6-7-1990

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Charles W. Howe & Jeffrey K. Lazo, *Economic and Social Impacts of Agriculture-to-Urban Water Transfers: The Arkansas Valley of Colorado*, *in* MOVING THE WEST'S WATER TO NEW USES: WINNERS AND LOSERS (Natural Res. Law Ctr., Univ. of Colo. Sch. of Law 1990).

ECONOMIC AND SOCIAL IMPACTS OF

AGRICULTURE-TO-URBAN WATER TRANSFERS
THE ARKANSAS VALLEY OF COLORADO

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May, 1990

I. INTRODUCTION: Some economic principles.

The social purpose of any resource reallocation (i.e. transferring valuable inputs from one use to another) should be to improve "social welfare," however that might be defined. It is clear that "social welfare" is composed of more than the usual aggregate measures of regional product, value added, or personal income.

Markets have proven to be powerful mechanisms for adjusting resource allocations to changing tastes, demands, costs, scarcities, and technologies. The differential experience between the non-market centrally directed economies and those of the western industrialized countries is proof enough. However, markets, as is true of all institutions, are imperfect in the social results they produce for at least the following reasons:

a. the results depend on the distribution of income, and market-determined income distributions usually are not socially desirable;

b. important social and cultural values are generated outside the market and are thus not protected by market transactions;

c. economic activities create both positive and negative "externalities" that are not incorporated in private decisions;

d. economic systems typically do not exhibit full employment of resources and costless mobility of resources among uses and locations. In the context of water transfers, rural areas frequently exhibit long-term unemployment, and the movement of population involves both privately-borne financial costs and psychological costs.

In the light of these observations, let's consider agriculture-to-urban water transfers. They are justified by the benefits to the recipient urban areas (in comparison with other sources of water, e.g. lower costs, lesser environmental damage, possibly better water quality). The costs of the transfer are imposed largely on the basin or area of origin in the form of directly reduced farm incomes and employment, indirectly induced employment and income losses, and environmental damages. The direct costs are presumably more than compensated by the sale price of the water, while there is generally no compensation for the indirect income and employment losses nor for the environmental damages. While some of the new indirectly unemployed resources may move to new jobs, the movement from rural areas is likely to be slow (entailing lost productivity/income) and costly--

contrary to the competitive model assumptions.

Can we then expect market-initiated water transfers as practiced in the western United States to lead to socially desirable results? Answering this question requires (at a minimum) assessing the uncompensated indirect income losses and the environmental damages associated with water transfers. The present study assesses simultaneously the direct and indirect income losses stemming from agriculture-to-urban water transfers originating in the Arkansas Valley of Colorado. The early transfers were to urban uses within the same basin, while later and all future transfers are out-of-basin.

This study analyzes the employment, population, income and public sector impacts on the basin of origin attributable to a set of historic and prospective inter-regional agriculture-to-urban water transfers from the Arkansas River Valley of Southeastern Colorado. The geographic isolation of the Valley from the major industrial and urban centers of Colorado, its integrated agriculture-to-agriculture processing structure, and the size of past and potential transfers, make the Valley an ideal study opportunity for measuring the impacts of transfers on basins of origin where such impacts may be expected to be relatively severe. The benefits to the receiving urban areas have not been evaluated, nor has allowance been made for the impacts of payments to water rights owners for the transfers. Another study of the Crowley County experience as well as the generally depressed conditions in many rural areas suggest there is no major reinvestment of the proceeds in the local area (see Weber 1989).

II. REGIONAL OVERVIEW

The study region encompassed a seven county area in Southeastern Colorado corresponding to State Planning Region VII (Pueblo) and Region VI (Baca, Bent, Crowley, Kiowa, Otero and Prowers). The seven counties comprise 7.6 million acres of which 77% or approximately 6,071,070 acres were in 3,035 farms; 312,758 acres were irrigated (1987 Census of Agriculture). Across the region, mean annual precipitation ranges from 12 to 20 inches, with a 29 year annual average of 14.66 inches for the Southeast Crop Reporting District. The modest amount of precipitation and its unpredictability make irrigation a necessity for reliable agricultural output, especially for high value, water-sensitive crops.

The 1987 population of the area was approximately 182,000; 50,000 in the six rural outlying counties and 132,000 in Pueblo County. This compares with a 1930 population count of 68,576 for the six county area and 66,038 for Pueblo County, indicating the extent of rural-to-urban migration. The City of Pueblo is the primary population and services center of southeastern Colorado. The primary economic base of the area is agriculture and agriculturally related enterprises, while most manufacturing and industrial activity centered in Pueblo. Transportation, education, retail, construction, tourism and government also add to the economy, for the most part based in or near the City of Pueblo.

