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COST OF UNDERGROUND COAL MINING IN ILLINOIS

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Philip Robare

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CONTENTS

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ERRATUM

Page 6, number 2: *for* Every 100 ton increase *read* Every 10 ton increase

COST OF UNDERGROUND COAL MINING IN ILLINOIS

INTRODUCTION

Economic data on the coal industry is limited to annual production, sales, and coal prices. Not much is published about the cost of existing mine operations and about how various factors correlate to cost per ton of clean coal. The objective of this report is to use easily available data and parameters to develop information on the cost of underground mining in Illinois, and to use the information for mine comparisons as well as for regression analysis of the factors that significantly explain the variability in cost per ton.

The approach used in this investigation is similar to the engineering analysis approach used in the Electric Power Research Insitute's (EPRI) cost model for underground coal mines (1). This report, however, limits itself to existing mines only and does not use the broader mine-planning and financial-analysis approach emphasized in the EPRI model. Other models have been developed for the purpose of cost estimation in underground coal mines, most notably by the U.S. Bureau of Mines (2), using the same engineering-analysis approach. Basically, our model is not new. The value of our model lies in its application to existing mines. Illinois underground mines are suitable for this kind of investigation because of their large average production per year (more than 1 million tons per year compared to the national average of less than 200,000 tons per year). Furthermore, there were only 30 underground mines in 1980 and all could be included in the investigation, which obviated the task of selecting representative mines. Thus, the conclusions drawn from their analysis are statistically valid for the purpose of assessing costs of future underground mines. Availability and reliability of data do not pose significant problems in Illinois as all data are taken from reports filed with the Illinois Department of Mines and Minerals.

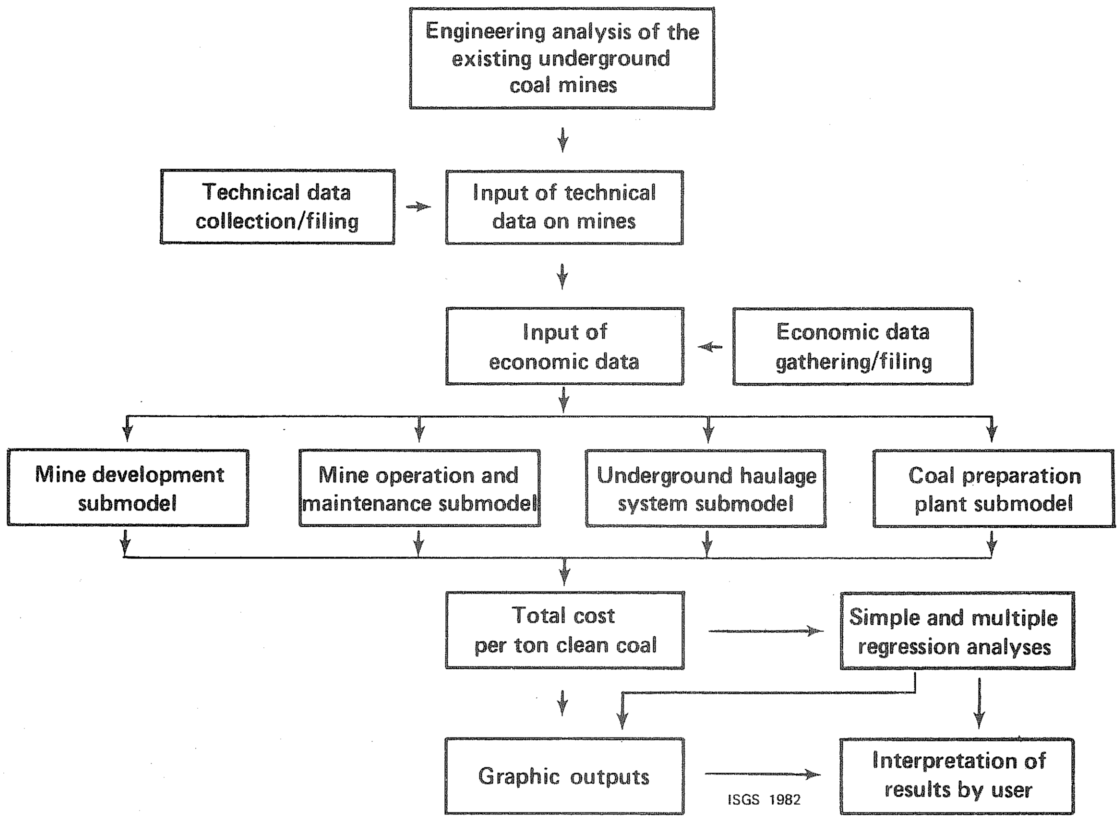

Figure 1. Schematic of the model for calculation of cost of mining coal by underground methods.

