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COMPETITION BETWEEN IRRIGATED AGRICULTURE AND HYDROELECTRIC POWER PRODUCTION: IMPLICATIONS FOR ECONOMIC GROWTH

by

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Introduction

From an economic perspective, irrigation development has been a means of promoting rural development and public funds have frequently been used to finance irrigation development for this reason. However, the water resources available for further irrigation development are becoming increasingly scarce and increasingly subject to competition from alternative uses. Washington State's water resources are used for irrigation, hydropower production, fisheries, navigation, and recreation among other uses. Competition between the first two is particularly intense in the Columbia River Basin. The future growth of the Washington State economy will depend in part on the allocation of the state's water resources among these competing uses. This paper focuses upon the state economic impacts of the tradeoffs between irrigation and hydropower production.

When additional land is irrigated in the Pacific Northwest, the supply of electrical energy available to other industries and consumers is reduced for three reasons. First, large amounts of water are lost from the river system due to transpiration and evaporation of water used for crop production. Second, the location at which irrigation water is diverted frequently fails to coincide with the place at which return flows re-enter the river; in many cases, return flows reach the river downstream from the point of diversion, bypassing available hydroelectric generation facilities. Third, electric energy is used in the irrigation process itself to operate the machinery needed to lift and distribute water to the land. Since more expensive thermal sources must now be used to replace the electricity used and "lost" as a result of irrigation, irrigation development will affect the cost of electricity and may pose serious problems for the state economy. This paper provides estimates of the socioeconomic impacts of simultaneous increases in agricultural

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ABSTRACT

Competition for water resources for irrigation and hydroelectric power generation has become intense in Washington State, with additional irrigation implying significant increases in electricity rates. Although the statewide socioeconomic impacts of simultaneous increases in agricultural output and electricity rates were found to be positive, additional irrigation caused significant distributional impacts.

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output and electricity rates in Washington State. The statewide impacts of irrigating an additional 796,000 acres in central Washington were measured, with two projects being selected for study: the East High Project (EHP), a publicly financed irrigation project encompassing 585,000 acres, and the Horse Heaven Hills (HHH), 211,000 acres of potentially irrigable land. Although neither project was found to be feasible for private development at this time, the secondary impacts of irrigating these areas were estimated. If irrigation development in the East High Project and Horse Heaven Hills is undertaken, significant quantities of additional agricultural output will be produced and processed, resulting in substantial electrical energy losses (Whittlesey, Buteau, Butcher, and Walker) and higher electricity rates for all electric utility customers.

Methodology

Input-output analysis was used to trace the interindustry changes that would be expected to occur in the Washington State economy as a direct and indirect result of additional irrigation development. The 1972 Washington State I-O model (Bourque and Conway) was used, but was modified significantly to reflect changes in the economy occurring between 1972 and 1985, and to more accurately model the electric utility sector. The short run effects of changes in wholesale electricity rates and agricultural product prices were assessed using a methodology developed by Lee, Blakeslee, and Butcher, for analyzing the impacts of an exogenous price change in an I-O framework. This procedure was modified to reflect intraindustry transactions as well as interindustry flows, and all behavioral equations were partitioned so that simultaneous changes in output production, final demand, and exogenous prices could be modeled. By using the 1985 updated Washington I-O model in conjunction with this methodology, it was possible to trace the direct and indirect impacts of

simultaneous increases in agricultural output production and electricity rates, decreases in agricultural product prices, and increases in the final demand for transportation services on an industry-by-industry basis to determine the net effects as well as the distributional impacts of irrigation development.

Study Results and Interpretation

When the statewide impacts resulting from increases in agricultural output are assessed without consideration of higher electricity rates, it is apparent that irrigation stimulates statewide economic development. When increases in field and seed crops, vegetables and fruits, livestock, dairy and meat products, and canning and preserving output were modeled, real gross output in Washington increased by $1,187 million, employment by 45,640 jobs, wage and salary income by $238 million, and residual income (dividends, rent, interest and other value-created income) by $353 million annually.

However, the quantity of electric power used and lost as a result of this additional economic activity was found to be significant: 9440 kWh per acre in the East High Project and 7890 kWh per acre in the Horse Heaven Hills. If this power is replaced by more expensive thermal power, wholesale electricity rates can be expected to increase by as much as 43 percent above 1980 levels if both areas are irrigated, assuming that the opportunity cost of power equals 50 mills per kilowatt-hour. A large increase in wholesale rates is reasonable. Since wholesale electricity rates in Washington have historically been the lowest in the nation, the development of nuclear and coal sources can be expected to substantially increase energy costs in the state.

Higher electricity rates due to increased thermal power production have a depressing effect on statewide economic activity. Since most of

the non-labor inputs used to construct nuclear generation facilities are imported to the state, the increase in power gross revenues resulting from higher electricity rates are siphoned off and "exported" to pay for all thermal plant construction. Therefore, the increased rates due to power replacement from thermal sources mean decreased statewide output, employment, and income, since the additional gross revenue earned by the electric generation sector is essentially exported.

Despite the adverse economic effects of higher electricity rates, the net impact of irrigation is found to be positive to statewide economic development if the additional investment costs necessary for irrigation development are ignored. These results are shown in Table 1, where the socioeconomic impacts of irrigation development with and without higher electricity rates are compared. When the impacts of higher electricity rates and increased agricultural production are simultaneously estimated, total state output increases by $1,122 million, employment by 43,130 jobs, wage and salary income by $220 million, and residual income earnings by $209 million. Increased power rates reduce employment by 2,510 jobs and total income by $174 million from the levels attributed to irrigation when changes in electricity rates are not modeled.

