, Milgate, and Newman as "this deepest and most beautiful result in all of economics" (p. 514). When HOV is modified to relax simplifying assumptions (i.e., to permit technical differences, a breakdown in factor price equalization, the existence of nontraded goods, and costs of trade), HOV is consistent with data from 10 OECD countries and a rest-of-world aggregate (Davis and Weinstein). Trefler (1995, 2002) shows the effect of country-specific neutral technological differences and preferences for home goods in demand on en-

hancing the predictive powers of factor-proportions models of international trade. Antweiler and Trefler demonstrate the importance of allowing for the presence of increasing returns to trade. Conway identifies the importance of allowing for differences in the mobility of domestic factors.

The other path has concentrated on the labor and human capital factors (i.e., treating labor input as a heterogeneous factor with various traded goods requiring different levels of labor skills [embodied human capital] in their production). When U.S. trade is analyzed from this perspective, the U.S. exports high-skill labor intensive goods consistent with what would be expected because of its endowment of high-skilled labor. This particular line of research became prominent as the wage disparity between high-skilled workers and low-skill workers widened in recent decades and the effects of trade became a potential explanation for this phenomenon (Wood, 1994, 1995).

Borjas, Freeman, and Katz use a factor-proportion approach to show that immigration has been important in reducing the pay of high-school dropouts, whereas immigration and trade have contributed modestly to the falling pay of high school–equivalent workers. Increased inequality can be a multiplicative interaction of the effects of trade opening and (localized) sector-specific technological change (Leamer; Richardson). Brauer and Hickok concluded that the relative increase in demand for labor triggered by technological change could explain most of the change in observed skill differentials during the 1980s. Wood (1995) argues that there are causal links between technical change and trade, accepting the view that technical change is important, but linking it back to trade. Skill-biased technological advances, technological change that requires greater skills—again more of the human capital factor—may have increased demand for high-skilled workers by enhancing their productivity. In addition, technological change may have reduced demand for low-skilled workers, and as new technology is adopted, the demand for higher educated workers increases compared with the demand for less educated workers. Although empirical evidence fails to directly place the burden of the explanation for the observed decline in real wages of the low-skilled compared with high-skilled on freer trade, the multiplicative interaction of the effects of trade opening and (localized) sector-specific technological change continue interest in this line of analysis.

Lee and Schluter examined nine broad categories of U.S. trade for 1972, 1977, 1982, 1987, and 1992. They found agreement with the general results of other cited studies. On balance, growth in trade has expanded the demand for high-skilled workers more than low-skilled workers. Technological change expressed through labor requirements per unit of output were labor-saving. Yet they found differences between the broad categories of trade: one category switched. Traded processed food products switched from exports being more high-skilled intensive than imports in 1972 to less high-skilled intensive than imports in 1992.

This intriguing result warranted further investigation for two reasons. Reason one is to determine what changes occurred in the economic and policy environment that led to this switch in skill intensity of trade for processed food products. Reason two is because the finding of a switch to lower skill intensity of trade for processed food products accompanying expanded trade in processed food products differs from the usual finding of studies of skill intensity of trade (i.e., that expanding trade in developed countries enhances the demand for high-skilled workers relative to low-skilled workers). For the United States, this counter example is in an industry with rural roots in processing raw agricultural products. With low-skilled workers making up a relatively larger share of the rural work force, this seems to be a rare example of an expansion in trade providing support for low-skill workers.

Methodology

Our analysis of the skill content of processed food trade builds upon the long tradition started by Leontief of using I/O analysis to estimate the economy-wide factor commitment to a particular internationally traded bill of goods. Therefore, our calculations of the fac-

tor content of international trade rely upon an I/O model. In an open I/O system, we calculate output of each sector of the economy needed to produce a given set of final demand of goods and services. The system can be expressed in a matrix form by

