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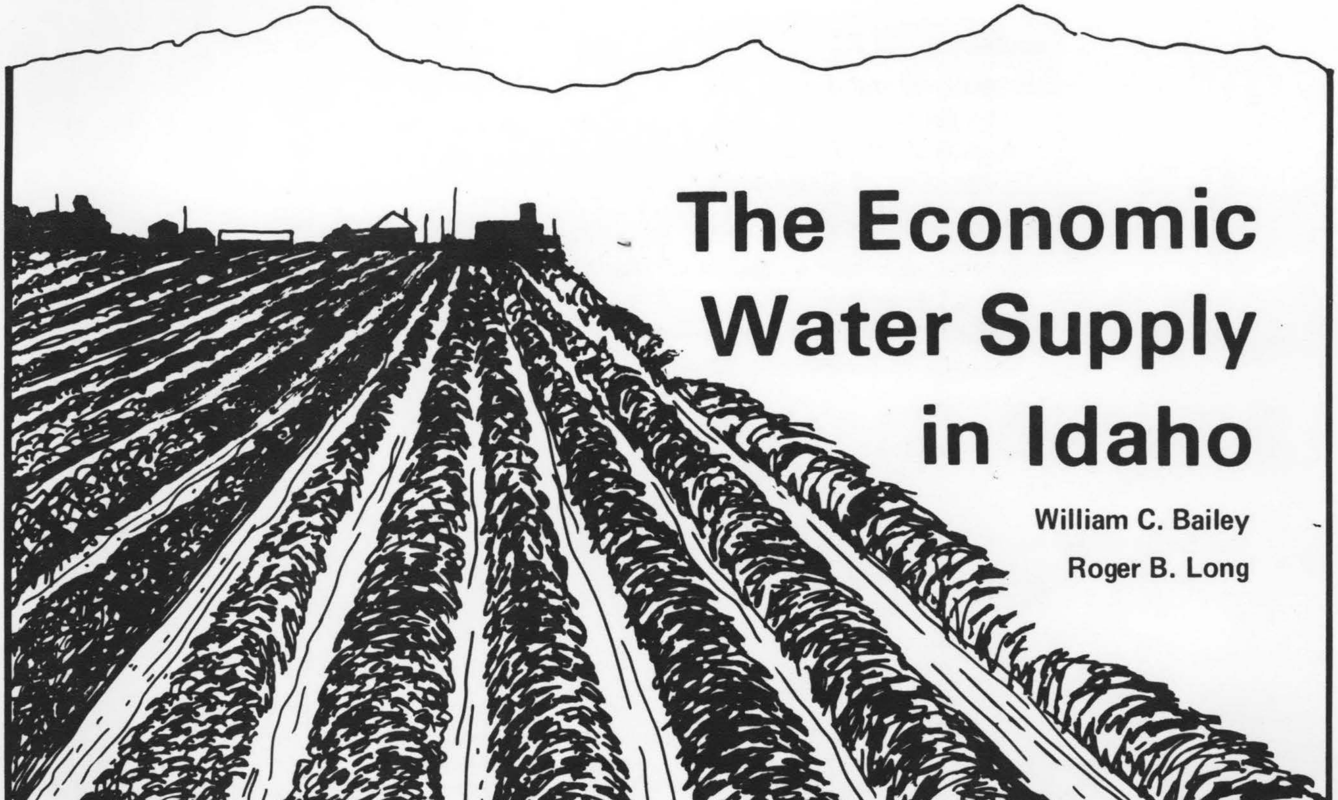

The Economic Water Supply in Idaho

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Summary

This study examined the costs involved in making water available for use in Idaho. The difference between the quantity of water available and a supply of water requires that costs be incurred.

In examining the cost for making water available for use in Idaho, the water supply industry was segmented into three categories: municipal, industrial, and irrigation. Primary and secondary sources were used in the collection of the data from these three categories.

When the data were assembled, least squares regression analysis was performed on the data to estimate the relationship between total, fixed, and variable costs, and water output for each category. The results of the regression analysis showed there is a reasonably high correlation, 0.70 to 0.81, between cost and output. The economic interpretation of the regression results indicated the water industry in Idaho is in Stage I of a standard production function and subject to economies of scale. In other words, costs of producing water tend to fall as output increases.

Supply curves for these water categories were shown to be downward sloping and highly elastic. Results indicated sufficient water is available in Idaho to meet present and foreseeable needs. If past experiences can be used to predict the future, increased demands for water in Idaho can be met by further natural resource development. Future costs will depend on the scale of development, but experiences indicate that the larger the scale of output the lower will be the per unit costs.

Introduction and Scope

Water is an indispensable requirement for life. However, compared to certain items which are not requirements for life, such as diamonds, the price of water is very low. When abundant, water may be free; in some cases, as with a flood, water may have a negative value. The value of water then depends on having the proper amount in the right place at the right time. To achieve this goal, costs are incurred for capturing, transporting, and distributing water from its source to its place of use. This study is concerned with the costs of water supplies in the state of Idaho.

The Problem

By virtue of having 223 million acre feet of water resources (see Table 1), Idaho potentially has enough water to meet its annual consumptive requirements of 5.3 million acre feet (see Table 2). When compared with annual precipitation, Idaho consumes only about 14 percent of the potential annual supply. However, when the annual mean precipitation in Idaho is compared with land presently irrigated, it is apparent that water is not necessarily located where it can be most gainfully used. Irrigation of farmlands accounts for 99.1 percent of Idaho's water consumption. Southern Idaho, where most irrigated and potentially irrigable land is located, has an average annual rainfall of less than 12 inches. Northern Idaho, on the other hand, with the smallest amount of irrigated and potentially irrigable land, has an average rainfall of 38.9 inches and the largest quantity of water in the state (5). Consequently, the problem is to make water supplies available to the areas where they are demanded.

Making the water resources available where needed involves costs for capturing, transporting, and distributing the water from existing sources. When these relationships are placed into an economic context, the relative scarcity or abundance of water resources can be better evaluated for each source and each use in Idaho. Such an understanding is desirable for policy makers.

This study proposes to construct and evaluate the production functions and associated cost data involved with making water available to users in Idaho on a statewide basis.

Table 1. Idaho's water resources.*

Source of water	Quantity, in acre-feet**
Groundwater	137,345,000
Stock (lakes, reservoirs, etc.)	18,350,000
Inflow from out-of-state (rivers)	29,951,000
Average annual water yield from precipitation	37,581,000
Total	223,227,000

* Source: Water Resources Research Institute. 1968. Idaho Water Resources Inventory. University of Idaho, Moscow.

** One acre foot equals 325,851 gallons of water.

Significance of Water Resources

In Idaho, water is especially important to agriculture. Approximately 6 million acres of cropland are in the state — of which 3.8 million acres (6.3 per-

Table 2. Estimated water use in Idaho, 1970.*

Use	Water withdrawn	Water consumed
	(acre-feet)	
Water used for public supplies	124,320	32,483
Water used for self-supplied industry	504,050	17,922
Water used for irrigation	16,916,491	5,264,526
Total	17,544,861	5,314,931

* Source: C.R. Murray and E. Bodette Reeves. 1971. Estimated Use of Water in the United States in 1970, Geological Survey Circular No. 676. Washington, D.C. U.S. Government Printing Office.

cent) are irrigated (5). In 1973, irrigated crops accounted for 50 percent of Idaho's $658,928,000 earned from marketing crops (4). While agriculture used 16.9 million acre-feet of water in 1970, industry required 504,050 acre-feet, and municipalities needed 124,320 acre-feet (9).

Physical availability of water has been the focus of most previous research in Idaho. The *Idaho Water Resources Inventory* (16) and the *Interim State Water Plan* (5) summarize the physical availability of water in Idaho and predicted future water requirements. Kimball (6), Lindeborg (7), and Schatz (10) examined costs of making water available for agricultural use in specific areas in Idaho, but no attempt has been made to summarize the aggregate economic water supply situation as it exists for the entire state.

