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US Agricultural Exports: A Balanced Regional Model

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Using a balanced regional input-output model we estimate that US agricultural exports generated 951,000 jobs in 1995 and will create 1.7 million jobs in 2005. The Corn Belt is the number one region for export related jobs in 1995. In 2005 the Pacific region will be number one.

I. Introduction

Agricultural exports are becoming increasingly important to the US economy. In 1995 they totaled \$55.8 billion, nearly double the \$29 billion total in 1985, and represented ten percent of all US exports. Although the overall trade balance was negative throughout the period, agricultural exports partially offset the deficit in other goods, exceeding agricultural imports by \$25.8 billion in 1995. More fundamentally, agricultural trade is important to the economy because it provides employment and generates income for hundreds of thousands of workers. The location of these workers in the economy varies significantly among industries and among regions. Using information on the interindustry structure of the economy and the geographic distribution of production, the purpose of this paper is to estimate the direct and indirect employment impact of agricultural exports across industries and across regions of the United States in 1995 and for projected exports in 2005.

II. The Commodity Composition of US Agricultural Exports

Agricultural exports include a wide range of products from farm commodities such as wheat and corn to processed foods such as meat products and canned fruits and vegetables. Table 1 presents the composition of US agricultural exports by major commodity group. Among farm commodities, feed grains (corn, sorghum, oats, barley and hay) comprised 15.1 percent of 1995 exports, followed by oil crops (mostly soybeans) with 10.5 percent and food grains (wheat, rice and rye) with 9.8 percent of exports. Processed foods are also important with meat products comprising 16.2 percent of exports

and feeds and flour products 7.6 percent. Other processed foods which includes beverages, confection and baked goods and miscellaneous food processing comprised another 7.9 percent of agricultural exports in 1995. The other category, with 3.3 percent consists of grass seeds, sugar crops, forestry products and other miscellaneous crops.

Table 1. Composition of US Agricultural Exports, 1995 and Projected 2005					
	1995	2005	Change	1995	2005
Commodity Group	\$millions	\$millions	percent	percent	percent
Livestock	720	1,944	169.9	1.3	2.4
Food grains	5,454	7,500	37.5	9.8	9.4
Feed grains	8,432	11,871	40.8	15.1	14.9
Cotton	3,713	3,070	-17.3	6.7	3.9
Veg,fruits,nuts	4,247	8,847	108.3	7.6	11.1
Oil crops	5,862	9,064	54.6	10.5	11.4
Tobacco	1,400	1,287	-8.0	2.5	1.6
Meat products	9,051	14,298	58.0	16.2	17.9
Feeds & flours	4,250	4,329	1.9	7.6	5.4
Veg fats & oils	3,488	4,494	28.8	6.2	5.6
Veg & fruit preps.	2,914	3,354	15.1	5.2	4.2

Other processed	4,427	6,287	42.0	7.9	7.9
Other	1,856	3,353	80.7	3.3	4.2
Total	55,814	79,700	42.8	100.0	100.0

Table 1 also presents estimates of agricultural exports for the year 2005. These projections are part of the long-run baseline projections of the agricultural sector developed by the US Department of Agriculture (USDA). The baseline incorporates the provisions of the 1996 Farm Act and assumes favorable global economic growth over the baseline period (1995-2005). Together with liberalized trade resulting from the GATT agreement and other policy reforms, the baseline points to strong growth in world trade and in US agricultural exports. Strong economic growth in developing regions is expected to significantly increase demand for U.S. meat products for consumption and for livestock, feed grains and oil crops to supply expanding foreign livestock sectors. Similarly, higher incomes are expected to lead to increased purchases of US vegetables, fruits, and nuts. The effects of these anticipated changes can be seen in Table 1. The share of feed grains remains about the same. However livestock, oil crops, and meat products all increase in relative importance with the largest increase occurring for vegetables, fruits, and nuts rising from 7.6 to 11.1 percent of agricultural exports.

How the composition of agricultural exports in 1995 and 2005 affects the regional distribution of employment depends on interindustry relationships and the degree of

regional specialization.

III. The Ten US Farming Regions

USDA classifies the states into ten farming regions. These regions differ with respect to soils, climate, distance to market, storage and marketing facilities, and hence in product specialization. The Northeast (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, and Maryland) and the Lake States (Minnesota, Wisconsin, and Michigan) are the primary milk-producing regions of the nation. The soils and climate in these regions are suited to growing grains, forage and pasture land for cattle. In addition Maine, Delaware and Maryland are important areas of broiler production.