$$\mathbf{X} = A\mathbf{X} + \mathbf{F}. \tag{1}$$

In our empirical analysis, $\mathbf{X}$ is an 80 by 1 vector of sectorial output, A is an 80 by 80 I/O direct requirements matrix, and $\mathbf{F}$ is an 80 by 1 vector of aggregate final demands consisting of aggregates of vectors of household consumption ($\mathbf{C}$), inventory change and gross private domestic investment ($\mathbf{I}$), government purchases of goods and services ($\mathbf{G}$), and net trade ($\mathbf{Nt}$ = exports − imports). The output levels needed to satisfy final demand $\mathbf{F}$ are

$$\mathbf{X} = [\mathbf{I} - A]^{-1}\cdot\mathbf{F} = [\mathbf{I} - A]^{-1}[\mathbf{C} + \mathbf{I} + \mathbf{G} + \mathbf{Nt}]. \tag{2}$$

The output, $\mathbf{X}_t$, to satisfy net trade, $\mathbf{X}_t$, and domestic use, $\mathbf{X}_d$, can be obtained by replacing $\mathbf{F}$ with $\mathbf{Nt}$ for net trade and $\mathbf{D}$ ($\mathbf{D} = \mathbf{C} + \mathbf{I} + \mathbf{G}$) for domestic use, such that

$$\mathbf{X} = \mathbf{X}_t + \mathbf{X}_d, \tag{3}$$

and labor demands are estimated by

$$\mathbf{L}_{nt} = \mathbf{dl}\cdot\mathbf{X}_t, \tag{4}$$

for net trade, and

$$\mathbf{L}_d = \mathbf{dl}\cdot\mathbf{X}_d \tag{5}$$

for domestic use, where $\mathbf{dl}$ is an 80 by 80 diagonal matrix of labor coefficients, labor required per unit of output in each industry. Thus, $\mathbf{L}_{nt} + \mathbf{L}_d$ is the total labor employment in the U.S. economy for a particular year.

High-skilled and low-skilled labor demand for a given component of final demand was estimated using the nine major occupational categories of U.S. workers as classified by the Bureau of Labor Statistics:

> The nine major categories are (1) Executive, administrative managerial; (2) Professional; (3) Technicians and related support; (4) Sales occupations; (5) Administrative support; (6) Precision production, craft and repair; (7) Service occupations; (8) Operators, fabricators, and laborers; and (9) Farming, forestry, and fishing. (USDL, BLS)

Because of differences within a group, any skill classification of broad occupational groups captures only general effects at best and is arbitrary at worse. Because the nine major categories are roughly listed by declining skill level, we were comfortable grouping the nine major categories into high-skill and low-skill with the break between (3) technicians and related support and (4) sales occupations. That is, we combined BLS categories 1–3 into the high-skilled category and BLS categories 4–9 into the low-skilled category. Our results were robust to an alternate grouping of the nine major categories into high-skill and low-skill with the break between (6) precision production, craft, and repair and (7) service occupations. Grouping occupational labor categories into high-skilled and low-skilled labor allowed estimation of high-skilled and low-skilled labor embodied in U.S. exports. The grouping also allowed estimation of the amount of high-skilled and low-skilled labor that the U.S. would need if the goods and services imported were produced domestically.[2]

Changes in the ratios of high-skilled to low-skilled labor used in processed food production between 1972 and 1992 shows how

[2] The authors recognize the oversimplification of trade implicit in this measure. As discussed later, observed trade flows are endogenous outcomes of many forces including factor endowments, technology, tastes, and trade barriers. It is unlikely that all imports could have been produced domestically. Yet because at the I/O sector level it is competitive imports in final demand, the tradeoff decisions between domestically produced goods and imported goods are made in the domestic market. Therefore, using the same domestic sector factor requirement coefficients in calculating factor content of exports and imports provides an appropriate factor content comparison at the decision point. Implicit in that calculation, however, is the number of domestic jobs embodied in imports. The authors recognize this as an overstatement of the actual domestic jobs that may have been replaced by imports. And, on the export side, they recognize that all of the required domestic workers may not be available.

