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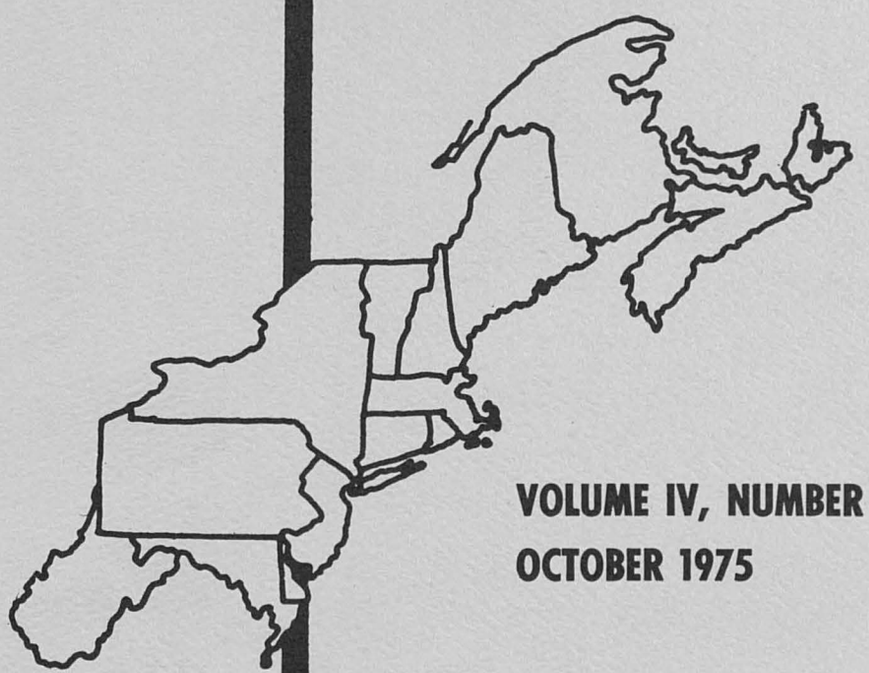

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FARMERS' CAPITAL EXPENDITURES, WHO BENEFITS?

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Farm employment fell from 12.8 million workers in 1929 to 4.4 million in 1974. One frequent explanation for this drastic drop in employment is the replacement of labor inputs in this sector by cheaper and more productive capital inputs. Assuming the farm labor market was in equilibrium at the start of this substitution process (admittedly a weak assumption but not crucial to this paper) the farm workers forced out of their chosen occupations were the most apparent losers in the process. If labor's share of the farm income dollar did not decrease as rapidly as the number of workers, then the remaining farm workers would be one group of beneficiaries of the process. Another would be society in general if total productivity increased. This paper will examine another potential group of beneficiaries, the shareholders and workers in the rest of the economy whose business and employment are tied to the provision of fixed capital inputs for the farming sector. Data availability, unfortunately, only allows us to identify economic implications for these groups at one point, 1971, in this ongoing process of transition. Nevertheless, these results are of interest since the groups who have benefited have not likely changed and our understanding of the rural adjustment process as well as the impact of technological innovations may be enhanced.

Data and Research Procedure

The business and employment tied to the provision of fixed capital inputs for the farming sector was estimated with an input-output (I/O) based economic model. The I/O model is a 39 sector aggregated version of the 1967 Department of Commerce 484 sector I/O table for the

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* The views presented herein are those of the authors and not necessarily the views of the U.S. Department of Agriculture.

U.S. Economy [5]. An aggregated version lessens the data manipulation requirements by using detailed information only in those sectors of particular interest. The sectoring plan and its relation to the Commerce plan is presented in Table 1.

The 1971 Survey of Farmers' Production Expenditures [4] provided us detailed estimates of farmers' expenditure for farm capital items in 1971. Because the I/O matrix was specified in 1967 dollars and the expenditure data was 1971 dollars, we chose a set of price of deflators is listed in the last column of Table 1.