Idaho has a large quantity of water potentially available for use. In addition, precipitation annually renews part of this supply. In Northern Idaho, however, where the greatest quantities of water are available, physical and economic limitations preclude widespread use. In Southern Idaho, surface water is almost entirely claimed, limiting the water available for future or alternative use. For these reasons, water supply problems and associated costs are expected to vary considerably by area.

Idaho is primarily an agrarian state and probably will remain so into the foreseeable future, so water needs for irrigation will continue to be far greater than the needs for industrial and municipal uses. Recent predictions are that by the year 2070, water suppliers will need to make 29.6 million acre-feet of water available for use in Idaho (5). While this increase would only be 13 percent of Idaho's total water resources, it amounts to 79 percent of annual precipitation received (Idaho's total annual flow resource).

What about the economic availability of water resources? Increasing water needs will bring about pressure for additional water development projects. Consequently, placing the cost-quantity relationships of making water available for use into an economic framework may help relate economic realities to the potential availability and the most efficient allocation of water resources.

Writing in the *Southern Economic Journal* (8), J. M. Milliman commented that "because basic economic analysis has not been used in dealing with water, current pricing and administrative policies are inconsistent with economic realities and perhaps in direct conflict with efficient allocation of water resources". While this statement was not addressed specifically to Idaho's situation, it points out the need for looking at water resources from an overall economic point of view.

Objectives of This Study

1. To summarize the stock and flow water resources in Idaho.
2. To determine cost functions for supplying water by use: municipal, irrigation, and industrial.
3. To estimate appropriate supply curves.
4. To evaluate the elasticities of aggregate supply.

The concept of elasticity is important for this study, and for public policy, because it measures the ability of water suppliers to adjust production to changing economic conditions (12). Economically, elasticity refers to the percentage increase in the supply of water induced by each percentage increase in competitive price.

Water Supply Costs

Creating an economic supply of water has certain cost requirements peculiar to making water available for irrigation, industrial, and municipal water users. Supply refers to the amount of a good — water in this study — which can be made available for use at various costs. The supply curve is a functional relationship between those quantities which are economically feasible to produce and the inputs required to make the water available. For this study, supply curves are developed under market conditions which are assumed to be perfectly competitive. This assumption simply serves as a base on which to develop supply functions.

The study also assumes there are no external effects on marginal cost curves for water suppliers. Usually, water supplied by one firm imposes no appreciable external pecuniary diseconomies on other firms supplying water. If this is true, the supply curve then is that portion of the marginal cost curve equal to or lying above the average variable cost curve for both the single supplier and the entire water industry.

Irrigation

Approximately 14 percent of Idaho's total irrigation water originates from ground water sources, with the other 86 percent from surface sources. The federal government, through the Bureau of Reclamation, is the principal surface water supplier, accounting for 72 percent or 10.8 million acre-feet of the total surface water supplied (14). The remainder of the total irrigation water is supplied by private irrigation districts or individuals.

The early days of irrigation in Idaho were successful primarily through the efforts of homesteaders irrigating small tracts of land. To meet increasing demand for irrigation water, existing irrigation facilities were expanded and new projects initiated. Irrigation water suppliers needed financial assistance and aid from state and federal agencies to meet large capital requirements for increasing the quantity of water that could be used. Consequently, while individual water suppliers are probably closer to surface water resources, meaning that less cost is involved in making water available for use, government-assisted large reclamation projects tended to reduce this cost difference through economies of scale from large projects.

The doctrine of appropriation, subscribed to by western states, stipulates that water rights are acquired by using the water (3). Consequently, in order for individuals with land further from surface sources than the early homesteaders to acquire effective water rights, storage facilities and canals were needed to capture and transport water from its source to where it could be used.

As opposed to the tremendous capital requirements involved for making surface water available for use, $72 million initial investment for the Boise Project alone (14), capital requirements for groundwater may be quite small. Kimball (6) found, in the areas of Idaho he studied, that the largest amount of money expended for making groundwater available for use, for a single farm, was $19,300. However, the life expectancy for the Bureau of Reclamation projects is 100 years (15) while the life expectancy for a well drilled for groundwater is 20 years (2). Thus, the comparison of federally funded projects in Idaho versus smaller private projects is a case of heavy initial cost versus relatively heavy continuing costs. The more efficient supplier of water should be determined by the long run per unit cost.

Bureau of Reclamation projects provide water to a larger area than do groundwater projects for individual farms. The Boise Project supplied water for 342,528 acres (14: p. 240), or $210 per acre. Without converting figures to present value, the expenditures Kimball noted, over a hundred-year span, total to $96,500 (5 x $19,300), or $301 per acre ($96,500 /320 acres). Thus, economies of scale appear to favor large irrigation projects.

The initial investment for the Minidoka Project was approximately $37 million. Of this total, $25 million or 68 percent was associated with canals and other distribution outlays. Although groundwater suppliers do not incur this large capital expenditure for distribution facilities, because wells are dug where water is available, groundwater is not uniformly available throughout the state.

Municipal

The total cost of public water systems in Idaho can be divided into two main elements:

1. Costs incurred in transmitting water from its origin to a central distribution facility (facilities).
2. Costs incurred in distributing the water to users.

The following features are typical of most public water systems in Idaho: source of water is normally groundwater; pumps and storage areas are associated with the collection of the water; a distribution system is included; and equipment includes some items incidental to transmission, collection, and distribution — such as valves and meters used to measure and control the flow of water from its source to its place of use (3).

Most cities in Idaho incur little cost for transmission of water from its source to a central pumping facility since groundwater is a primary source. Consequently, most expenses are for distribution systems. In cities where the terrain is level enough, all water is distributed by gravity flow. In such cases, elevated structures are sufficient to maintain pressure and equal flows throughout the system. In cities with a marked elevation difference, pumping stations are required to maintain pressure and equalize rates of flow.

Although water loss through seepage and evapotranspiration is not as excessive as in irrigation, municipalities are subject to similar problems. Water losses in municipal distribution systems are estimated at approximately 12 percent of total water delivered (3) and are often difficult to detect.

Water requirements for municipalities, like irrigation, are highly seasonal. Swimming pools, lawns, and air conditioners all need water during the summer months, and municipal water suppliers often incur high marginal costs to meet these peak demands (3). Municipalities also attempt to maintain on hand at all times a certain minimum amount of water for fire protection. Consequently, water production, treatment, and distribution systems are built to produce larger quantities of water than are normally used. Besides meeting domestic requirements, municipalities make available over 2 billion gallons of water for industrial use in Idaho.

Self-Supplied Industrial Water

One of the primary differences between municipal and irrigation water suppliers compared to industrial water suppliers is that water provided for industrial use is normally recycled several times before being discharged. However, the largest industrial water user in Idaho, fresh and frozen fish production, does not recycle water. Recycling of water for fish production is physically possible but not now necessary because the supply is ample (5). For the entire state, the estimated re-use factor for water is 3.0, somewhat less than the re-use factor of 3.43 for other mountain area states (5).

Collection and Interpretation of Study Data

Data Collection

Irrigation

To collect data from 37 irrigation districts in Idaho, three sources of information were used: personal interviews, financial statements published in newspapers, and information published by the Bureau of Reclamation. Although only 55 percent of the 37 irrigation districts were contacted, these suppliers accounted for 76 percent of the total water supplied in Idaho for irrigation. Data were collected on an annual basis for the year 1970.

A feature common to all three categories of water suppliers is the seasonal variation in water withdrawals. For example, in Idaho's dehydrated food product industry, water withdrawals were eight times greater in July than in April (17).