THE MODEL

Engineering analysis (fig. 1) involves categorization of mines by the type of mine opening, the mining technology used, and the determination of mathematical cost functions for each (Appendix A). Three types of mine openings occur in Illinois–shaft, slope, and drift. In 1980, seven of a total 30 mines had both a shaft and a slope. Five mines employed longwall technology, whereas 25 worked conventionally, using room-and-pillar technology.

Technical data include seam depth and thickness, numbers and types of equipment, number of labor and supervisory personnel, number of workdays per year and shifts per day, size of 1980 annual production, types of coal cleaning practiced, and mine age. The data are readily available from publications of the Illinois Department of Mines and Minerals (4) and the Keystone Coal Industry Manual (5).

Economic data were collected from various sources (1,2,3; and personal communications) and include costs of equipment (1980 dollar base), energy, shaft sinking, slope and drift construction, drift portal construction, labor, overhead, and royalties; investments in preparation plants (dollars per ton annual capacity); and the material consumption ratio (percent of operating costs). No distinctions were made between individual mines regarding the economic data.

Mathematical relationships established in the engineering analysis as well as the subsequent data collection were used to calculate the total cost per ton clean coal in four submodels on mine development, operation and maintenance, haulage, and coal preparation.

Regression analyses, simple and multiple, were performed with cost per ton clean coal as the dependent variable and the following as independent variables: mine development cost (dollars per ton annual capacity), depth, seam thickness, mine age, annual production, labor productivity (tons per worker-year), total investment in equipment, and the level of coal cleaning. Simple regression analyses were also performed to determine the relations of some independent variables.

LIMITING FACTORS

The analysis is based on results computed from 27 of the 30 underground coal mines operating in Illinois in 1980. Three mines were not included because of production problems. No distinction was made between conventional mines and those using longwall technology because of the small number of longwall mines, all operated by the same company under similar conditions of seam depth and thickness. The total number of longwalls in Illinois mines is too small to be investigated alone.

The areal expansion of a mine depends essentially upon its age, annual production, and seam thickness. Since the three factors vary considerably in Illinois, incorporating the variations in mine expanse into the model would involve additional data collection but not significantly add to the accuracy of the model. Therefore, a uniform pattern of main entries, cross cuts, and section-entry lengths was assumed for all mines. As a result, the cost calculations of the submodels on haulage and maintenance must show some inconsistencies. However, the overall effects of the inconsistencies are estimated to be minimal because mine expanse is inversely related to seam thickness, and the annual production of a mine is exponentially related to the increase in the field radius.

> *For example:* A mine with 500,000 tons per year production from a 5-foot seam expands at a rate of 56 acres per year, while a mine producing 3 million tons per year from a 7-foot seam expands at a rate of 238 acres per year. In the former case, the radius equals 300 yards as compared with 600 yards for the larger mine. Thus, although the production in the latter case is 6 times larger than the former, the mean transportation length is only 2 times the former length.

Geologic factors (roof and floor conditions, tectonic disturbances) and operational factors (implementation of health and safety regulations, differences in maintenance man-hours between mines) have not been explicitly built into the model. This simplification is not considered significant, however, because productivity (tons per worker-year) indirectly covers the omitted factors better than individual coverage of all the factors could.

It has been assumed that mining equipment is replaced after 10 years. This may not be true for some mines, thus resulting in some errors in estimating costs. Also, prices used are from the higher end of the price range for each type of equipment, contributing somewhat to cost overestimates. Moreover, a 100-percent debt financing is assumed instead of the 50-percent rate used by other models. Based on the volume of investments required, we expect total debt financing in the future.

DISCUSSION OF THE MODEL RESULTS

Cost per Ton of Clean Coal

The cost of underground coal mines and coal cleaning in Illinois ranged from $14.20 to $40.70 per ton of clean coal (fig. 2). The overall weighted average cost per ton of clean coal was $23.70. The estimated 1980 average value of coal mined by underground methods in Illinois was about $26.00 per ton.

The seven mines displaying costs less than $20.00 per ton of clean coal averaged 2 million tons annual production per mine, and a correspondingly high labor productivity of 3,600 tons per person per year. In comparison, the average of all Illinois underground coal mines for 1980 was 1.16 million tons production per mine and a labor productivity of 2,775 tons per person per year. Three out of five mines that did not clean their coal displayed costs less than $20.00 per ton, while the remaining two mines were close to the overall average costs of $23.70 per ton, indicating the importance of having coal reserves with low ash, low sulphur, and high Btu.