the factor content of trade and domestic use changed over time under different labor productivity, I/O technology, and final demand situations. The resulting estimation reflects an interactive effect of labor productivity, direct requirement of intermediate inputs, and final demand. Data availability influenced the selection of the years; 1972 was the first year (USDC-BEA 1979) and 1992 was the last year (USDC-BEA 1998) that BEA/USDC constructed an official U.S. I/O tables using the System of National Accounts' Make and Use tables.[3]

In the spirit of Syrquin and Urato, we estimate the skill intensity of trade. Paraphrasing their definition of factor intensity of trade, the skill intensity of trade is defined as a ratio where the numerator is the ratio of high-skilled workers to low-skilled workers for the production of output necessary to support export demands, and the denominator is the ratio of high-skilled workers to low-skilled workers for the production of output that would be required to replace imports.

$$(6) \qquad SI = \frac{S_e}{S_m} = \frac{\sum_i \sum_j s_i r_{ij} e_j}{\sum_i \sum_j u_i r_{ij} e_j} \Bigg/ \frac{\sum_i \sum_j s_i r_{ij} m_j}{\sum_i \sum_j u_i r_{ij} m_j},$$

where S_e is the ratio of high-skilled workers to low-skilled workers in exports; S_m is the ratio of high-skilled workers to low-skilled workers in imports; s_i is the high-skilled workers output ratio in sector i; u_i is the low-skilled workers output ratio in sector i; r_{ij} is the ith row, jth column element of the total requirements matrix, $[\mathbf{I} - A]^{-1}$; e_j = jth sector exports; and m_j = jth sector imports.

If SI, the skill intensity of trade, is greater than unity, exports are high-skill intensive relative to imports. As measured by Equation (6), skill intensity of trade depends upon sectorial employment, high-skilled and low-skilled employment patterns, interindustry structure, and sectorial patterns of foreign trade.

Finally, the estimated urban and rural employment is generated by using the *County Business Patterns* matrix as

$$(7) \qquad \mathbf{R} = d\mathbf{L}_{nt} \cdot \mathbf{C},$$

where $\mathbf{R}$ is an 80 by 102 matrix of urban and rural employment of 80 sectors for 50 states and the District of Columbia, $d\mathbf{L}_{nt}$ is a diagonal matrix of $\mathbf{L}_{nt}$, and $\mathbf{C}$ is an 80 by 102 matrix of urban and rural employment share coefficients derived from *County Business Patterns* data. The results of Equation (7) are used to estimate urban and rural employment due to trade. Lacking better information, we also used $\mathbf{C}$ to estimate urban and rural high-skilled and low-skilled employment due to trade.

Empirical Analysis

Comparing employment for producing exports with the estimated employment needed if imports would have been produced domestically provides a measure of the relative importance of employment in export production or import replacement—the employment intensity of trade. Differing sectorial trade balances and employment requirements can yield differing sectorial effects of net trade (exports less imports). The net trade employment impacts in 1972, as a share of total processed food employment, were small. Yet their net effect on trade, −2.2% of employment in the industry, was larger (in absolute terms) than the −0.2% net trade effect on the whole U.S. economy. Between 1972 and 1992, processed food exports grew faster than imports. The net trade effect on food processing employment fell to −1.0% of food processing employment, whereas the net trade effect on the U.S. economy rose to −0.5% of employment. The pattern of low-skilled and high-skilled labor usage in U.S. processed food trade had changed. In 1972, processed food exports used a higher ratio of high-skilled labor to low-skilled labor per unit of output than processed food imports.

[3] USDC Bureau of Economic Analysis released their 1997 benchmark table in 2002. The switch from the Standard Industrial Classification (SIC) as a system for classifying business establishments to the North American Industry Classification System (NAICS), which provides a new comparability in statistics about business activity across North America, also led to a resectoring of the benchmark I/O account that severely constrains comparisons with earlier tables.

By 1992, as measured by skill intensity—the ratio of high-skilled to low-skilled labor per unit of exports compared with the same ratio for imports, had reversed.