III. HISTORICAL AND POTENTIAL TRANSFERS

As a preliminary step of this investigation, an accurate record of historical water transfer activity was developed from water records for Water Division Two of the State Engineer Office which covers the Arkansas River drainage in Colorado. Ditches currently involved in some sort of transfer case, currently or recently listed for sale, or which have indicated informal interest in selling were included in the study as potential transfers. Table 1 lists the ditches considered for purposes of this analysis as historical or potential water transfers in the study area.

TABLE 1: HISTORICAL AND POTENTIAL WATER TRANSFERS

YEAR	DITCH	DECREE DATE	ACREAGE
HISTORICAL TRANSFERS			
1955	Otero	1902	4,500
1971	Las Animas Town Ditch	1884	1,900
1972	Booth Orchard Grove	1861/64/71/81	1,447
1972	Hobson	1871/80/86/87	275
1985	Colorado Canal	1890	40,267
TOTAL			48,389
POTENTIAL TRANSFERS			
1987	Rocky Ford (majority)	1874/90	4,100
1990	Keesee	1871/83/93	1,400
1994	Rocky Ford (minority)	1874/90	3,800
1998	Las Animas Consol. & Ext.	1875/84/88	6,950
2001	Holbrook Mutual	1889/93	9,775
2004	Fort Lyon	1884/87/93	61,100
2007	Amity Mutual	1887/93/1908	22,610
2010	Bessemer	1861/64/64	9,725
2013	Catlin	1875/84/87	9,750
TOTAL ACREAGE			129,210

The sale of Twin Lakes water used to irrigate Colorado Canal lands is modelled as if it had been part of the sale of the direct flow rights associated with the ditch. Based on decreed consumptive use over a number of cases, it is reasonable to assume that approximately two acre feet per acre of consumptive use is typical of the land under irrigated production in the Arkansas River Valley. This would vary from ditch to ditch depending on the seniority of the water right involved, on the soils, and on the types of crops grown.

IV. METHODOLOGY

Removal of agricultural water will impact the economy in three ways. 1) backward linkages occur when the reduction in crop acreage reduces the demand for inputs, such as labor, machinery and fertilizer; 2) the reduction in crop outputs will reduce the availability of inputs to other production processes such as food processing and feedlots (these are called forward linkages); 3) the reduction in incomes in any sector will lead to a reduced consumption demands for outputs from other sectors, thus creating a ripple effect throughout the economy, reducing income by more than the original decrease (these are called multiplier effects). The purpose of this study was to model and quantify these impacts resulting from historical or potential water transfers.

The analysis was carried out insofar as possible on a "with-without" basis, i.e. projections were made of the regional and state economies as they would have been without the agricultural buy-outs. The conditions of the economies with the buy-outs were then either observed or calculated (for future buy-outs) and compared with the first scenario.

For the historical transfers listed in Table 1, input-output analysis was used to evaluate the effects on the Colorado economy. The input-output model used is from IMPLAN data based on the 1977 Bureau of Economic Analysis Input-Output table updated to 1982. IMPLAN input-output data are derived from the national input-output model on a county or regional level. The region used for this analysis is the State of Colorado.

Future transfers were analyzed using the Colorado Forecasting and Simulation Model, designed for projection of future economic impacts. The data upon which C.O.F.S. is based include the historical effects of the water transfers and thus future projections made by C.O.F.S. implicitly include the impacts of past transfers.

The market value of the reduced agricultural output for each ditch sold was derived using cropping patterns from court records where available. Where not available in court records, average values of irrigated acreage were calculated for each county from the Colorado Agricultural Statistics. These values of reduced production were then analyzed, using one of the models. No attempt was made to project trends in cropping patterns, yields or prices. Discussions with farmers, agricultural consultants and others strongly indicate that the lands removed from irrigated agriculture would not be suitable for any type of dryland agriculture.

In keeping with our understanding of the cropping patterns and nature of economic activity in the Valley, vegetable crops formerly grown on retired lands were assumed to be "picked up" by other ditches in the region instead of being eliminated due to the water removal. Thus, in the analysis of the historical transfers, we have not assumed any forward linkages (the methodology of input-output analysis is generally inadequate for dealing with forward linkages).