Of the seven mines with costs more than $30.00 per ton clean coal, one was shut down in 1981. Three other mines in this group had yet to reach their planned production in 1980 as they were relatively new mines. In the remaining three mines, a combination of thin seams, use of conventional cutters instead of modern continuous miners, and difficult roof conditions (observed by ISGS geologists), resulted in high costs per ton.

Cost per ton in mines using longwall technology did not differ significantly from the overall weighted average cost of all Illinois underground mines indicating that the mines may be successfully using the longwall technology in spite of encountering some difficult geologic roof conditions.

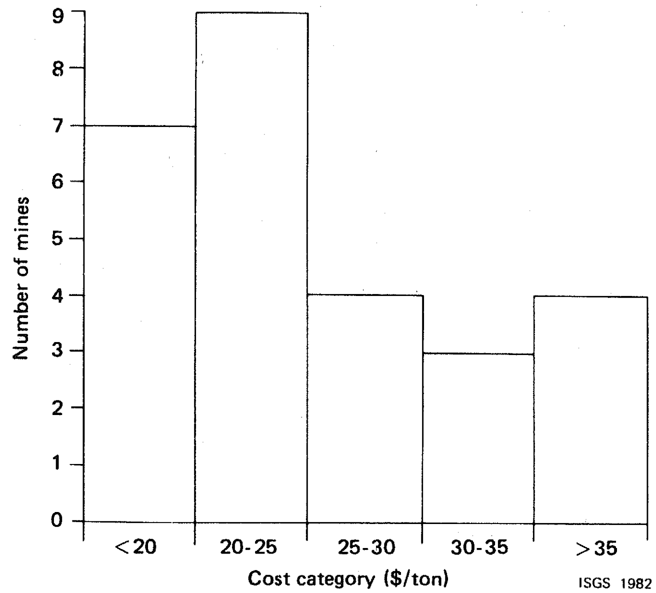

Figure 2.

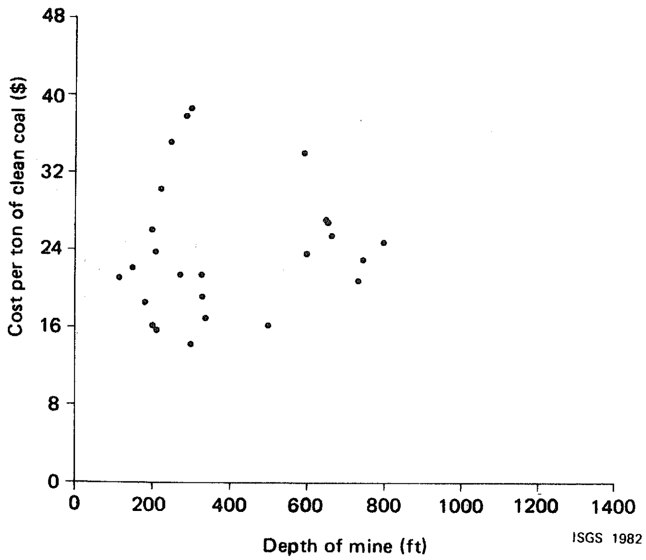

Figure 3.

Simple Regression Analyses

Simple regression analyses were performed, and an attempt was made to determine whether a statistical correlation exists between cost per ton clean coal (dependent variable) and the following independent variables:

- Depth (feet)
- Level of coal cleaning (0 through 4)
- Age of mine (years)
- Mine development cost (dollars per ton annual production)
- Annual production (tons per year)
- Labor productivity (tons per worker per year)
- Seam thickness (feet)

Depth of mines (fig. 3) seemed to have little effect on cost of coal production per ton. Although a trend line could be drawn to indicate rising cost per ton as depth increases, the confidence interval of the slope of the trend line at 90 percent confidence level included the zero value for the slope, indicating that no definite relationship between mine depth and cost per ton exists in Illinois.