Groundwater is the primary source of water for both industrial and municipal water suppliers, supplying 76 and 87 percent of total water, respectively (9). Consequently, costs incurred by industrial water suppliers were expected to be similar to those encountered by municipalities. Any additional costs could be expected in meeting more stringent water quality standards required for some industries. The last expectation is not unrealistic in that for "many industrial users, the quality of water . . . is of utmost importance" (9). Federal standards for drinking water are not strict enough for some commercial purposes. For example, in the canning industry, water quality standards must meet federal drinking water standards, yet have less iron and manganese than the federal standards permit (3).

Operation and maintenance cost records maintained by the irrigation districts were all excellent. The primary guide used for determing variable cost items which were unique to irrigation districts was Brockway and Reese (1).

The cost of plant, property, and equipment (fixed costs) for the districts was based on original expenditures for the items, not on replacement costs. Needless to say, replacement costs at current prices would be considerably higher. In addition to the cost of plant, property, and equipment, repayment contracts in dams or reservoirs and storage in the facilities were included as fixed costs. Information from eight irrigation districts contacted showed fixed cost data were not as complete as information on variable costs. As a result, fixed costs for these districts under the Boise Project Board of Control were determined by multiplying the total cost of the project by the percentage of water distributed to the districts to obtain an approximation of total fixed costs for the districts. Certain items such as vehicles and office space were not included for these districts because of insufficient information. Therefore, the total fixed costs of these districts are probably biased downward.

Municipalities

Of the 30 municipalities selected to form the data base for the cost of supplying water for this group of water suppliers, 27 provided sufficient information, including 6 cities with populations under 1,000. These 27 municipalities supply 70 percent of all water supplied by municipalities in Idaho. City engineers in 13 municipalities were personally interviewed; information from the remaining 14 was a combination of responses to questionnaires and budget information published in newspapers.

Records for operation and maintenance were excellent. However, information concerning fixed costs was almost non-existent. Consequently, to arrive at fixed cost information, the city representatives were asked to list water investments in physical terms, such as amounts of pipe in place for water distribution, number of wells, number of treatment plants, etc. The physical quantities of these items were then multiplied by 1970 replacement costs taken from *Engineering News-Record* (13) to arrive at estimated total investment costs. These costs, as opposed to irrigation districts, were replacement costs, not original installation costs. Like irrigation districts, though, the figures are probably biased downward because office space, vehicles, etc., were not included in fixed costs.

Industries

Some difficulty was encountered in collecting data from industries supplying their own water. Of the 22 industries contacted, 8 companies chose not to participate and 4 companies purchased their water from cities. The 10 providing information account for 35 percent of the total water produced by self-supplied industries in Idaho. The number of observations was too small for statistical regression analysis.

Not included in the study was the fresh and frozen fish industry which accounts for 48 percent of the 504,450 acre-feet of water supplied by industries. However, costs for this water are extremely small because the fresh and frozen fish industry uses natural flows as the source of water. Their capital outlay amounted to only $1 per 3,000 acre-feet of water used; no operating and maintenance costs were incurred (17).

Data Organization and Analyses

Water quantities, measured in acre-feet, (325,851 gallons) were considered as output. Total cost information was separated into fixed and variable costs and was analyzed for each of the categories' municipalities, irrigation suppliers, and industries. Data from the three categories were aggregated to examine the total supply and cost functions for all water suppliers. The data were analyzed using the simple linear regression program of the statistical analysis system (11).

Results of Regression Analysis

Three regression models were applied to the municipal, irrigation, and aggregate water cost data. The three models were:

$Y_i = A + BX$	linear model
$Y_i = A + BX + CX^2$	quadratic model
$Y_i = AX^B$	log linear model

Where Y_i ($i = 1,2,3$) are total, fixed, and variable costs, respectively, and X is output measured in acre-feet. Statistical estimates were made of the parameters involved using regression analysis.

Municipalities

Regression analysis was applied to data obtained from 27 municipalities.The results of the analysis follow:

Total Cost. The model $Y_1 = A + BX$ was applied to the 27 observations of this category. An R^2 (coefficient of determination) of 0.68 was obtained; the t value for the B coefficient was highly significant. However, the t value for the A was insignificant (-0.05). The regression lines and observed data are graphed in Fig. 1.

The quadratic model $Y_1 = A + BX + CX^2$ yielded a negligible improvement in the R^2 (0.68). Neither the intercept nor the C coefficient was significant but the B coefficient was. Setting the first derivative of the regression model $Y_1 = -112{,}587.43 + 525.5X - 0.005X^2$ equal to zero and solving for X, the inflection point was 52,550 acre-feet, far beyond the range of data. The second derivative is minus: $d^2y/dx^2 = -0.01$. Consequently because $f'(X) > 0$ and $f''(X) < 0$, the slope of the total cost curve is positive but decreasing — the value of the function is increasing but at a decreasing rate. Theoretically, with a total cost

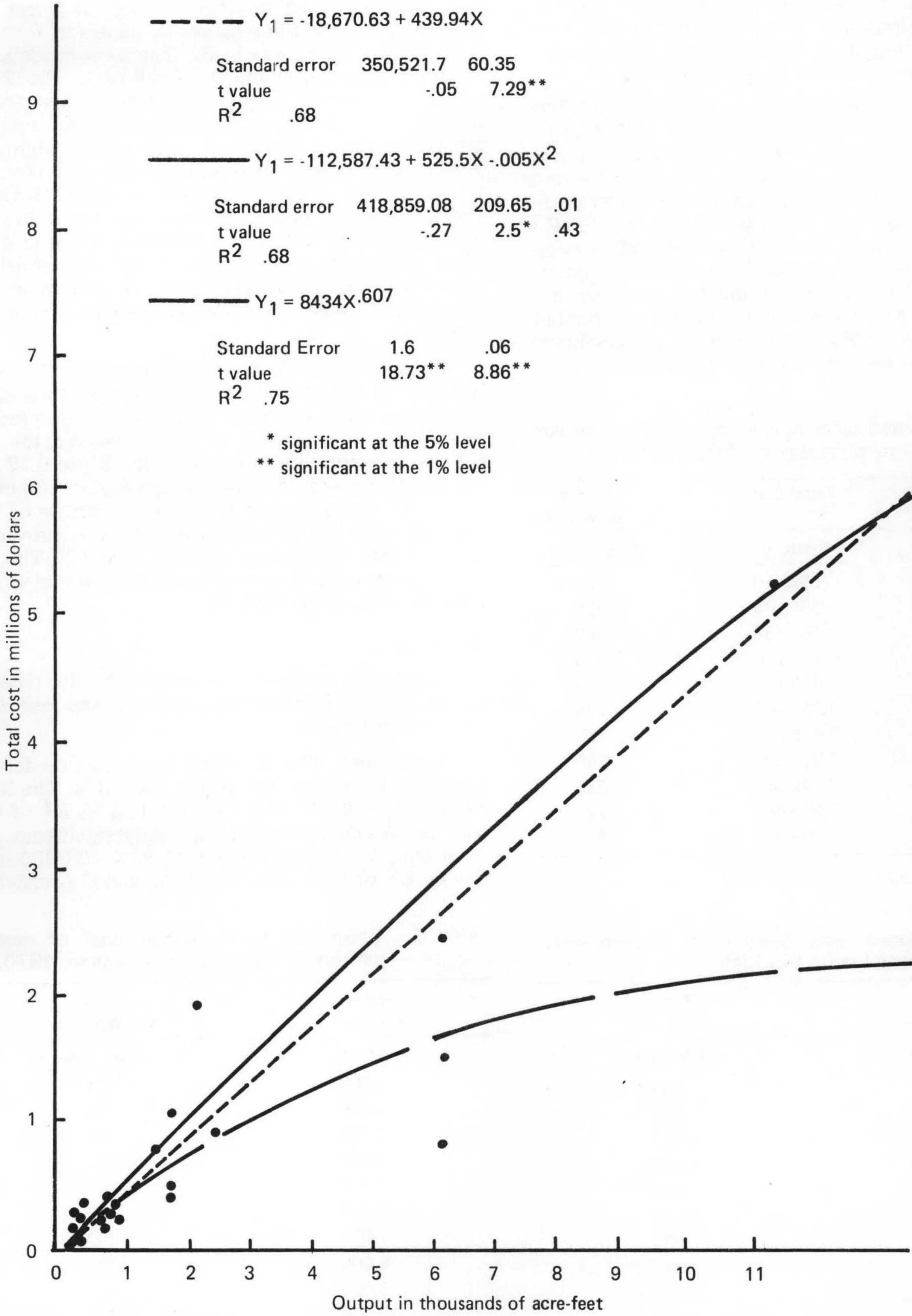

Fig. 1. Total cost regression analysis for cities: Idaho, 1970.