The Appalachian region (West Virginia, Virginia, Kentucky, Tennessee, and North Carolina) produces most of the country's tobacco as well as cattle, dairy production and peanuts. The Southeast region (South Carolina, Georgia, Alabama, and Florida) is a major producer of peanuts, fruits, and vegetables and of beef and broiler production. The Delta States (Arkansas, Louisiana, and Mississippi) are major producers of broilers and grow significant amounts of cotton, sugar cane and rice. In the aptly named Corn Belt (Iowa, Missouri, Illinois, Indiana, and Ohio) farmers typically grow over half the nation's corn crop. The rich soils and good climate of this region also make it a major producer of other feed grains, soybeans, and wheat. In addition, Corn Belt farmers are big producers of beef cattle, hogs, and dairy products.

In the Northern Plains (North Dakota, South Dakota, Nebraska, and Kansas) and Southern Plains (Oklahoma and Texas) agricultural production is restricted by lack of

rainfall in the western part and by cold winters and short growing seasons in the northern areas. Nevertheless, Northern Plains farmers produce over forty percent of the nation's wheat crop and Southern Plains farmers produce another ten percent of the total.

The Mountain States (Idaho, Montana, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico) have large areas suited to raising cattle and sheep. Wheat is a major commodity in the northern parts of the region. Irrigation in the region's valleys enable the production of potatoes, sugar beets, hay, and fruits and vegetables.

In the Pacific Region (Washington, Oregon, California, plus Alaska and Hawaii), cattle are raised throughout the entire region. In the northern mainland farmers grow potatoes, wheat and fruit. In the southern mainland, fruits, vegetables and cotton are the major crops.

IV. Empirical Procedures and Data

The model that we use to estimate the regional impacts of agricultural trade is based on the balanced regional input-output (I-O) model, pioneered by Leontief (1953, Chapter 4) and described in Miller and Blair (1985). In the model, sectors are characterized as national or regional depending on whether production and consumption of their products tend to balance on a national or regional level. For example, the textile industry is classified as a national sector since textile producers serve a national market area. In contrast, eating and drinking places are classified as a regional sector because production and consumption for its services tend to balance at a regional rather than national market area. Following Leontief, we classify the farm sectors, the processed food sectors, and tobacco manufacturing as national sectors. Among the regional

sectors, the most important are transportation, trade, and agricultural services.

Classifying these sectors as regional ensures that their production as intermediate services to support the production of agricultural exports is credited to the regions producing those exports.

Using the national I-O tables from the Bureau of Economic Analysis (BEA), we partition the matrix of direct requirements A into four submatrices. The upper left submatrix, A^{RR} represents the required flow of inputs from regional sectors to regional sectors. The upper right submatrix, A^{RN} represents the flow of inputs from regional to national sectors. The lower left submatrix, A^{NR} gives the flows of inputs from national to regional sectors and the lower right matrix A^{NN} , the flow from national to national sectors. The basic I-O accounting identity states that total output is the sum of intermediate output and final demand.

$$(1) \quad (I - A) X = Y$$

where,

X is a vector of sector outputs

Y is a vector of final demand by sector

A is the matrix of value of commodities required per dollar output of each sector.

And the solution is given by:

$$2) \quad X = (I - A)^{-1} Y .$$

In the case of the partitioned A matrix, equation 1) can be rewritten:

$$3) \quad (I - A^{RR}) X^R - A^{RN} X^N = Y^R$$

$$-A^{NR} X^R + (I - A^{NN}) X^N = Y^N,$$

where,

Y^R is the vector of final demand for regional goods.

Y^N is the vector of final demand for national goods.

The inverse of the partitioned matrix $(I-A)$ can be partitioned into four corresponding submatrices, S, T, U, and V such that:

$$4) X^R = S Y^R + T Y^N \text{ and}$$

$$X^N = U Y^R + V Y^N$$

where,

X^R is the total output of regional goods.

X^N is the total output of national goods.

Using the results from the inverse of a partitioned matrix, we can write:

$$5) X^{R(L)} = (I - A^{RR})^{-1} Y^{R(L)} + (I - A^{RR})^{-1} A^{RN} X^{N(L)}$$

where $X^{R(L)}$ is the production in region L to meet region-specific final demand for regional goods plus region L's share of production of national goods, $X^{N(L)}$.

We use information from U.S. Commerce Departments's County Business Patterns to estimate each region's share of national goods output. Finally, using data from the Bureau of Labor Statistics, employment is calculated as:

$$6) E = p \cdot X$$

where,

E is a vector of employment in each sector.

P is a diagonal matrix showing the ratio of base year to current year labor productivity.