As indicated in figures 4 and 5, level of coal cleaning and mine age indicate a positive and a negative correlation respectively with cost per ton, i.e., cost per ton increases with greater sophistication in coal cleaning and decreases with increasing age of mine. However, in both cases the confidence level in the slopes of the trend lines is low

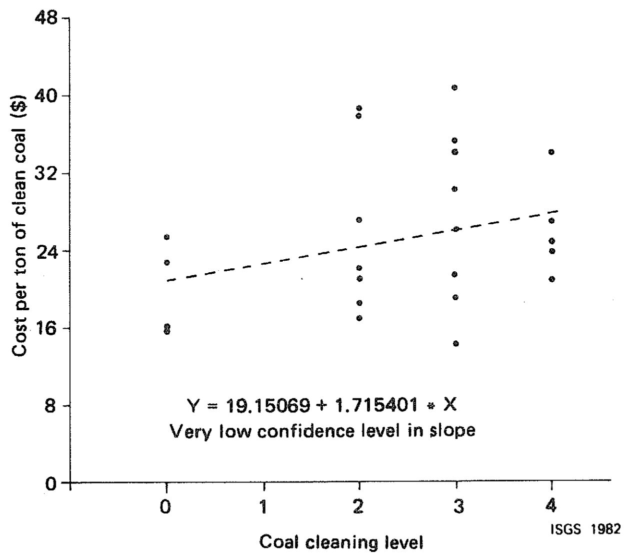

Figure 4.

because the lower ends of confidence intervals for the slope just about include the zero value. Nevertheless, the effects of more sophisticated coal-cleaning methods, as seen in figure 4, are confirmed by common experience.

The apparent contradiction in figure 5—the older the mine, the lower the cost—is explained by further regression analyses indicating that older mines tend to work thicker seams and also tend to be larger in terms of annual production. Combined with the effects of inflation, they lead to lower per ton mine development cost as well as lower overall costs per ton. Figure 6 indicates that initial mine development costs significantly affect overall costs per ton of clean coal. The mine development costs per tons of annual production are presented in 1980 dollars, which results in lower development costs per ton for older mines and helps explain the lower overall costs of older mines. On the average it is estimated that each additional dollar (per ton production capacity) spent on mine development may increase the per ton cost by nearly \$.40, with actual values ranging between \$.26 and \$.53 per ton. However, the correlation between mine age and mine size was found to be extremely weak, and the confidence level of the slope of the trendline representing the relationship between mine age and seam thickness was found to be low, as indicated by the broken trend line in figure 7.

Statistically reliable cost-lowering effects of larger mine sizes, greater labor productivity, and thicker coal seams

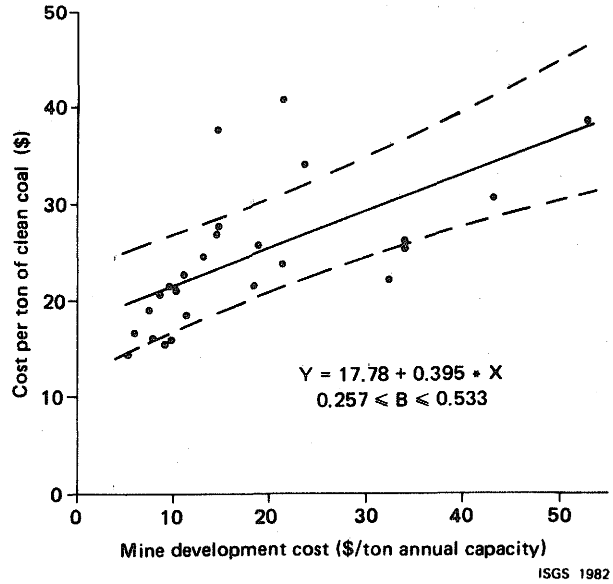

Figure 6.

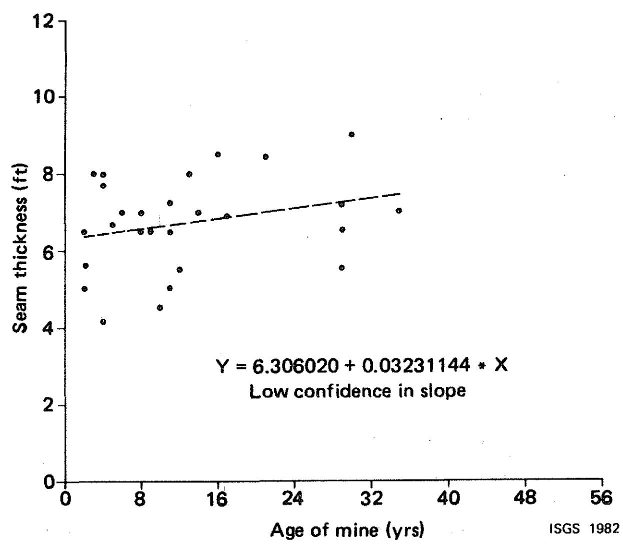

Figure 7.