The skill intensity of trade analysis is measured similarly to employment intensity, but with greater detail about the skill levels of the employees (Lee and Schluter). When the skill levels of these workers are considered, different labor demands by skill levels from the net trade of processed food result. For example, in 1972, the 5,200 high-skilled workers used in producing exports of processed food totaled just 0.119 of the 43,700 low-skilled workers. The comparable share for imports was lower, 0.108. Comparing the export and import estimates, the processed food trade skill intensity ratio was 1.097 (0.119/0.108) in 1972. A skill intensity ratio greater than 1 indicates that in 1972 the food processing industry exported products requiring a higher proportion of high-skilled workers than imported processed food products. By 1992, the share was lower for processed food exports, 0.103 compared with imports, 0.106, with a resulting skill intensity ratio of 0.973. Thus, there was a reversal in skill intensity between 1972 and 1992 in processed food industry trade. Traded processed food products switched from exports being more high-skilled intensive than imports in 1972 to less high-skilled intensive than imports in 1992.[4] In fact, of the broad industry groups analyzed by Lee and Schluter, processed food was the only group that reversed skill intensity, dropping from a ratio >1 to a ratio <1 between 1972 and 1992.

These changes in trade-related employment occurred while employment in the food-processing industry was declining 5.4% during the 1972–1992 period, even as employment in the U.S. economy as a whole gained 43% (Table 1). The loss of employment in the food processing industry fell more heavily on urban than rural workers (10.9% versus 1.2%) and on high-skilled than low-skilled workers (8% versus 5.2%). This contrasts with the U.S. economy as a whole, where employment gained more in urban than rural areas (44.1% versus 37.7%) and the high-skilled workforce gained more than the low-skilled workforce (60% versus 38.5%).

The low-skilled labor share of total employment in the United States declined from 78.7% (66.6 million of 84.6 million total employment) in 1972 to 76.2% (92.2 million out of 121.0 million) in 1992 (Table 1). In food processing, however, the opposite occurred. Already in 1972 the industry employed a higher proportion of low-skilled workers than the economy-wide average. Yet total food processing employment dropped between 1972 and 1992, and high-skilled food processing employment declined even faster. Counter to total U.S. employment, the proportion of low-skilled workers in the industry rose from 0.908 to 0.911. In the absence of other factors, this switch toward a heavier use of low-skilled labor should benefit rural areas more than urban areas because food processing (Standard Industrial Classification [SIC] 20, North American Industry Classification System [NAICS] 311) is more rural-based than most U.S. manufacturing (USDC, *County Business Patterns*). Also, the rural labor force tends to include a larger proportion of low-skilled workers.

Importance of Trade-Related Employment in Meat Packing and Poultry Processing Industries

Processed food trade shifted from exports using relatively more high-skilled workers per unit than imports in 1972 to exports using relatively fewer high-skilled workers per unit than imports in 1992. A detailed exploration of the food processing industry provides a plausible explanation. Table 2 presents the 1972–1992 changes in trade-related employment in the food processing industry in 12-sector detail. Export-related employment gained in 11 of 12 sectors, led by poultry processing's 510% increase from 2,000 in 1972 to 12,200 in 1992. Export-related rural em-

[4] For the interested reader, this switch occurred between 1987 and 1992. Comparable intermediate period estimates of the skill intensity of processed food trade were 1.079, 1.044, and 1.016 for 1977, 1982, and 1987, respectively.

Table 1. Total, Food Processing, and Trade-related Urban and Rural Employment, 1972 and 1992