The employment requirement data necessary for the analysis of the employment impacts of farm capital expenditures were obtained from a special study of 1967 employment by I/O sector of orgin [9]. These data reflect 1967 labor productivity. Employment needs estimated in this study would be overestimated by the amount labor productivity increased between 1967 and 1971.

Our estimation procedure is a standard input-output analysis. The gross output or business activity generated by farmers' expenditure for capital items was estimated by equation 1.

1) $X = (I-A)^{-1} Y$

where X = a 39x2 matrix of business activity generated in the ith sector (i = 1 - 39) by farmers' expenditures in the jth category of farm capital items (building and other improvement, 1, or machinery and equipment, 2)

$(I-A)^{-1}$ = a 39x39 total requirements matrix of the U.S. economy

Y = a 39x2 matrix of direct sales by the ith sector (i = 1 - 39) to farmers as capital expenditures in the jth category of farm capital items (j = 1 -2)

The estimates of total business activity generated (represented in the matrix X) contain varying degrees of double counting of economic activity. Premultiplication of X by a diagonal matrix of value-added coefficients, V, as in equation 2 yields an estimate of the income retained in the sectors.

2) $R = VX$

where R = a 39x2 matrix of estimates of income retained in the ith sector due to farmers' expenditures in the jth category of farm capital items

Similarly the employment effect of these farm capital expenditures can be estimated by premultiplying the X-matrix by a diagonal matrix of average employment needs per dollar of output as in equation 3.

3) $E = LX$

Table 1
Relationship to U.S.D.C. I/O Sectoring Scheme and Sources of Sector Price Deflators

Sector	Title	Related 1967 I/O No.	Source
1.	Agricultural Products	01-02	W.P.I. 01
2.	Mining	05-10	Average of S.I.C., 1111, 1211, 1311, 1421, 1442, 1475, 1467, 1477, In Handbook Lab. Stat. Table 133 1972.
3.	Water, Sewer and Conservation Construction	110306, 110307, 110506	
4.	Highway Construction	110400	Construct Review, Aug. 1972, Table E1.
5.	Farm Service Facility Construction	110502	" " " " " "
6.	Other Non-building Construction	110507	" " " " " " "
7.	Non-Agricultural Construction	110100-110305, 110308, 110501, 110503-110505	" " " " " " " Dept. of Commerce Composit Cost Index.
8.	Maintenance Water, Sewer and Conservation Facilities	120209, 120210 120213	See 3.
9.	Maintenance Other Non-building Facilities	120216	See 6.
10.	Maintenance Farm Service Facilities	120203	See 4.
11.	Maintenance Non-Agricultural	120100-120202, 120204-120208, 120211, 120212, 120214, 120215	See 7.
12.	Farm Machinery	44000	W.P.I. 11-1
13.	Construction Machinery	450100	W.P.I. 11-2
14.	Industrial Trucks and Industrial Tractors	464000	Handbook Lab. Stat., 1973 Table 133, SIC 3537
15.	Truck Bodies and Trailers	590100, 590200	W.P.I. 14-11
16.	Motor Vehicles, Parts and Accessories and Motorcycles	590301, 590302, 610500	W.P.I. 14-11
17.	Aircraft and Parts	60	W.P.I. 14-1
18.	Transportation Equipments	610700	Handbook Lab. Stat., 1972 Table 133, S.I.C. 3519
19.	Internal Combustion Engines	430200	W.P.I. 10-14
20.	Hardware and Hand tools	420202, 420300	W.P.I. 08-1
21.	Logging, Saw Mills and Forestry	200100, 200200,030000	W.P.I. 08
22.	Wood Products and Treatments	200700, 200800, 200900, 2100000	W.P.I. 07
23.	Tires, Rubber and Rubber Products	320100, 320301, 320302	W.P.I. 07
24.	Synthetics, Plastics and Plastic Products	280100, 280200, 320400	W.P.I. 05-7
25.	Petroleums Refining and Related Products	31	W.P.I. 13-3
26.	Cement, Brick, Clay and Related Products	360100, 360200, 360400, 360500, 361000 361200, 360701-360900	W.P.I. 10-3
27.	Steel and Steel Products	37, 420500	W.P.I. 10
28.	Other Metals and Primary Metal Products	38-41	**
29.	Manufacturer of Food, Beverages and Tobacco Products	140100-150200	C.P.I. 1972 Handbook Lab. Stat. Tables 127
30.	Household Appliances and Refrigeration Equipment	520300,540700	W.P.I. All Commodities
31.	Other Manufacturers	13, 16-19, 200300-200600, 22-27, 280300-30, 320200, 33-35, 360300, 360600, 361300-362200, 420100-420201, 420401-420402, 420600-430100, 450200-460300, 470100-520200, 520400-540600, 55-58, 610100-610400, 610600, 620100-641200	C.P.I. Transportation Services
32	Transportation Services	65	C.P.I. Fuel and Utilities
33.	Utilities	68	C.P.I. All Items
34.	Wholesale and Retail Trade	69	***
35.	Finance, Insurance and Real Estate	70-71	C.P.I. All Service
36.	Other Services	66-67, 72-77	****
37.	Government Enterprises	78-79	Survey and Current Business July 1972 1968 Table 16 Change base to 1967.
38.	Imports	800100, 803200	C.P.I. All Items
39.	Dummy Industries	81-82	