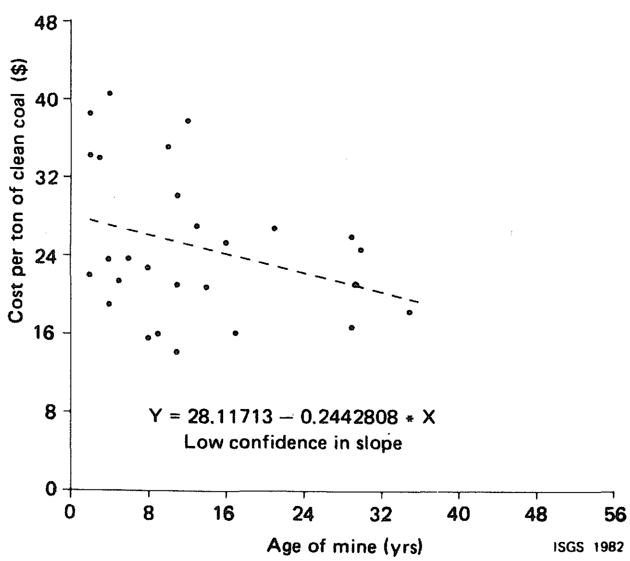

Figure 5.

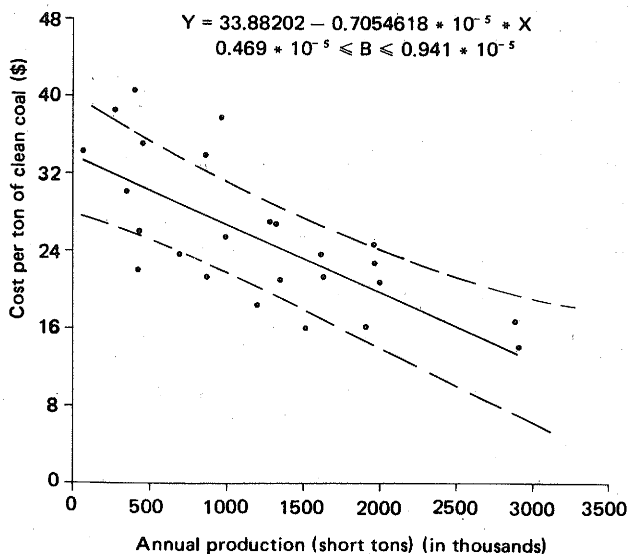

Figure 8.

are indicated in figures 8, 9, and 10, respectively. The results of figures 8, 9, and 10 can be summarized as follows:

1. Every 100,000 ton increase in the annual production of a mine could lead to a decline of \$.47 to \$.94 in the cost per ton of clean coal, with an estimated average decline of \$.70.
2. Every 100 ton increase in labor productivity (tons per worker-year) could lead to cost decreases of \$.055 to \$.095 per ton with an average \$.075 per ton cost decline.
3. An increase in seam thickness by 1 foot could lead to cost decreases of between \$1.10 and \$4.70 per ton with an estimated average decrease of \$2.90 per ton clean coal produced.

Simple regression analyses help study the relation between variables. However, they should not be used separately for cost predictions for the obvious reason that no single factor can satisfactorily explain the variations in overall costs per ton.

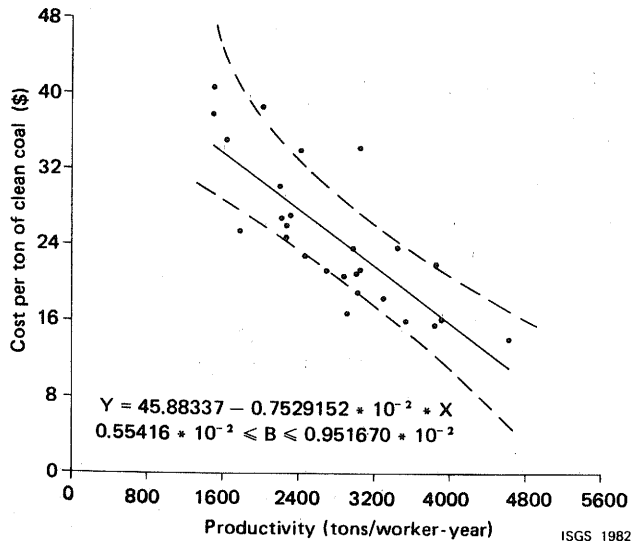

Figure 9.