The ditch transfers in the future scenarios were ordered in time by those involved in legal proceedings to alter the water right. This includes the Rocky Ford minority, the Las Animas Consolidated and Extension ditches and the Keesee. The second group includes those that are or were recently listed for sale. This includes the Holbrook, Fort Lyon and Amity Mutual. We understand the Bessemer and Catlin Ditches to have considered sale or possibly have already been involved in sales negotiations (possibly for investment purposes) but for these we have less explicit information. The acreages indicated in the scenarios are based on the portion of the ditch indicated by the relevant court case documents, on the listing for sale, or from data supplied by persons familiar with the ditches.

Timing of the future scenarios is based on a roughly even spacing of the different transfers over the period from 1986 to 2013, even though history may suggest that the past sales have been "bunched" as demand for transfers to cities has peaked and subsided.

The Rocky Ford (majority) transfer is still in progress and is thus modelled as a "future" transfer.

Five different scenarios were developed to analyze the impacts of potential future water transfers. The first three scenarios did not include forward linkages. Scenario One considered the impact of the first four transfers. Scenario Two modelled eight of the potential transfers (omitting the Catlin), and Scenario Three included all potential transfers. Transfers from the Bessemer and Catlin ditches were assumed to include reductions in vegetable output. The earlier ditches were assumed to lead to reductions in food and feed grain outputs only.

Scenario Four included all of the ditches with some forward linkages to food production and a 30% decrease in feedlot operations. Scenario Five included all of the ditches with the same forward linkages to food production and a phased 80% decrease in feedlot operations. Because of the importance of feed costs in feedlot operations, these businesses are likely to be impacted as the local supply of feed crops is reduced under the water transfers.

V. THE C.O.F.S. MODEL

The C.O.F.S. Model, developed by the Center for Economic Analysis in the Department of Economics at the

University of Colorado-Boulder, is a state econometric model driven in part by current and forecasted values of national economic and demographic trends. C.O.F.S. has the flexibility of non-linear models but incorporates the detail provided by a state input-output model of narrowly defined sectors. The model is more comprehensive than an input-output model in that it assimilates and projects relative state input costs, input intensities, wages, prices, income, employment, population, input demands and consumption, and government and residential investment demands.

The model can be used in a purely forecasting mode, or it can be used to analyze the effects of policy changes that are under consideration. In the present study of potential agriculture-to-municipal water transfers, a baseline forecast of the state was projected to the year 2025. Forecasts are then made incorporating the five scenarios as exogenous changes in specific agricultural sectors. The C.O.F.S. Model calculates a new projection for each of the variables in the model and reports the differences between the baseline and scenario values. The principal variables we consider are employment (farm and total), population, personal income, and value added (farm and total).

VI. ANALYTICAL RESULTS

Table 2 summarizes the results of the input-output analysis of the historical transfers. While the input-output model calculates these impacts on a statewide basis, the majority of these impacts will occur within the region from which the water is transferred. The local impacts will be more significant the greater the degree of local processing of the agricultural products and the greater the local supply of inputs in the production process.

TABLE 2: IMPACTS OF PAST TRANSFERS (1982 DOLLARS)

REDUCTION IN:	TOTAL	
EMPLOYMENT STATEWIDE	156.7	308.8 acres/job
VALUE ADDED STATEWIDE(1)	$6,083,270.72	$125.72/acre
REGIONAL INCOME	$5,290,133.40	$109.33/acre
LOCAL AND STATE GOVERNMENT REVENUES	$ 506,350.13	$ 10.46/acre

(1) Lost value-added overstates losses for it assumes that none of the unemployed inputs find new employment.

The total reduction in agricultural output due to the historical transfers was calculated as a single annual reduction. The impacts can be thought of as the change in total economic activity had all of the transfers occurred in the same year and if there were no shifting of unemployed resources to other uses. As unemployed labor induces some movement out of the region, as opposed to remaining unemployed within the region, some of the employment impacts would be translated into out-migration over the thirty year period. This will have intensified the rural-to-urban population migration experienced by most agricultural communities.

Value added is the residual payments of wages, rents and profits summed over all stages of production. The reduction in value added as calculated here is a permanent reduction due to the reduced agricultural output. This may be partially offset by the payment to the farmer for his water rights, which in averaged about $350.00 an acre or less. The effects of the application of these funds were not included in the analysis.

Table 3 presents some of the analytical results from future scenarios 3 and 5 (from C.O.F.S.). Scenario 3 represented the largest impact without considering any forward linkages and Scenario 5 considered an 80% reduction in feedlots due to the reduced availability of feed grains creating a comparative disadvantage for further feedlot operations in the Valley. The results are presented as per cent reductions from the baseline as projected by the model for the year 2020. By 2020 the effects of the final potential transfer have worked through the economy and impacts in sectors affected by the reduced agricultural output have stabilized in the model. The results of Scenario 4, considering a 30% reduction in feedlot operations, generally lay between those of the data presented in Table 3.