function, both the first and second derivatives of the function should be positive, indicating the slope is positive and increasing — the value of the total cost function increasing at an increasing rate. The observed data and regression lines are plotted in Fig. 1.

A logarithmic transformation improved the R^2 to 0.76. Since the model $Y_1 = AX^B$ was judged to fit the data better than the other two models, it was used to estimate total costs to supply water for municipalities. Both parameters were found to be significant at the one percent level (see Fig. 1), and the R^2 increased from .68 to .75 for this model when compared to the first two models. Table 3 shows estimated total costs for producing water for municipal use in Idaho. Because a log linear model was accepted as the best estimate of total cost for cities, marginal cost is decreasing and no fixed costs are estimated.

Table 3. Estimated total cost of supplying water for municipal purposes in Idaho, 1970.*

Water supplied	Total cost	Average total cost
(acre-feet)	(dollars)	($/acre-foot)
1,000	558,498	558
2,000	850,642	425
3,000	1,088,014	362
4,000	1,295,604	323
5,000	1,483,531	296
6,000	1,657,142	276
7,000	1,819,686	259
8,000	1,973,321	246
9,000	2,119,567	235
10,000	2,259,550	225
11,000	2,394,128	217

*Using the regression model: $Y_1 = 8{,}434X^{.607}$

Table 4. Estimated total fixed costs (investments) for municipalities in Idaho.*

Water supplied	Total fixed cost
(acre-feet)	(1,000 dollars)
1,000	326
2,000	715
3,000	1,103
4,000	1,493
5,000	1,881
6,000	2,270
7,000	2,659
8,000	3,047
9,000	3,436
10,000	3,825
11,000	4,213

*$Y = -62{,}087.34 + 388.68X$

Total Fixed Cost. Because fixed costs were not significantly related to output using the linear total cost model (note the negative A value for $Y_1 = A + BX$), further study was made. The same models were used for analyzing municipal fixed costs. Fig. 2 contains the observed data and regression lines for the models. Note that the linear and quadratic functions are co-located on the graph. Although a large graph would show a small difference between these functions, the high degree of linearity is apparent. Due to the linearity of both functions, the linear function $Y_2 = -62{,}807 + 388X$ was accepted as the best estimate of fixed cost for cities. From this model, approximate capital requirements for making various quantities of water available for use can be estimated (Table 4).

Total Variable Cost. The linear model, $Y_3 = A + BX$, had an R^2 of 0.50. The t value for B was significant, but the t value for A was not. The quadratic model improved the R^2 to 0.56; however, the logarithmic transformation increased the R^2 to 0.77 with the A and B coefficients highly significant. The model $Y = AX^B$ was accepted as the best estimate of total variable costs for cities because of the improved R^2 and the high significance of both A and B. The data and regression lines are in Fig. 3 and estimated total variable costs are in Table 5.

Irrigation

Regression analysis was applied to the data obtained from 37 irrigation districts. The results of the analysis follow:

Total Cost. The first two regression models for irrigation total cost had rather high R^2s. The linear model, $Y_1 = 2{,}618{,}211 + 6.31X$, had an R^2 of 0.75 with the A and B coefficients highly significant. The quadratic, $Y_1 = 1{,}625{,}528 + 11.96X - 0.000001X^2$, had an R^2 of 0.81 with the A, B, and C coefficients

Table 5. Estimated total variable cost of municipalities to supply water in Idaho, 1970.*

Water supplied	Total variable cost
(acre-feet)	(1,000 dollars)
1,000	64
2,000	116
3,000	165
4,000	211
5,000	257
6,000	300
7,000	343
8,000	385
9,000	427
10,000	467
11,000	507

* Using $Y_3 = 162X^{.865}$

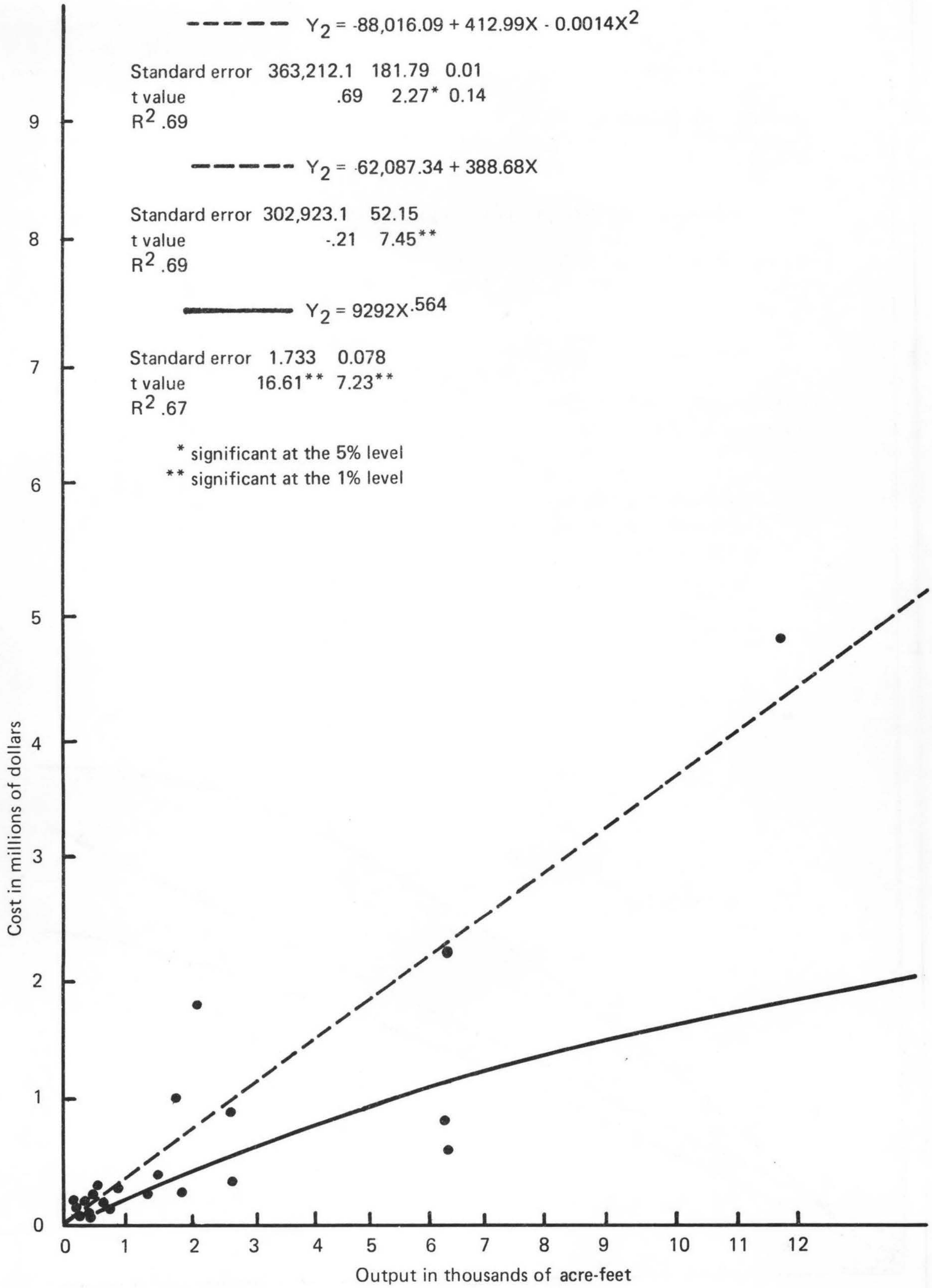

Fig. 2. Total fixed cost regression analysis for cities in Idaho, 1970.