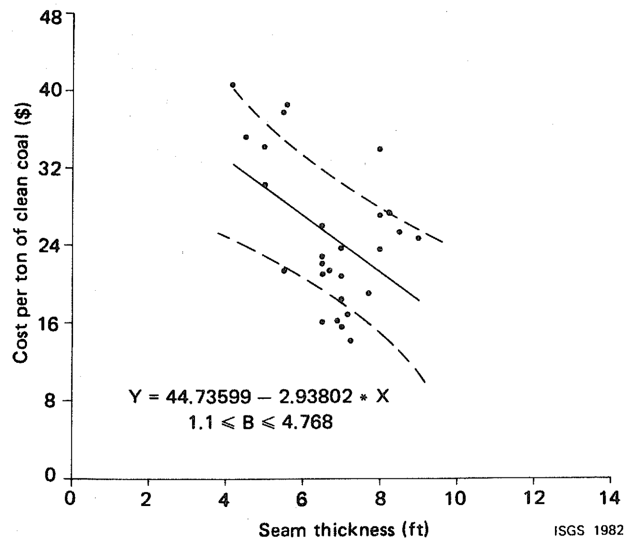

Figure 10.

Multiple Regression Analysis

The multiple regression analysis was performed with cost per ton of clean coal as the dependent variable and the following as independent variables:

- Mine development cost
- Number of longwalls
- Depth of mines
- Annual production (mine size)
- Mine age
- Seam thickness
- Labor productivity
- Investment in equipment per ton annual production
- Level of coal cleaning

At a 90 percent significance level, the multiple regression analysis showed the following five factors to explain about 90 percent of the variations in cost per ton:

- Mine development cost
- Labor productivity
- Mine size
- Mine age
- Level of coal cleaning

Because the multiple regression selects factors with significant marginal contributions in explaining the variability of the target function (cost per ton) over and above that explained by other factors, factors such as seam thickness and depth do not appear as significant, although they have strong correlations with productivity and mine size as shown in previous Illinois State Geological Survey investigations (6). Those correlations are confirmed by the results of this investigation as indicated in the final printout of the multiple regression analysis (Appendix B). Parts I and II in Appendix B compare the regressions performed with 9 and 5 independent variables and suggest that the simple 5-factor model (with $R^2 = 0.897$) is as good as the larger 9-factor model (with $R^2 = 0.908$).

The resulting equation for cost per ton of clean coal (Y) is:

$$Y = 44.22 - (1.9085*10^{-6})X_1 - 0.19906*X_2 - (6.3166*10^{-3})X_3 + (6.4903*10^{-2})X_4 + 0.75955*X_5$$

where: X_1 = annual production (tons per year)
X_2 = age of mine (years)
X_3 = labor productivity (tons per worker per year)
X_4 = mine development cost (dollars per ton annual production)
X_5 = coal cleaning level (0 through 4)

In figure 11, about three fourths of the cost predictions based on the above five variables fall within a ±10 percent range of those calculated with the full cost model based on cost functions developed earlier. In four notable exceptions, the predicted values differ by 15 to 30 percent from the calculated values. These exceptions cannot be explained with the limited approach of the present investigation. However, the regression equation with 5 variables tends to underestimate the costs of large and highly productive mines with lowest cost per ton of clean coal, indicating that investments made toward improving productivity escape consideration in the approach used by this model. Generally, cost predictions based on the regression equation tend to be slightly above the costs calculated by the full model, as reflected by a larger number of points above the zero line than below it.

Data on actual cost per ton of clean coal for each Illinois underground mine are not available and, for competitive reasons, are not likely to be available in the future. The model approach used here succeeds in comparing costs by mines and analyzing the variables affecting the costs. Since the model takes a snapshot look at the mining and coal cleaning costs as of 1980, some mines with temporary production problems may appear as high-cost mines. In the long run, they may not be so. On the other hand, some mines may have had an exceptionally problem-free year, although their long-term costs may be slightly above the costs calculated here. It is estimated, however,

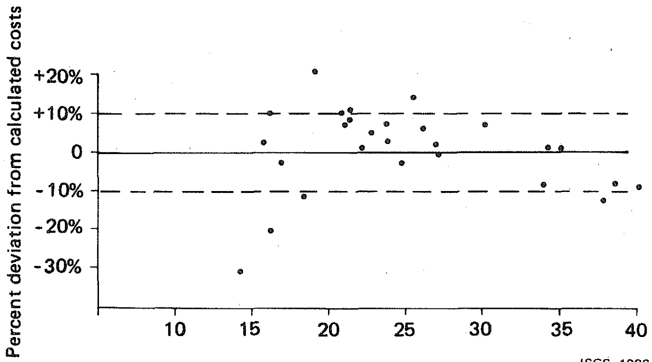

Figure 11. Deviation of cost predictions based on regression equation from cost calculations based on full model.