	1972		1992		
	Workers (1,000)	Share (%)	Workers (1,000)	Share (%)	1972–1992 % Change
Total	84,590	100.0	121,000	100.0	43.0
Urban	71,230	84.2	102,610	84.6	44.1
Rural	13,360	15.8	18,390	15.4	37.7
High-skilled	18,020	21.3	28,830	23.8	60.0
Low-skilled	66,570	78.7	92,170	76.2	38.5
Food processing	1,768	100.0	1,672	100.0	−5.4
Urban	771	43.6	687	41.1	−10.9
Rural	997	56.4	985	58.9	−1.2
High-skilled	162	9.2	149	8.9	−8.0
Low-skilled	1,606	90.8	1,523	91.1	−5.2
Exports	48.9	100.0	99.6	100.0	
Urban	36.0	73.6	66.0	66.3	83.3
Rural	12.9	26.4	33.6	33.7	160.5
High-skilled	5.2	10.6	9.3	9.3	78.8
Low-skilled	43.7	89.4	90.3	90.7	106.6
Imports	87.9	100.0	117.0	100.0	
Urban	65.7	74.7	83.4	71.3	26.9
Rural	22.2	25.3	33.6	28.7	51.4
High-skilled	8.6	9.8	11.2	9.6	30.2
Low-skilled	79.3	90.2	105.8	90.4	33.4

Sources: Employment of total and food processing from BLS. Urban and rural shares are from *County Business Patterns data.* Employment for exports and imports are estimated by authors using Equations (3), (4), (5), (6), and (7).

ployment gained for all of the 12 sectors. Import-related employment increased as well (except for sugar processing), but the increase in export-related employment was larger.

Two sectors, meat packing (SIC 2011 and 2013) and poultry processing (SIC 2015), accounted for nearly half of the growth in export-related food processing employment over the 20-year period. Total export-related employment in the meat packing and poultry processing sectors increased 271.3%, from 8,700 in 1972 to 32,300 in 1992 (Table 3). Export-related rural employment increased by 437.1%, from 2,981 to 16,011, more than the urban employment increase of 184.8% from 5,719 to 16,289 during the period. Import-related employment increased only 27.6% (from 18,100 to 23,100).

Processed food trade shifted from exports using relatively more high-skilled workers per unit than imports in 1972 to exports using relatively fewer high-skilled workers per unit than imports in 1992. Without the changes in the meat packing and poultry processing sectors, there would have been no food processing industry switch in skill intensity of trade. When these two sectors are included, as shown in Table 1 and related previous discussion, food processing's skill intensity of trade estimate fell from 1.097 in 1972 to 0.973 in 1992. Excluding those two sectors, by using data from Tables 1 and 3 food processing's skill intensity of trade estimate also fell from 1.110 $[(5.2 - 0.4)/(43.7 - 8.3)]/[(8.6 - 1.0)/(79.3 - 17.1)]$ in 1972 to 1.052 $[(9.3 - 1.8)/(90.3 - 30.5)]/[(11.2 - 1.2)/(105.8 - 21.9)]$ in 1992, a fall but not a switch from high-skill intensity to low-skill intensity. In contrast to the decline in total food processing employment between 1972 and 1992, employment re-

Table 2. Changes in Trade-related Employment in Food Processing, 1972–1992

Item	Meat Packing	Poultry Processing	Dairy Processing	Canning and Preserving	Flour Milling	Prepared Feeds	Sugar Processing	Oil Mills	Bakery Products	Beverages	Fish and Seafood	Misc. Foods	Total
Exports	13,400	10,200	100	7,199	1,601	2,100	1,000	−1,000	8,400	2,600	100	5,000	50,700
Urban	6,857	3,713	4	4,792	777	945	568	−1,145	7,179	2,341	−439	4,359	29,951
Rural	6,543	6,487	96	2,407	824	1,155	432	145	1,221	259	539	641	20,749
High-skilled	800	600	0	700	200	300	0	−100	600	400	0	600	4,100
Urban	425	218	−8	466	89	135	−6	−132	512	357	−59	525	2,522
Rural	375	382	8	234	111	165	6	32	88	43	59	75	1,578
Low-skilled	12,600	9,600	100	6,499	1,401	1,800	1,000	−900	7,800	2,200	100	4,400	46,600
Urban	6,432	3,495	12	4,326	688	810	574	−1,013	6,667	1,984	−380	3,834	27,429
Rural	6,168	6,105	88	2,173	713	990	426	113	1,133	216	480	566	19,171
Imports	3,100	1,900	100	9,100	1,500	600	−13,300	1,200	7,700	9,200	4,200	3,800	29,100
Urban	−758	682	4	6,034	1,013	207	−9,177	644	6,392	8,347	1,119	3,229	17,736
Rural	3,858	1,218	96	3,066	487	393	−4,123	556	1,308	853	3,081	571	11,364
High-skilled	200	0	0	900	200	200	−1,400	100	500	1,000	500	400	2,600
Urban	−20	−1	−8	599	134	87	−966	40	408	908	149	338	1,668
Rural	220	1	8	301	66	113	−434	60	92	92	351	62	932
Low-skilled	2,900	1,900	100	8,200	1,300	400	−11,900	1,100	7,200	8,200	3,700	3,400	26,500
Urban	−738	683	12	5,435	879	120	−8,211	604	5,984	7,439	970	2,891	16,068
Rural	3,638	1,217	88	2,765	421	280	−3,689	496	1,216	761	2,730	509	10,432