Table 1: Statewide Increases in Economic Activity Due to Irrigation Development With Versus Without Higher Electricity Rates (ΔP_E) Considered

Impact	Without ΔP_E	With ΔP_E
Aggregate Output (mil. $)[a]	1,187	1,122
Total Income (mil. $)	634	460
Residual (Value-Created) Income (mil. $)	353	209
Wage and Salary Income (mil. $)[b]	238	220
Job Opportunities Created (number of jobs)	45,640	43,130

[a]Assuming an opportunity cost of 50 mills/kWh.

[b]Excluding proprietor income earnings.

Although the net impacts on output production, employment, and income in Washington State are positive, these aggregate estimates hide two important facts. First, the cost of living will increase in Washington State as energy prices rise. For example, if both projects are developed, residential electricity customers will pay an average additional $11.36 per person annually to maintain current electricity consumption levels, while not all households will benefit from irrigation development. At least 94 percent of all additional employment and at least 91 percent of all additional labor income will accrue to wage and salary employees in agriculture, food processing, trade, services, and transportation, industries employing approximately 51 percent of all household employees in Washington State (Bonneville Power Administration). However, all residential electricity customers must pay the higher electricity rates associated with irrigation development. If additional irrigation development is undertaken, a redistribution of income from all Washington households to households supported by wage and salary workers employed in agriculture, food processing, trade and services, and transportation will take place. Households in the benefiting sectors would earn an additional $200 million in wages and salaries annually while paying approximately $25 million more annually for electricity, whereas employees in all other sectors would be required to pay higher electricity bills costing $24 million more annually, while earning only $20 million in additional wage and salary income as a result of irrigation development.

Several important industries, most notably the aluminum industry, will experience significant absolute declines in residual income earnings. However, the rate of return on fixed capital in all industries will decrease, if it is assumed that the fixed costs of production will increase proportionally to increases in output production. Those indus-

tries experiencing a net decrease in residual income earnings are shown in Table 2. Industries shown to experience only a small decrease in residual income relative to total output are relatively immune to changes in electricity rates, and irrigation development will have little impact on these sectors. However, industries which rely heavily on electricity as an input (principally those industries included in Table 2) may be significantly affected by increases in power rates. Such industries will experience short-run declines in residual income and will, in most cases, find it necessary to pass along price increases to consumers, to adjust their production processes over time, or to accept lower rates of return on fixed capital. Although the long run effects of reductions in residual income are not considered in this analysis, it is possible that the changes in wealth due to reductions in fixed asset values or changes in investment opportunities may have significant negative effects on the state economy.

Table 2: Residual Income Losses Due to Additional Irrigation Development.

Industry	Annual Reductions in Residual Income
	(Dollars)
Aluminum	18,344,000
Mining	603,000
Wood Products	1,926,000
Pulp and Paper	2,158,000
Glass, Cement, Stone, and Clay	360,000
Iron and Steel	745,000
Other Nonferrous Metals	85,000
Aerospace	2,090,000

The distributional impacts of irrigation development are significant. The agricultural producing and processing sectors as well as those sectors closely related to agriculture are the primary "gainers" from irrigation, while the industries outlined in Table 2 are the principal "losers." Unlike the "gainers" which tend to be concentrated in agriculture,

the "losers" are diverse, with the negative impacts of irrigation development spread throughout the Washington State economy. Since the major source of negative effects are the electricity rate increases that are needed to recoup the costs of power replacements, the energy-intensive industries, in particular the aluminum industry, will lose the most if irrigation is undertaken. If development of both the EHP and HHH is initiated, the aluminum industry could lose as much as $18 million per year in residual income earnings. In addition, absolute residual income losses will occur in mining; wood products; pulp and paper; glass, cement, stone, and clay; iron and steel; other nonferrous metals; and aerospace, in addition to aluminum. These industries have traditionally been important to the Washington State economy and can be expected to produce almost 30 percent of all output produced in the state in 1985. The ability of these industries to cope with significant earnings losses in the face of rapidly increasing energy prices will have an important effect on the economic well-being of Washington State in the future.

Conclusions

Before publicly financed irrigation development is undertaken, the total impacts of such development should be carefully measured. If irrigation is undertaken in either the East High Project or the Horse Heaven Hills, development will need to be heavily subsidized by the public sector with farmers paying only a fraction of the total costs of additional development. In return, taxpayers receive the additional output, employment, and income generated throughout Washington State. However, because of the competitive nature of water use in the state, the economic gains from irrigation that could have been achieved in the past will be

progressively eroded away as electricity rates increase in the future. In an era of rapidly rising energy prices, the subsidization of energy-intensive irrigated agriculture may not be either economically efficient or equitable. As electric energy and water resources become scarcer, public investment in other alternatives may be more beneficial to long-run economic growth in Washington than irrigation development.

Since large federal expenditures would be required to develop the East High project, it may also be relevant to raise other questions. Is it wise to spend scarce federal funds for this type of investment while also spending money to increase farm income in several parts of American agriculture? Or, if additional food output is a desired national goal, is it possible that this increase could be achieved with greater efficiency in other ways and other places? These questions are given little consideration in the benefit-cost calculations of a state input-output model.

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