that the number of mines with production and/or marketing problems in 1980 was larger than the number of mines without problems. It is not possible to determine what percentage of production was affected in 1980 without investigating at least 5 consecutive years concerning cost per ton. Considering the employment and productivity data of the mines under study, it is estimated that 10 to 15 percent of production could have been affected in 1980 due to either geological, technical, or market factors. The net effect on cost per ton of the positive and negative influences cannot be quantified. However, they might result in a generally somewhat lower actual cost per ton of clean coal than calculated in this investigation for all Illinois underground mines.

CONCLUDING OBSERVATIONS

Cost estimates for existing underground coal mines could be useful in negotiating long-term coal delivery contracts and property transactions. Low-cost mines are likely to offer more stable contract conditions than high-cost mines. With simplicity of data collection and calculation as the goal, an attempt has been made to construct a model for cost calculation. The results are found to correlate well with the average value of coal mined by underground methods in Illinois.

The simple regressions generally confirm the expectations based upon experience. A multiple regression analysis established mine development cost, labor productivity, mine size, mine age, and the level of coal cleaning practiced as the most significant factors in explaining variations in cost per ton. Obtaining input data pertaining to these factors is not difficult and the cost-predicting capability of the multivariate equation, with about 75 percent of cost predictions within ±10 percent of the calculated full model costs, could be considered as an acceptable first approximation. The model should be useful for comparisons between mines.

Improvements in the cost-estimating capability of the model are tied to expansion in the amount and accuracy of input data. To produce any improvement in cost estimation would probably require an exponential increase in the collection of data.

The model could be expanded in more than one way. Similar models have been developed for financial analysis. With minor changes, the model could be used to test the sensitivity of costs per ton to changes in individual cost factors such as labor, overhead, and energy. Applying the model to assess resource utilization is also conceivable, with appropriate modifications.

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APPENDIX A. Cost Functions for Underground Coal Mines in Illinois

Part I: Development Costs

$D(J)$ = Development costs for mine J

$$= \left[D_1(J) + D_2(J) + D_3(J) + D_4(J) + D_5(J)\right] * Y(J) * \left[\frac{1}{20} + \frac{1}{20}\right] (\$/yr)$$

where $D_1(J)$ = Shaft construction = $\left[A(J) * B(J) * 5{,}500\right] + 650{,}000$ ($)

$D_2(J)$ = Slope construction = $F(J) * 2{,}600 * \left[\frac{G(J)}{\sin 17^\circ} + 500\right]$ ($)

$D_3(J)$ = Cost per portal for drift mines = 150,000 ($)

$D_4(J)$ = Main entries and longwall development, if any = $\left[H(J) * 2 * 3 * 2000\right] + \left[2 * 5 * 3000 * 200\right]$ ($)

$D_5(J)$ = Other surface facilities excluding preparation plant related facilities

$T(J)$	$0 \leq T(J) \leq 1{,}000{,}000$	$1{,}000{,}001 \leq T(J) \leq 2{,}000{,}000$	$2{,}000{,}001 \leq T(J) \leq 3{,}000{,}000$
$D_5(J)$	2,500,000 ($)	3,000,000 ($)	4,000,000 ($)

$A(J)$ = Number of shafts

$B(J)$ = Average depth of each shaft (ft)

$F(J)$ = Number of slopes

$G(J)$ = Vertical distance covered by the slope (ft)

$H(J)$ = Number of longwall faces

$Y(J)$ = Deflation index corresponding to the year $V(J)$ in which the mine started (see Part X)

$T(J)$ = Annual production of the mine (t/yr)

Cost of shaft sinking	5,500 ($/ft)
Shaft hoist, lining, etc.	650,000 ($)
Slope construction cost	2,600 ($/ft)
Underground development entries cost (net after adjusting for coal value produced)	200 ($/ft)

Depreciation period assumed to be 20 years.

Average interest rate assumed to be 10% p.a. on 50% of initial investment (1980 U.S. dollars assumed).