Table 3. Trade-related Employment in Meat Packing and Poultry Processing, 1972 and 1992

	1972		1992		
	Workers	Share	Workers	Share	% Change
Exports	8,700	100.0	32,300	100.0	271.3
Urban	5,719	65.7	16,289	50.4	184.8
Rural	2,981	34.3	16,011	49.6	437.1
High-skilled	400	4.6	1,800	5.6	350.0
Low-skilled	8,300	95.4	30,500	94.4	267.5
Imports	18,100	100.0	23,100	100.0	27.6
Urban	12,973	71.7	12,897	55.8	−0.6
Rural	5,127	28.3	10,203	44.2	99.0
High-skilled	1,000	5.5	1,200	5.2	20.0
Low-skilled	17,100	94.5	21,900	94.8	28.1

lated to meat exports more than tripled, whereas the domestic employment equivalent of meat imports rose slightly over one quarter. In 1972 the skill requirements for meat production for trade were already more dependent on low-skilled labor than food processing in general and remained so in the next 20 years. The shift of meat production from urban to rural areas during the 1972–1992 period made rural areas the primary beneficiary of greater trade-related employment. However, the late 20th century economic environment found some rural-based meat packers hiring foreign and commuting workers to work in their packing plants (Broadway; MacDonald et al.; Stull, Broadway, and Griffith), suggesting host rural areas did not have sufficient labor surplus to accommodate the rising employment opportunities.

Late Twentieth Century Economic Environment and Trade-Related Meat Processing Employment

A more detailed examination of trade-related employment in the processed food industry showed that changes in the level of meat and poultry trade could explain the reversal of skill intensity of labor from 1972 to 1992. This shift in skill intensity in the processed food trade was not so much a shift in skills required for food processing production as it was a change in product mix to a larger share for exported meats. Because meat packing and poultry processing use a larger proportion of low-skill workers than food processors in general, the average skill intensity fell.

As with most economic changes, the increase in meat trade was not an isolated event resulting from one change in the economic or policy environment. Some of the economic pressures that fostered more U.S. meat trade are discussed under three categories: (1) pressures that affected the cost of production, (2) pressures that affected the demand for the product, and (3) pressures resulting from public policy.

Because of the United States' abundant and productive cropland and the resultant abundant supply of livestock feed, the nation should have long had a competitive advantage in international meat trade. A major change in the economic environment that allowed underlying cropland/feed availability forces to be more fully realized was the consolidation of meat processing (SIC 201) firms into larger businesses with larger processing plants. This allowed meat processing costs to drop and the average costs of industry marketing, research, and development to be spread over larger production complexes, lowering the per-unit cost of production. Low-skilled labor became complementary to the technology used on the processing lines as the size of the processing plants increased.

Analyses by MacDonald et al. and Ollinger, MacDonald, and Madison indicate that

consolidating the U.S. meat processing industry resulted in economies of scale leading to meat products with lower real costs. Ollinger, MacDonald, and Madison estimated that a 1% increase in meat processing output at constant factor prices is associated with less than a 1% increase in total cost. They estimate the total cost with respect to poultry output is 0.901, of cattle is 0.953, and of hog slaughter is 0.926. That is, average costs fall as output increases. These estimates suggest that economies of scale exist in the meat processing industry with greater economies in poultry processing than in beef and pork processing.