**** From Survey of Current Business, National Income Issues, July 1972 and July 1969 government computed from table 18, changing base year to 1967=index of 143.5.

*** From Survey of Current Business, National Income Issues, July 1972 and July 1969: Real Estate is computed from Table 8-5, changing base to 1967=index of 151.5. This is averaged with the C.P.I. index for mortgage interest rates (120.4) and Property insurance rates (119.9).

** Average of W.P.I. 02 (114.3), W.P.I. 15-2(116.7) 1967 weights food .92, tobacco .08.

* Average of E.P.A. Sewers Index (143.8) and Ag. Construct (126.0) found in Construction Rev., Aug. 1972.

where E = a 39x2 matrix of employment needed in sector i (i = 1 -39) to produce the 1971 level of purchases of farm capital in category j (j = 1-2).

The current dollar estimates of business generated and income retained in each of the sector are made by premultiplying the X and R matrix respectively by a diagonal matrix of sector price inflators, i.e.

$$4)\quad X_{71} = PX \text{ and } R_{71} = PR$$

Results

In 1971 farmers spent $7.0 billion for all capital items. This expenditure required $15.1 billion of total business activity in the U.S. economy. Machinery expenditures accounted for $4.9 of this $7.0 billion expenditure and $10.4 of the $15.1 billion of total business activity in the economy. Buildings and other capital improvement accounted for the remaining $2.1 billion of farm fixed capital expenditure and $4.7 of the $15.1 billion of estimated total business activity.

The above totals and their distribution by economic sector are presented in Table 2. For example, reading across row 27 of Table 2 shows that $1.186.9 million of business activity was required from the steel and steel products sector. Of this amount, $329.8 million was required to support farmers' capital expenditures for buildings and other improvements and $857.1 million was required to support farmers' capital expenditures for machinery and equipment.

The employment needed to maintain the levels of economic activity presented in Table 2 was estimated as discussed above. These estimates are presented in the columns headed "Employment Needs" in Table 3. Over 660,000 workers were needed to produce and deliver farm capital items to farmers in 1971. With a total civilian labor force in 1971 of 84 million, this result suggests about 0.8 percent of American workers were committed to the provision of fixed capital items for farming.

The input-output variant of the old saw "there is no such thing as a free lunch", is that the amount of income generated in an open I/O model analysis can be no greater than the amount of final demand introduced into the analysis (in fact, it must be less by the amount of leakage through imports required in the production process). Thus the magnitude of the income effects of farmers' expenditures for fixed capital expenditures is less interesting than the distribution of this income among sectors of the economy. The distribution of the income effects of the two expenditures categories is presented in the last two columns of Table 3. Reading down these two columns one learns

Table 2
Economic Activity Required for Production and Delivery
of Farm Capital Items, 1971