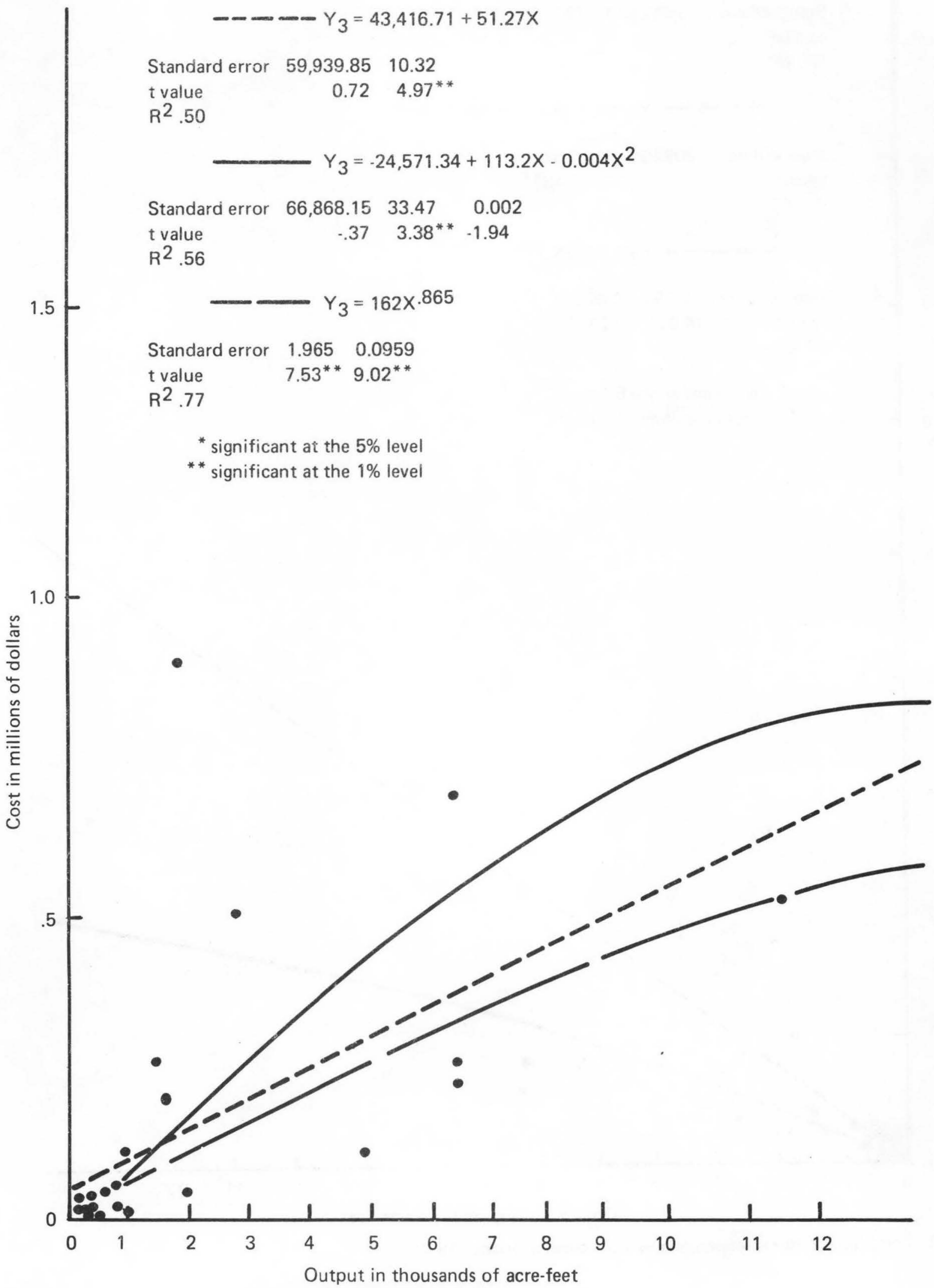

Fig. 3. Total variable cost regression analysis for cities in Idaho, 1970.

all highly significant. The logarithmic transformation resulted in the lowest R^2, 0.73, with both A and B coefficients highly significant. The quadratic model was accepted as the best estimate of total cost for irrigation districts. The data and regression lines are in Fig. 4 and estimates in Table 6.

The quadratic cost functions are similar to those for the cities. The second coefficient is positive for the quadratic cost function for irrigation, and the third is negative, indicating the slope of the total cost function is positive but decreasing. With an inflection point of 4,983,333 acre-feet, the function is highly linear throughout the observed data. Under this situation, the marginal cost curve lies below the average variable cost curve.

Total Fixed Cost. Of the three regression models used for total fixed cost for irrigation districts, the quadratic model, $Y_2 = 1{,}545{,}448.67 + 11.48X - 0.000001X^2$, yielded the highest R^2, 0.81. The A coefficient was significant; the B and C coefficients were highly significant. The second highest R^2, 0.76, was in the linear model, $Y_2 = 2{,}487{,}165.96 + 6.13X$. Both the A and B coefficients were highly significant. An R^2 of 0.73 resulted from the logarithmic transformation. The quadratic model was selected as giving the best estimates of total fixed cost for irrigation water suppliers. The regression lines and observed data for total fixed cost for irrigation suppliers are in Fig. 5. The estimated total fixed costs are in Table 7.

Total Variable Cost. The linear regression estimate of total variable cost for irrigation was $Y_3 = 131{,}045.11 + 0.19X$ with both A and B coefficients highly significant. The quadratic model, $Y_3 = 80{,}079.54X + 0.48X - 0.00000006X^2$, with all three coefficients highly significant, improved the R^2 to 0.68. The best estimate of total variable cost for irrigation was the logarithmic transformation. In the model, $Y_3 = AX^B$, the R^2 was 0.74 and A and B were highly significant. This model was chosen as giving the best estimate of total variable cost for irrigation. The observed data and regression lines are shown in Fig. 6. Regression estimates of total variable costs are presented in Table 8.

Table 6. Estimated total cost for 37 irrigation districts in Idaho, 1970.*

Water supplied	Total cost
(100,000 acre-feet)	(dollars)
1	2,811,528.20
2	3,977,528.20
3	5,123,528.20
4	6,294,528.20
5	7,355,528.20

* $Y_1 = 1{,}625{,}528.2 + 11.96X - .000001X^2$

Combined Results

The data for irrigation and municipal water suppliers were aggregated and analyzed to gain a total concept of Idaho's water industry.

Total Cost. The linear regression model of total cost for Idaho's water industry resulted in the estimate, $Y_1 = 2{,}025{,}135.09 + 6.57X$, and R^2 of 0.69, and the A and B coefficients highly significant. A logarithmic transformation improved the R^2 to 0.73 with both coefficients highly significant. The quadratic model, $Y_1 = 1{,}445{,}062.34 + 12.41X - 0.000001X^2$, was accepted as the best estimate of total cost because of the highest R^2, 0.74. All of the coefficients for the quadratic model were highly significant. The inflection point was 6.2 million acre-feet, far in excess of the range of observed data. Fig. 7 depicts the regression lines and observed data. Because average variable cost exceeded marginal cost, the cost function was determined to be in State I, which is an irrational area of production for private enterprise. These results indicate economies of scale exist for water supply, in Idaho, and that private enterprise would not be expected to provide this water supply.