TABLE 3: FUTURE TRANSFERS: PER CENT REDUCTION FROM BASELINE (YEAR = 2020)

	REG VI		REG VII		VI & VII		STATE	
SCENARIO	3	5	3	5	3	5	3	5
FARM EMPLOYMENT	10.5	23.3	7.7	11.1	10.1	21.0	1.2	2.5
TOTAL EMPLOYMENT	2.0	4.4	0.2	0.3	0.8	1.6	0.0	0.1
POPULATION	0.5	0.8	0.1	0.1	0.2	0.3	0.0	0.0
VALUE ADDED - FARM	10.5	23.4	7.8	11.3	10.0	21.1	1.2	2.5
VALUE ADDED - TOTAL	2.6	5.9	0.3	0.5	1.4	2.5	0.0	0.1
PERSONAL INCOME - TOTAL	3.8	8.4	0.3	0.4	1.6	3.4	0.0	0.1

0.0 indicates negligible differential (< 0.05%)

Several observations should be made regarding the results of these scenarios. First, the reduction in employment in a single sector such as the farm sector does not mean there is an equal increase in unemployment. Some of this unemployed farm labor could be expected to move into other sectors or to migrate out of the region. The reduction in regional population is evidence of this effect. A decrease in total employment is a better indicator of net increased unemployment.

Second, the reduction in total employment involves reduced employment in the farm sector and other sectors due to the linkages and multipliers resulting from decreased agricultural production. In absolute terms, for the year 2020, the reductions in farm employment in Region VI and VII and Statewide are 716, 81 and 799 respectively. The transfers induce reduced farm employment in the two regions (797) and then an additional reduction of two positions elsewhere in the state. Total employment is reduced by 1075 and 145 in Regions VI and VII respectively and by 1824 statewide. Within the region an additional half job is lost for every farm job lost whereas statewide an additional 1.28 jobs are lost for each farm job lost. This is the result of a reduced agricultural output requiring fewer inputs from elsewhere in the state.

Third, the impact of forward linkages appear to be significant. Comparing the size of the impacts between Scenarios 3 and 5 indicates the potential importance of forward linkages. For some variables, such as farm employment in Region VI, the impacts of the water transfers when forward linkages are considered are more than double those without the linkages. Such indirect losses are not compensated by water market transactions.

The fourth general observation from Table 3 concerns the relationship between the impacts within Regions VI and VII and the impacts statewide. Reductions which may be significant regionally may have virtually no impact on the state's economy. As a per cent of state employment, population, value added and personal income the economic, demographic and social effects of these potential water transfers have little significance. In Scenario 5, for example, the required percentage reduction in farm value-added due to the water transfers exceeds 20%, while as a per cent of total state value-added, it is less than 1/10 of 1%.

Fifth, population losses historically have occurred in areas which have experienced water transfers. The population projections of the C.O.F.S. model capture this effect as well. Out-migration compared to the baseline from Regions VI and VII total 510 persons and a statewide population reduction of 770 is forecast by the year 2020 for Scenario 5. These reductions result from decreased factor demand in the state and induced decreases in wages. It should be noted that the baseline projection, with no removal of water from the agricultural sector, also indicates a decline in regional population. This out-migration is then magnified by the future water transfers.

Finally, the ratio of acres to jobs lost is significantly lower than indicated in the earlier input-output analysis. The C.O.F.S. analysis projects this ratio to be about 67 acres per job lost whereas the input-output analysis indicated about 309 acres per job lost.

VII. CONCLUSION

While these historic and projected future transfers appear to do little economic harm statewide, they have significant local and regional impacts in the rural communities of the area of origin. These must be considered a cost of the transfers. The negative impacts are more evident in the rural areas where there are preexisting high levels of unemployment and minimal opportunities for re-employment outside of agricultural and agriculturally related sectors. It must be noted that the impacts of the water sales extend beyond the agricultural sector to all sectors of the economy both regionally and statewide.

This study has not examined the positive effects of the use of water in whatever new use is made of it. The net benefits may well be positive, but this is not guaranteed since privately arranged transfers do not take secondary impacts into account beyond those enforced through court actions initiated by other water right holders. When water is moved between regions, the area experiencing the benefits may in no way correspond to the area suffering the costs. These differential impacts may be even larger if the recipients of the payments for the water do not reinvest their money in new activities in the region.

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