Sector	Farm Capital Expenditure Category		
	Total	Buildings and Other Improvements	Machinery and Equipment
		$1,000	
1	65,075	27,134	37,941
2	212,081	92,864	119,217
3	261,939	261,939	0
4	9,812	9,812	0
5	1,266,511	1,266,511	0
6	248,579	248,579	0
7	0	0	0
8	7,745	2,024	5,721
9	3,083	1,010	2,073
10	595	221	374
11	97,426	27,480	69,946
12	2,757,614	1,062	2,756,552
13	78,292	2,392	75,900
14	3,291	711	2,580
15	9,081	311	8,770
16	1,188,950	10,266	1,178,684
17	35,581	5,337	30,244
18	11,037	164	10,873
19	196,882	2,008	194,874
20	37,294	9,270	28,024
21	331,966	299,492	32,474
22	24,327	14,202	10,125
23	115,024	9,976	105,048
24	84,736	30,297	54,439
25	102,673	48,739	53,934
26	156,871	151,791	5,080
27	1,186,889	329,777	857,112
28	873,352	468,069	405,283
29	57,031	16,109	40,922
30	86,631	3,302	83,329
31	1,493,768	403,286	1,090,482
32	472,385	158,436	313,949
33	167,369	48,084	119,285
34	1,752,719	334,874	1,417,845
35	435,782	118,179	317,603
36	663,882	186,951	476,931
37	103,529	26,732	76,797
38	409,188	97,934	311,254
39	114,201	31,053	83,148
Total	15,123,191	4,746,378	10,376,813

that 18 percent of the expenditures for building and other improvements are retained in the farm service facility construction sector in the form of wages, indirect business taxes, interest, depreciation and profits. Slightly more than 21 percent of the expenditures for machinery and equipment are retained in the farm machinery manufacturing sector.

Discussion

What do these results have to say about the question raised in the title of the paper, "Farmers' Capital Expenditures, Who Benefits?"? We have seen that each dollar of expenditure for farm fixed capital items has stimulated $2.10 of total business in the economy and that a total of more thant 660,000 jobs are associated with these purchases. We will now look at these effects in detail.

Output Effect

Eight of the 39 economic sectors had over $500 million of business due to farmers' fixed capital expenditures in 1971. Two of these were the "other manufacturing" and "other services" sectors which could be expected to receive large effects because of their size and prevasiveness in the economy. Three others; farm service facility construction, farm machinery manufacturing and motor vehicle manufacturing, could be expected to be stimulated because they directly construct and manufacture the capital items. But sectors 27 and 28, which produce primary metal and primary metal products, were also major beneficiaries of these farm pruchases. The eighth sector in this list; sector 34, wholesale and retail trade; actually was the second largest beneficiary of farm capital expenditures.

While these eight sectors were the major beneficiaries of the $7.1 billion of direct expenditures by farmers, less than 1 percent of this expenditure was recycled back as stimulated farm output. Thus this was nearly a pure capital export from the farm sector to the nonfarm sector. The farm sector receives the capital stock and its associated income streams but does not share in the direct economic activity stimulated by the investment.

Now that the major specific sector beneficiaries of the capital export have been identified, it may be useful to look at the beneficiaries by broad groupings. All the construction sectors, sectors 3-11, both new and maintenance received nearly $1.9 billion of economic activity, all at the impetus of farm capital expenditures for buildings and other improvements. Machinery manufacturing (sectors 12-19), received nearly $4.3 billion, mainly at the impetus of farm machinery and equipment expenditures. The group of material input sectors, sectors 2 and 20-28, which supply wood, metal, plastics, rubber, petroleum products and so on for construction and machinery manufacturing had their output augmented by over $3.1 billion with about equal impetus from the two farm fixed capital expenditures categories.

The remainder of the manufacturing sectors, 29-31, received $1.6 billion.