Table 7. Estimated total fixed cost, 37 irrigation districts, Idaho, 1970.*

Water supplied	Total fixed cost
(acre-feet)	($ millions)
100,000	2.683
200,000	3.801
300,000	4.899
400,000	5.977
500,000	7.035

* $Y = 1{,}545{,}448.87 + 11.48X - .000001X^2$

Table 8. Estimated total variable cost, 37 irrigation districts, Idaho, 1970.*

Water supplied	Total variable cost
(acre-feet)	(1,000 dollars)
100,000	$111.8
200,000	$173.8
300,000	$225.0
400,000	$270.3
500,000	$311.6

*Using $Y = 73X^{.637}$

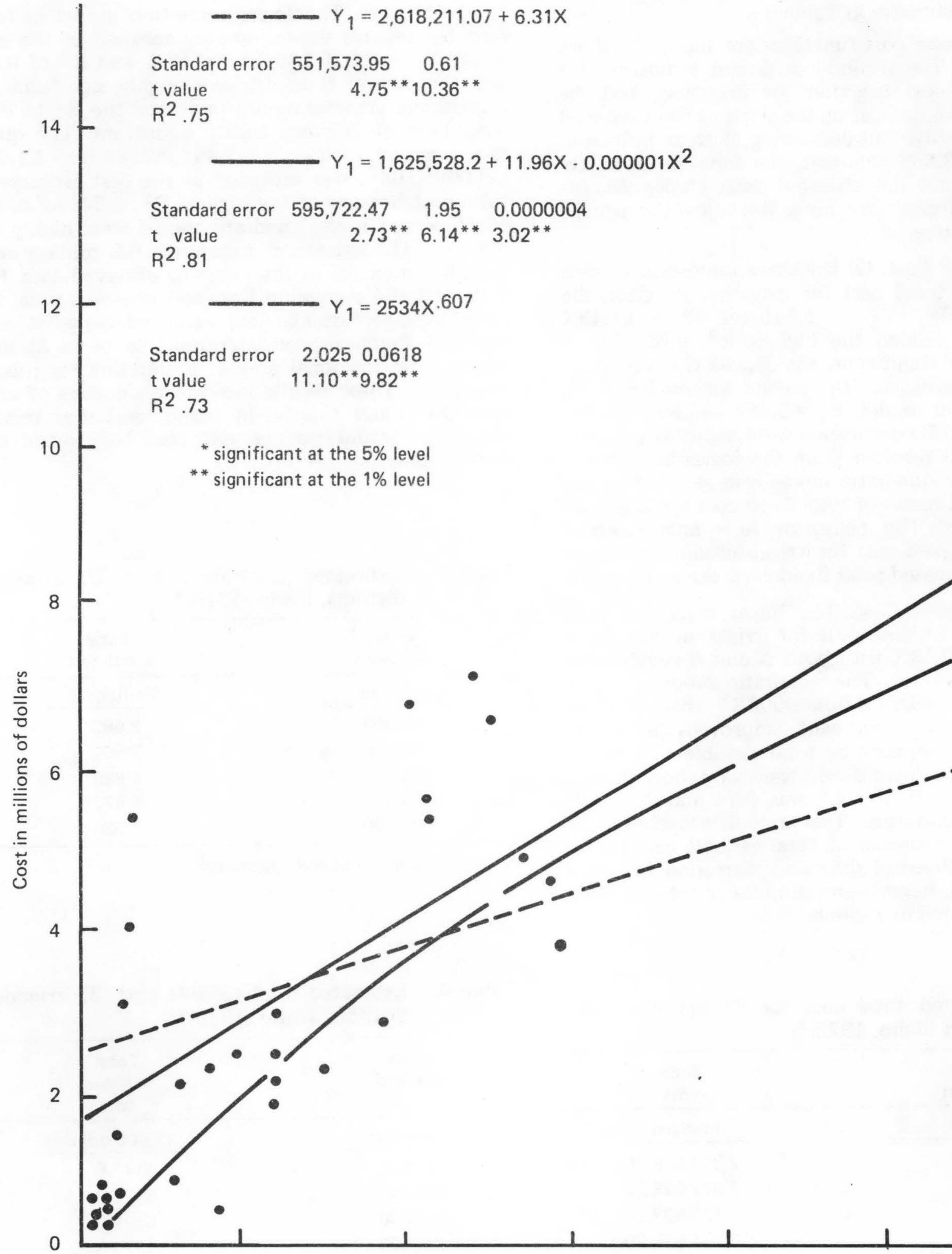

Fig. 4. Total cost regression analysis for irrigation in Idaho, 1970.

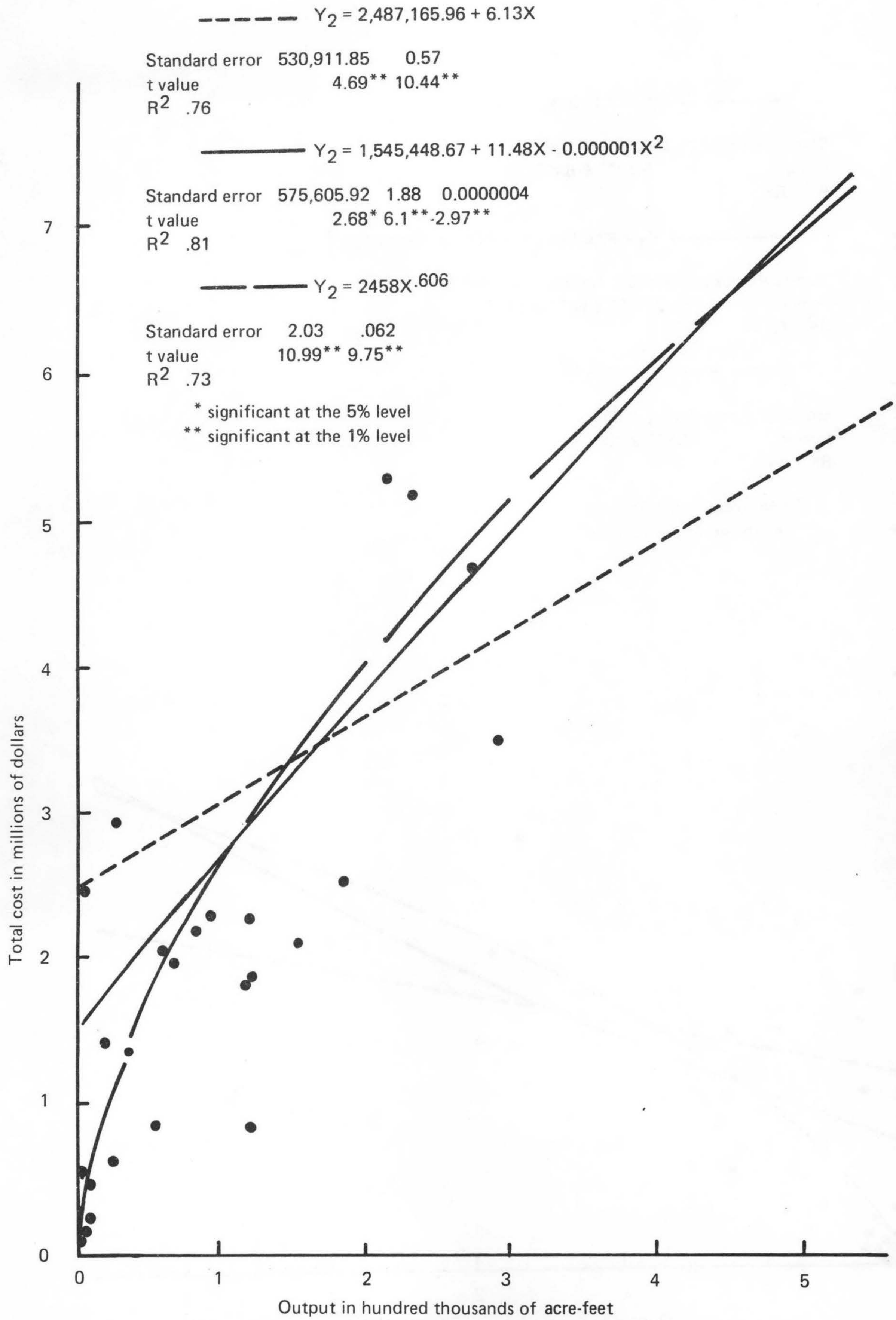

Fig. 5. Total fixed cost regression analysis, irrigation water in Idaho, 1970.