I is a diagonal matrix of employment coefficients per dollar of sector output.

V. Results

Table 2 presents the estimates of employment by industry required to produce US agricultural exports in 1995. Nearly 951,000 workers throughout the economy were required. About a third of these workers were in the farm sectors, with employment at 311,000. Among the farm sectors some 88,000 workers were involved in vegetable, fruit, and nut production, 57,000 workers in oil crops production, 35,000 workers in cotton production, and 28,000 in feed grains. Nearly 64,000 workers were involved in producing meat animals, poultry and other livestock. Employment in agricultural

Table 2. Regional Employment Generated by Agricultural Exports, 1995											
Sectors	NE	Lake	Appal	SE	Delta	Corn	N. P.	S.P.	Moun	Pacific	U.S
Farm	16,870	19,194	19,697	28,512	21,343	57,388	25,398	27,477	15,376	79,431	310,687
Livestock	5,821	5,975	6,850	5,776	4,876	12,314	7,985	5,976	3,362	4,998	63,933
Cotton	102	80	2,234	3,300	8,049	1,188	82	11,131	2,136	6,938	35,239
Tobacco	24	3	708	100	8	19	4	12	4	15	897
Food grains	475	1,043	602	305	1,186	1,933	5,741	1,719	2,215	1,929	17,146
Feed grains	1,466	2,659	1,595	867	698	10,186	4,666	1,942	1,760	1,809	27,650

Table 2. Regional Employment Generated by Agricultural Exports, 1995											
Veg, fruits, nuts	4,791	3,092	1,802	11,766	790	2,013	705	2,267	4,191	56,102	87,518
Oil crops	1,954	5,013	4,239	3,876	4,578	27,144	5,326	2,260	622	1,802	56,812
Other crops	2,237	1,331	1,668	2,523	1,158	2,592	889	2,170	1,087	5,836	21,491
Agric. services	2,782	2,925	4,224	6,289	7,546	9,414	3,874	9,385	3,369	14,266	64,074
Meat products	3,883	3,729	4,881	5,277	4,372	6,928	3,996	3,395	1,548	2,822	40,831
Other proc foods	6,426	3,606	3,525	3,614	2,251	8,972	1,789	3,048	2,211	8,832	44,275
Tobacco mfg	37	0	1,271	169	0	17	0	3	0	0	1,498
Ag chemicals	249	393	341	358	438	1,396	814	599	370	831	5,789
Prepared feeds	467	387	510	548	444	927	413	468	204	411	4,778
Other mfg	6,319	5,235	5,901	5,280	3,985	14,555	5,921	5,298	3,578	10,800	66,873
Trade	10,373	11,218	10,622	10,211	8,504	33,469	18,084	11,993	9,166	22,564	146,203
Transportation	7,079	7,343	8,844	7,614	5,892	21,845	11,172	8,252	5,858	16,389	100,287
Mining , forestry	815	750	762	790	618	2,006	984	813	900	1,571	10,008
Other services	10,685	11,391	12,519	10,951	9,950	37,895	18,116	13,088	8,740	21,531	155,405
Total	65,985	66,710	73,096	79,614	65,345	194,812	90,560	83,818	51,321	179,447	950,708
Percent of total	6.9	7.0	7.7	8.4	6.9	21	10	9	5	19	100
Rank	8	7	6	5	9	1	3	4	10	2	

services at 64,000 contributed another 7 percent of the total.

Over sixty percent of the employment generated by agricultural exports in 1995 occurred outside the agricultural sectors of the economy. Wholesale and retail trade

together employed the services of 146,000 workers, 15 percent of the total. These workers helped match the buyers and sellers of agricultural products at the farm, factory, and final consumer levels. In addition, they provided trade services for all the goods required indirectly in the production of agricultural exports. To move the agricultural products from farm and factory to ports of export required the services of some 100,000 workers in the transportation and warehouse industries. These workers, ten percent of the total, also transported the intermediate goods required in the production of agricultural exports, for example the flour required by a bakery.

The food processing industries employed 85,000 workers or 9 percent of total employment supporting 1995 agricultural exports. The largest employing sector was meat packing with over 22,000 workers; followed by poultry plants with over 16,000; canning, freezing, and dehydrating employing with over 13,000 worker and flour milling employing over 8,000 workers.

As our discussion of the US farming regions suggests, the regional employment impact of agricultural trade varies greatly, both with respect to the amount of employment and its sectoral composition. Table 2 shows the estimated employment by aggregated sector generated by agricultural exports in 1995 for each of the ten farming regions. The employment impact was largest in the Corn Belt with nearly 195,000 workers, . Of these, 45,000 were employed in crop production, 12,000 in livestock, and over 9,000 in agricultural services. As with the nation as a whole, about two-thirds of the employment (128,000) were generated in the nonagricultural sectors. The preeminence of the Corn Belt reflects its dominance in the production of feed grains, oil seeds, and livestock

production.