As previously noted, the wholesale and retail trade sector, sector 34, was an important beneficiary with nearly $1.8 billion of stimulated economic activity. The impetus for this trade activity was mainly farm machinery and equipment purchases. The transportation and utilities sectors, 32 and 33, received respectively, about three and one percent of the total economic activity stimulated by farm capital expenditures. Slightly over $400 million of foreign (sector 38) imports were included in the total of $15.1 billion of economic activity stimulated by farm capital expenditures. Proportionally this was 2.1 percent of the total activity due to building and other improvements expenditures and 3.0 percent of the machinery and equipment activity. The residual of this economic activity, $1.4 billion was received by the remaining service sectors and the farming sector.

Employment Effect

The labor intensive nature of construction is apparent from a comparison of the output total of Table 2 with the employment totals of Table 3. While the economic activity due to expenditures for machinery and equipment in 1971 was over twice that of the activity due to expenditures for building and other improvements, the employment needs of these two types of economic activity was nearly equal. The employment needs related to expenditures for farm building and other improvements were concentrated in the construction sector accounting for 198,900 or 65 percent of the total employment effect. Wholesale and retail trade employment due to the expenditures were 27,300 or 9 percent and the material supply sectors required 39,300 or thirteen percent of the total effect. The remainder of the employment effect was distributed over the rest of the economy.

In contrast to the concentration observed in the employment effect of farmers' expenditure for buildings and other improvements, the employment effect of farmers' expenditures for machinery and equipment was more widely dispersed throughout the economy. Machinery manufacturer's, sectors 12-19, employment needs related to these expenditures were 101,300 or 28 percent of the total effect. Employment of 41,000 or eleven percent of total employment due to farmers' expenditures for machinery and equipment occurred in the material supply sector, 2 and 20-28.

Perhaps the most striking difference between the employment effect of the two fixed farm capital categories is the effect upon the wholesale and retail trade sector. Employment in this sector with its impetus from farmers' machinery and equipment expenditures was 115,600 workers in 1971, greater than any other sector. This in part was a reflection of the concentration of machinery and equipment manufacturing both economically and geographically and the dispersion of the farm market which requires an extensive trade network to link the two.

Table 3
Employment Needs for and Distribution of Income Associated with Production and Delivery of Farm Capital Items.

Sector	Employment Needs (1000 workers)		Income Distribution (%)	
	Buildings and Other Improvements	Machinery and Equipment	Building and Other Improvements	Machinery and Equipment
1	1.6	2.2	0.513	.312
2	2.1	2.6	2.574	1.439
3	14.9	-	6.550	-
4	.3	-	.226	-
5	153.6	-	17.976	-
6	30.1	-	6.024	-
7	-	-	-	-
8	*	.1	.071	.088
9	*	*	.036	.033
10	*	*	.003	.002
11	.6	1.5	.810	.898
12	*	74.6	.019	21.358
13	.1	1.8	.050	.685
14	*	.1	.014	.022
15	*	.3	.005	.057
16	.2	18.9	.161	8.053
17	.2	1.0	.117	.288
18	*	.3	.002	.051
19	*	4.3	.035	1.496
20	.3	.9	.238	.312
21	10.7	1.2	5.762	.272
22	.7	.5	.285	.089
23	.3	3.1	.235	1.078
24	.9	1.5	.547	.428
25	.3	.3	.632	.305
26	5.4	.2	3.499	.051
27	8.0	20.9	6.899	7.810
28	11.3	9.8	8.572	3.233
29	.3	.7	.232	.257
30	.1	1.7	.050	.553
31	14.8	40.0	8.783	10.346
32	6.4	12.7	4.714	4.069
33	.7	1.8	1.158	1.252
34	27.3	115.6	12.299	22.684
35	1.9	5.2	4.175	4.888
36	11.6	29.5	5.963	6.626
37	1.4	4.0	.771	.965
38	-	-	-	-
39	-	-	-	-
Total	306.1	357.3	100.000	100.000

* Less than 50 workers

Income Distribution

A discussion analogous to that pertaining to the output and employment effects could be applied the income distribution data in Table 3. However, for brevity we ask our readers to simply note how a dollar spent for a farm fixed capital item is dispersed throughout the economy.