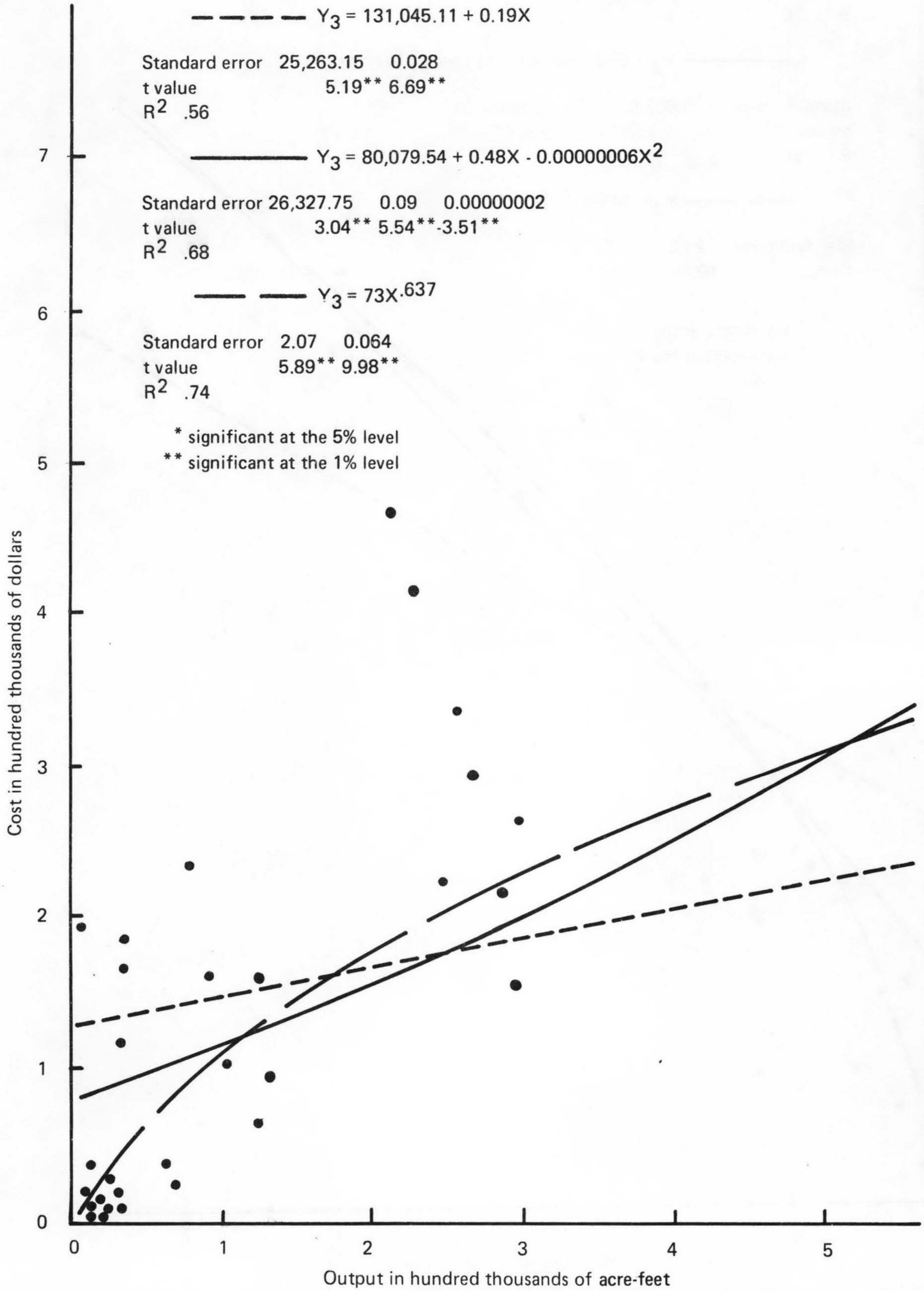

Fig. 6. Total variable cost regression analysis for irrigation in Idaho, 1970.

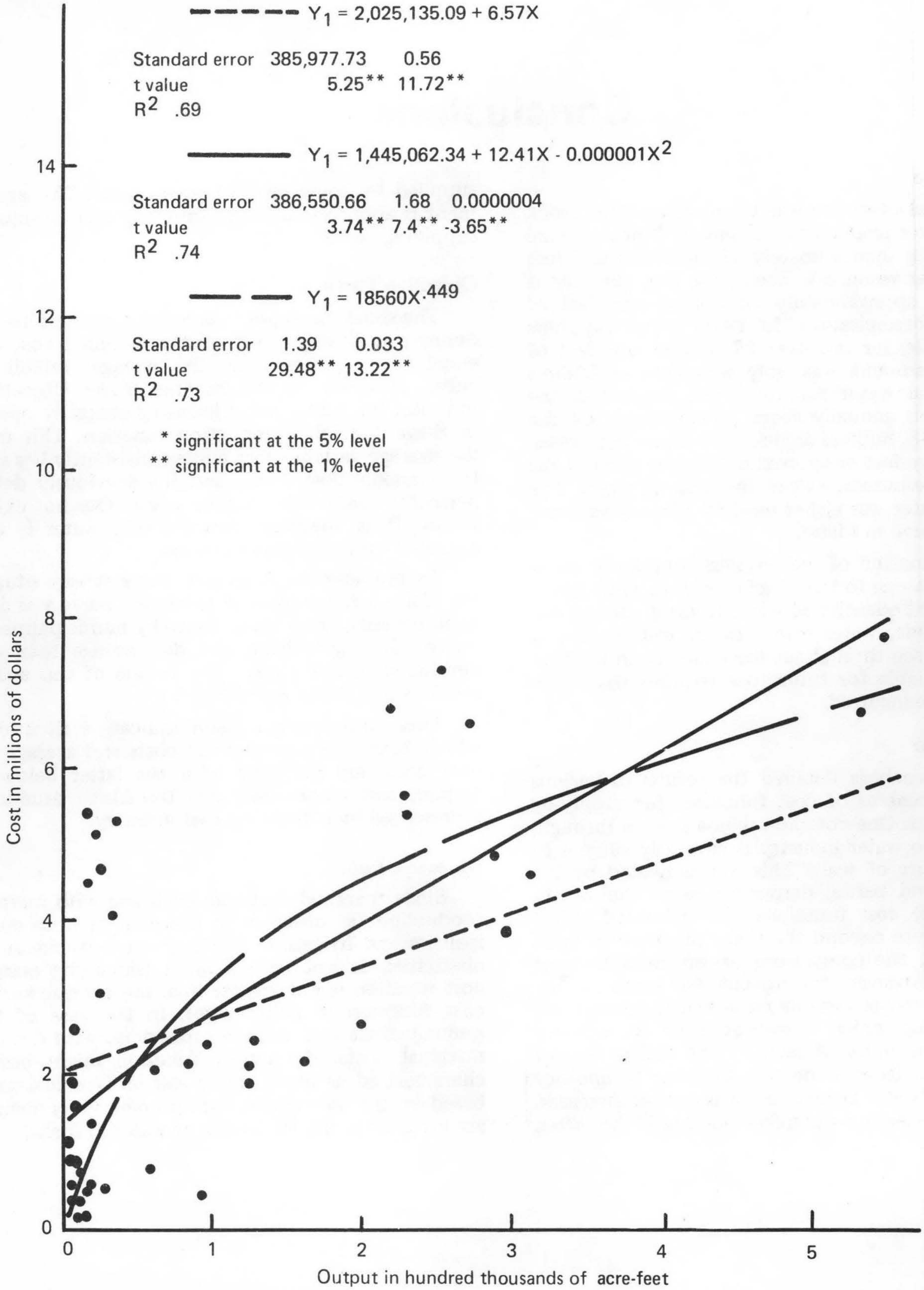

Fig. 7. Total cost regression analysis, water in Idaho, 1970.