The studies by MacDonald et al. and Ollinger, MacDonald, and Madison report the rapid consolidation of the meat processing industry during the last two decades. Far fewer meatpackers now slaughter livestock, but their plants are much larger. In 1997, four firms handled nearly 80% of all steer and heifer slaughter; just two decades earlier, four firms handled 36%, less than half as high. Concentration, the share of total slaughter accounted for by four firms, in hog slaughter has also increased. The top four firms handle over half of all slaughter (MacDonald et al.).

In addition to the effects of consolidation, changes in slaughter plant technology may have created scale economies, altered the mix of slaughter plant products, and changed the location and operation practices of cattle and hog production. Also, industry consolidation has been accompanied by important changes in labor relations in meat processing. For example, between 1980 and 1987 union membership in the meat products industry fell from 46% to 21% and has remained low (MacDonald et al.). Accompanying the decline in unionization was a routinization of packing plant tasks and a fall in real wages of 40%–50% between 1972 and 1992 (MacDonald et al., p. 15). Slaughterhouses have always been risky places to work. These forces combined to make employment in meat processing less attractive to U.S. domestic low-skilled workers. Furthermore, the number of immigrant workers on slaughter and fabrication lines rose.

Cattle, hog, and poultry production also consolidated. For example, MacDonald et al. report:

> Hog production ... has undergone a dramatic and ongoing consolidation, represented by a shift toward larger production establishments and toward long-term contractual arrangements among the production stages and between production and slaughter. In 1978, 96% of all hog farms sold less than 1,000 head and together sold two thirds of all hogs. By 1997, 77% of all hog farms sold less than 1,000 head, but together accounted for only 5% of marketings. The very large farms, those selling more than 50,000 head a year, handled 37% of all hog marketings in 1997, up from 7% only a decade before.... Very large hog producers are highly specialized, purchasing feed rather than growing it, and frequently linked to slaughterhouses through contractual agreement or common ownership. With hog production increasingly divorced from corn and soybean production, large operations could locate virtually anywhere in the country. (pp. 5–6)

Consolidation in the poultry industry led to larger average plant size and increased concentration by large firms. The share of production in slaughter plants with more than 400 employees grew from less than 30% in 1963 to more than 80% in 1997. Consolidation also led to substantial economies of scale in the poultry industry that have reduced the real unit costs of chicken and turkey production in the United States. Ollinger, MacDonald, and Madison report that the real retail price of chicken and turkey was reduced over 50% from 1963 to 1997.

Finally, increasing exports reinforced the cost-lowering effects of the meat processing industry consolidation by allowing processing plants to operate nearer to capacity and thereby more fully realize their economies of size. The United States' meat trade was also helped by technological innovations in transportation, which have facilitated trade in chilled fresh and frozen products. Available trade in chilled fresh and frozen products allows the United States to capitalize on the higher quality meat produced from abundant grain.

Consumer preference and spending pat-

terns in other countries, like Japan and Korea, increased demand for U.S. meat products substantially as their income grew. Countries like Japan and Korea are importing a rising share of their meat consumption as import barriers fall. Dyck and Nelson reported that the United States was actively able to negotiate with Japan for beef imports following the dismantling of its quota system for beef imports and reductions in tariffs since 1995. South Korea opened its beef market with an import quota in 1988, and subsequently has raised the quota level several times.