A Perspective on Fixed Capital Investment in Farming

Investment must be disaggregrated in several ways in order to explore its economic impacts. Firstly, total investment consists of replacement investment (that investment needed to maintain the present level of capital stock) and net new investment (investment that increases the level of capital stock). In the absense of technological innovations farm workers are not displaced by straightforward replacement investments, only by net investment. When the capital now being replaced was originally put in use workers were displaced. On the other side, all investment creates income and employment in the supplying sectors. Complication results from the simultaneous consideration of the concepts of investment flows and capital stocks. Our final demand sector is total investment in a one year period (1971) and this a flow. Another difficulty for us was introduced when the capital expenditures data was collected for the 1971 Survey of Farmers' Expenditures on a basis of gross expenditure less trade-in value of used equipment. This introduces bias into our estimates of total effects because ideally we would want total gross investment in our final demand sectors. The bias originates from dealers' markup on used machinery, and the uncertain disposition of the traded-in used equipment to other farmers, dealers, inventory, or scrap.

A direct comparison of the employment needs of investment with the number of workers displaced by investment may not be meaningful. It is complicated by the necessity of making intertemporal comparisons. An investment is made in one period, yet it displaces the farm workers for the life of the capital stock. Similarly the number of workers leaving the farm is not a complete measure of the people being displaced by farm capital investment. Capital investment in agricultural input and processing industries can cause jobs as well as workers to be transferred to the nonfarm sector. While a direct comparison may not be meaningful it is useful to note this capital substitution process is not costless initially and later takes a certain level of factor commitments (labor, raw material etc.) for replacement investment.

Farm workers traditionally have had lower incomes than members of most occupations. When a farm worker's services are replaced by a piece of capital equipment, the general distribution of income among factor shares may be affected. While the purchase of a piece of capital includes payment to the wage earners in the capital producing

sectors, as well as payments of a profit to the producer of that capital, wages paid to the farm workers obviously contains no profit component. This process redirects farm expenditures away from employee compensation toward property income. If the profit earners (owners of firms in the capital producing sectors) are generally wealthier than the farm worker displaced by capital, then the process of capital accumulation in the farming sector initially tends to concentrate the distribution of income in higher income groups.

Farmers make decisions to invest presumably on economically legitimate grounds. The private value of the investment is calculated by the farmers. They see great efficiencies accruing from the introduction of new capital. The problem is that the sum of the private value of investment may not add up to the social value of investment. For the farmer, the elimination of wage expenditure is a saving. For society the displacement of agricultural workers may be a cost. The divergence of social values and private values gets to the heart of economic development strategies. There are important trade-offs to be made. Do we want to maximize efficiency, profits and output or do we want to have high employment, and less income concentration?

These goals may not be mutually exclusive in fact, they may be complementary. If the rest of the economy is generating employment needs at skill levels compatible with the displaced workers as fast as these workers are being displaced by capital, then all goes well. If however, the other sectors are also displacing workers through the investment process or those jobs available are unsuited to the displaced workers, our problems are more serious. Fortunately, the former case tends to occurs in the U.S. economy. Historically nonmanufacturing sectors have expanded sufficiently to keep the economy at a fairly stable and usually acceptable rate of unemployment.

The capital intensification of agricultural production is not a painless process for the farm workers, the farmers or for the rest of society. Democratic societies often recognize the obligation to provide for those upon whom the burden of modernization has fallen. Providing farm workers access to such advantages, schooling, training etc. could make this adjustment easier. The industrial and trading sectors that are receiving the major portion of the income generated by the purchases of farm capital expenditures might play a larger role in providing for the rehabilitation of the displaced farm workers. The conclusion is not that agricultural capital expenditures should not be made, but rather that the benefits and costs of modernization should be brought into more equitable harmony.

Heady [2 p. 149] states:

"The crux of the rural community development problem is one of inequity in the distribution of gains and costs of technological and economic development at state and national levels. The challenging task in rural community development is to identify the nature, location,

and extent of inequities, falling on rural communities and various population strata of them, then to evaluate and provide alternative means of alleviating or redressing them."

We hope this study and paper have made a contribution towards meeting this challeging task.

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