Conclusions

Objective One

The initial objective was to summarize the stock and flow water resources of the state. Findings were that Idaho has approximately 185,640,000 acre-feet of total water resources. Each year this quantity is renewed by approximately 38 million acre-feet of water from precipitation. In 1970, water suppliers made available for use over 17 million acre-feet of water. This amount was only 8 percent of Idaho's potential total water resources, but nearly half the water received annually from precipitation. Of the remaining 168 million acre-feet of water resources, 72 million acre-feet or approximately one-third of the total water resources, exited the state in rivers. The remaining water was either used by plants, evaporated, or was stored in Idaho.

An examination of the physical supplies of water in Idaho leads one to the conclusion that while Idaho has a sufficient quantity of water to meet current and predicted needs, water resources are not present at the proper place throughout the state. To insure that water is available for future use requires that additional costs be incurred.

Objective Two

Previous analysis detailed the results of various regression estimates of cost functions for supplying water in Idaho. One common theme existed throughout: the Idaho water industry is currently subject to large economies of scale. This was indicated by the negative second partial derivatives in all the significant quadratic cost functions. All estimated inflection points were beyond the range of observed data. Consequently, the conclusions drawn are somewhat speculative. However, throughout the range of observed data, average variable costs and marginal costs were decreasing which is indicative of an industry subject to economies of scale — one still in Stage I of production. Results indicate that the technology for supplying water reduces costs as output increases. At present, water is a quasi-free good in Idaho, often supplied by some level of government. This arrangement is appropriate considering the cost structure of supplying water.

Objective Three

The short run supply curve for a product has been defined as that portion of the marginal cost curve equal to or greater than the average variable cost curve. However, as the findings under Objective 2 indicate, the Idaho water industry generally operates in Stage I of the production function. This means the average variable cost curve consistently lies above the marginal cost curve, and the previously defined perfectly competitive supply curve does not exist in Idaho. It is apparent, though, that water is made available for use at various prices.

To evaluate the aggregate water supply situation for Idaho a rough average total cost curve was developed utilizing gross water usage by municipalities, industry, and agriculture and the average total costs developed in this study. The results of this analysis are shown in Table 9 and Fig. 8.

These observations again indicate a situation in which both the average total costs and average variable costs are declining with the latter below the former, and emphasized that the Idaho situation is represented by a declining cost industry.

Objective Four

Since marginal costs are declining with increased production (as observed in the case of both municipalities and irrigation districts) conventional supply elasticities cannot be evaluated (since the marginal cost function is not greater than the average variable cost function in either case). In the case of both municipalities and irrigation districts, with declining marginal costs, the supply function might best be characterized as being highly elastic. Conclusions are based on the assumption that no monopoly elements are involved in the marketing of water in Idaho.

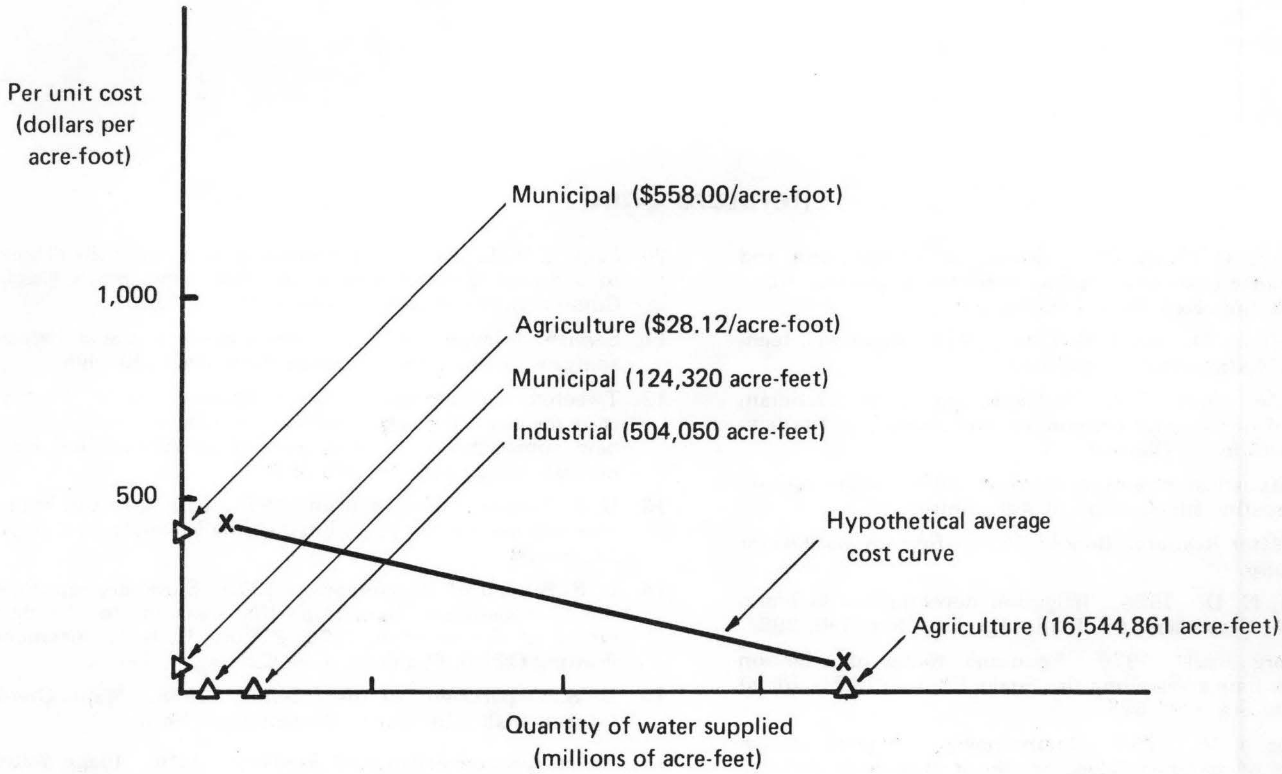

Fig. 8. Hypothetical average total cost curve for water supply in Idaho, 1970.

Table 9. Per unit cost for making various quantities of water available for use in Idaho, 1970.

Quantity (acre-feet)	Average total cost	Average variable cost
	(dollars)	(dollars/acre-foot)
	Municipalities	
1,000	558	–
5,000	296	231.25
10,000	225	155.20
	Irrigation Districts	
1,000	1,637	11.96
5,000	337	11.95
10,000	174	11.95
15,000	120	11.94
20,000	93	11.94
50,000	44	11.90
100,000	28	11.84
500,000	15	11.36
1,000,000	12	10.76

Note: One unit equals one acre-foot.

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Dean, College of Agriculture
University of Idaho

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