The Pacific Region is the next largest beneficiary of agricultural exports with estimated employment of over 179,000 of which 5,000 were in livestock and 74,000 in crop production. Employment in the Northern Plains, though well behind, was third at nearly 91,000 of which 29,000 was in farming and agricultural services. The Southern Plains followed close behind with estimated employment of about 84,000, of which 37,000 were in agriculture. Together, these four regions accounted for 58 percent of the total employment generated by agricultural exports in 1995.

The projections for agricultural exports in 2005 have a number of important effects on estimated employment by industry for the nation as a whole and for the ten farming regions. As Table 3 shows, export-related employment in 2005 is estimated at 1.7 million, an increase of 722,000 workers over the 1995 level. Sectors experiencing some of the largest increases in employment are vegetables, fruits, and nuts (159,000); livestock (89,000); oil crops (65,000) and food processing (65,000).

The regional impact of projected agricultural exports reflects the composition of exports in 2005 and the assumption that regional patterns of production remain the same as in the 1995. Thus changes in the relative importance of regions occur because of changes in the composition of exports between 1995 and 2005. The region generating the most employment in the projection is the Pacific at 361,000. This result reflects the large shift in exports towards fruits and vegetables. The Corn Belt follows with employment estimated at 327,000, due to its dominance in feed grains, oil seeds and livestock and the anticipated increase in demand for those products. The Southeast moves up to third place

with employment of 154,000 benefiting from the increases in vegetables, fruits, nuts and livestock exports. The Northern Plains follow close behind with employment of 153,000. Together, these four regions account for 59 percent of export-generated employment.

VI. Conclusion

This study has estimated the employment impact of US agricultural exports by sector and region using a balanced input-output model. In 1995 agricultural exports generated 951,000 jobs throughout the economy. The Corn Belt was the number region in terms of job creation at 195,000. Using projections of agricultural exports in the year 2005 we estimate the total number of jobs that will be created at 1.7 million. In that year the Pacific states will be the number one region in jobs created with 361,000. Changes in the number of jobs and the ranking of the ten regions reflect the changes in the total amount of exports, their commodity composition and the regional distribution of production.

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Table 3.
Regional
Employment
Generated by
Agricultural
Exports,
Projected
2005

	NE	Lake	Appal	SE	Delta	Corn Belt	N. Plains	Pla
Sectors								
Farm	38,847	43,467	42,474	68,200	40,549	122,494	55,261	48,
Livestock	14,177	13,638	17,472	14,795	12,948	27,632	18,228	14,
Cotton	200	155	2,788	4,060	9,753	1,693	160	13,
Tobacco	35	7	950	140	13	34	9	
Food grains	818	1,940	1,125	579	2,329	3,447	11,396	3,

Feed grains	3,121	5,537	3,473	1,927	1,568	20,928	9,774	4,
Veg, fruits, nuts	13,020	8,916	4,993	33,830	1,934	4,800	2,068	6,
Oil crops	3,932	10,892	9,056	8,395	9,982	59,110	11,643	4,
Other crops	3,543	2,382	2,617	4,474	2,022	4,850	1,982	3,
Ag Services	4,922	4,711	5,933	9,566	8,363	13,814	5,715	9,
Meat prods	7,779	7,214	10,199	11,549	9,769	13,178	7,322	6,
Other foods	9,638	5,454	5,404	5,919	3,685	13,155	2,751	4,
Tobacco manuf	43	0	1,448	193	0	20	0	
Ag Chemicals	470	713	593	664	663	2,467	1,436	
Prepared	825	665	995	1,085	918	1,516	710	
Feeds								
Other manuf.	12,298	9,877	10,546	10,412	7,075	26,235	10,535	8,
Wholesale, retail	15,410	16,608	15,237	16,535	12,000	47,448	26,202	16,
Transportatio n	9,191	9,561	10,166	10,431	6,971	27,486	14,086	9,
Mining & forestry	1,218	1,129	1,090	1,254	832	2,753	1,343	1,
Other services	16,416	18,358	18,142	17,712	14,300	56,833	27,429	17,
Total	117,056	117,758	122,227	153,519	105,125	327,399	152,791	124,
Percent of Total	7.0	7.0	7.3	9.2	6.3	19.6	9.1	
Rank	8	7	6	3	9	2	4	