This growth has been facilitated by significant reductions in barriers since 1985 that have advanced the growth of international meat trade. Both regional trade agreements and multinational trade liberalization have contributed to increasing trade among member countries. Although many of these agreements have come to fruition after 1992, many of the economic and political forces that led to the agreements were already having an effect. For example, although large increases in meat trade in North America have been associated with the NAFTA (Canada, Mexico, and United States in 1994) agreements, Mexico went from a net exporter of beef in the 1970s to imports accounting for about 3% of consumption of beef and pork just prior to NAFTA (García-Vega and Williams). Expanded meat trade within South America has been associated with the MERCOSUR (the common market of the south formed in 1991 among South American countries such as Argentina, Brazil, Uruguay, and Paraguay) agreement. Easing meat import barriers in some of these countries in the past 15 years has expanded opportunities for exporters. After the breakup of the Soviet Union and ensuing policy changes in the 1990s, major new markets emerged in Russia, especially for poultry. China and Hong Kong became fast-growing markets for poultry as China allowed imports to increase. The entry of China and Taiwan into the WTO as well as the end of Korea's pork and poultry meat quotas in 1997 and beef quota in 2001 mark the fall of barriers that will affect future trade flows. In addition to policy changes facilitating trade, active efforts by the U.S. government to establish and maintain a disease-free status on many of the major livestock diseases has opened or kept open some overseas markets for U.S. meats.

Summary and Conclusions

Since 1972, industry consolidation and economies of scale in meat processing have lowered the industry's cost of production. Consumer preferences for high-quality meats and rising consumer incomes in customer nations have expanded potential meat export markets. Bilateral and regional trade agreements have modified some barriers to international meat trade. These developments have allowed the industry to take advantage of the United States' relative abundance of cropland and capital and compete effectively in the world market for meat.

The growth in meat trade paralleled a spatial shift of the meat packing and poultry processing sectors from urban to rural locations.[5] Because on balance rural areas have a greater share of low-skilled workers in their labor force and have fewer employment opportunities for their workers, from an employment standpoint, this may appear to be a win-win situation for rural areas. Meat processing seemed to be just what was needed for rural areas—more rural jobs related to a growing industry experiencing growing trade.

However, although more jobs are available, they are predominantly low-skill jobs. Although rural areas have a greater share of low-skilled workers in their labor force, the jobs related to slaughtering livestock and processing the meat often do not appeal to rural domestic workers. The resulting need to accommodate work forces with a larger share of commuter and migrant workers has challenged

[5] A reviewer suggests this overlooks the role of environmental considerations in explaining the shift of meat processing toward rural areas. We treated the urban to rural shift as given; however, Adhikaril, Harsh, and Cheney did attempt to explain the shift and found, "Environmental compliance cost is considered one of the major factors of industry relocation; the analysis showed that the effect of such costs was minimal."

some rural communities that have meat processing plants.[6]

As MacDonald et al. write,

> Declining unionization coincided with changes in slaughter plant demographics. Immigrants, primarily from Southeast Asia, Mexico, and Central America, make up large and growing shares of the workforces at both hog and cattle slaughter plants. This has led to striking transformations in the rural communities that must provide schooling in the rural communities to the workers and their families. (p. 15)

Have rural areas benefited from the changing skills of labor used in U.S. processed food trade? It depends on one's point of view. A rural community that adds a new meat processing plant certainly adds to its economic base. Consumer spending and opportunities for businesses supporting the new plant will grow. If the number of available workers in the community is inadequate to support the plant's employment needs, commuter and migrant workers will supplement the local labor force. Commuter workers will bring additional traffic and migrant workers may introduce strains on the community educational system and housing. Both may be sources of income leakages from the community and thus lessen the potential benefits from higher consumer spending. Some community members will like the changes, and some will not.

Expanding international trade in resource-based products is beyond the scope of rural development policy-makers. There was a whole range of changes in the economic environment that occurred to facilitate an apparent comparative advantage in meat trade. Therefore, despite its attractiveness, expanding international trade in resource-based products was never a feasible rural development option. However, these changes did give rural development analysts a perhaps unprecedented chance to see the effects of expanded international trade in resource-based products. Were rural incomes and employment opportunities expanded? In fact, in this instance they were, but with significant leakages—migrant workers, commuter workers, profit-type-income, educational costs, public security costs, local tax revenues—from the rural areas where these meat processing plants were located.

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[6] Our rural effects are general. For examples of the effects of specific plants on specific rural areas, see Doeksen or Broadway, and an especially rich resource of examples and in-depth descriptions and analysis is in the book edited by Stull, Broadway, and Griffith.

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