Part II: Mine Operation and Maintenance Cost

$L(J)$ = Labor cost of mine J = $K(J) * 81.0 * N(J) * 1.93$ (\$/yr)

$S_1(J)$ = Salary costs = $0(J) * 20{,}000 * 1.5$ (\$/yr)

$$C_1(J) = \text{Machine depreciation and interest} = \left[\sum_{I=1}^{11} Q(I,J) * S(I) \right] * Y_1(J) * \left[\frac{1}{10} + \frac{1}{20} \right] \quad (\$/yr)$$

$$C_2(J) = \text{Longwall depreciation and interest} = H(J) * 7{,}000{,}000 * \left(\frac{1}{8} + \frac{1}{20} \right)$$

where

$K(J)$ = Number of labor on payroll

$N(J)$ = Days worked/year

81 = Dollars/day wages

1.93 = Labor overhead including payments agreed to in the UMWA contracts

$O(J)$ = Number of salaried persons on payroll

20,000 = Dollars/year average annual salary

1.5 = Salary overhead

$Q(I,J)$ = Number of machines of type I in mine J

$S(I)$ = 1980 price (\$) of machine of type I (See Part VIII)

$Y_1(J)$ = Deflation index; 10 year machine life expected; interest paid on 50% of investment over the expected life period

7,000,000 = Investment in a 500-ft longwall face; 8-year life expectancy assumed

$E(J)$ = Energy cost (\$/yr)

$$= \left\{ \left[\sum_{I=1}^{11} Q(I,J) * R(I) \right] + (300 * 3 * Z(J)/2) + [(F(J) + 1) * 300] + (A(J) * 1{,}000) + (H(J) * 780) \right\} * X(J) * 5 * N(J) * 0.08$$

where

$R(I)$ = Installed kilowatt/machine of type I

$Z(J)$ = Number of production units excluding longwalls; two production units served by a system of 3 conveyors each with a 300 kw drive

Conveyors in slopes assumed to need an additional drive

Shaft hoist and ventilation fan installed power = 1000 kw

Longwall installed power = 780 kw

$X(J)$ = Number of shifts worked/day

Total hours/shift for which machines actually run = 5

Price of electricity = 0.08 (\$/kwhr)

Part III: Underground Haulage

$$C_3(J) = \left[(\overset{\text{ft}}{3{,}000} * \overset{\$/\text{ft}}{37}) + \overset{\$/\text{terminal}}{61{,}500}\right] + \left[\left(3{,}000 * 25 * \frac{Z(J)}{2}\right) + 50{,}000\right] +$$

$$\left[\left(500 * 25 * Z(J)\right) + 50{,}000\right] + \left(1{,}000 * 30 * H(J)\right)$$

= Investment ($) in the haulage system in main entries, crosscuts, sections, and longwall sections respectively (slope conveyors not included)

$$C_4(J) = \left[\left(\frac{G(J)}{\sin 17^\circ} + 500\right) * 37\right] + 75{,}000 = \text{Investment (\$) in belt construction in slopes and belt terminal}$$

$$C_5(J) = \left(C_3(J) + C_4(J)\right) * \left(\frac{1}{5} + \frac{1}{20}\right) = \text{Annual underground haulage cost; 5-year depreciation period assumed (\$/year)}$$

$$C_6(J) = \text{Auxiliary equipment investment} = Z(J) * 125{,}000 * \left(\frac{1}{5} + \frac{1}{20}\right) \text{ (\$/yr)}$$

Part IV: Mining Related Cost ($/yr)

Sum of Parts I, II, and III plus materials, supplies, and royalties

$$M(J) = \left[D(J) + L(J) + S_1(J) + C_1(J) + C_2(J) + C_5(J) + C_6(J) + E(J)\right] * 1.22$$

(10% materials and supplies and 12% royalties based on cost)

Part V: Coal Preparation Cost ($/yr)

$$P(J) = \left[PI(J) * \left(\frac{T(J)}{N(J) * 14}\right) * Y(J) * \left(\frac{1}{20} + \frac{1}{20} + \frac{7}{200}\right)\right] + \left[6{,}000 * N(J) * 14 * 0.08\right]$$

P(J) = Annual coal preparation costs ($/yr)

PI(J) = Preparation plant investment ($/t/hr) (see Part VIII)

3.5% of investment for maintenance and supplies
20 year depreciation
10% interest on ½ of investment
6000 kw installed power
14 hrs/day working time
0.08 $/kwhr electricity price

Part VI: Total Cost Per Ton Clean Coal

$$\text{Cost}(J) = \frac{M(J) + P(J)}{T(J) * 0.9}$$

Preparation plant recovery factor 0.9

Part VII: Coal Preparation Investment ($/t/hr)

Tonnage Category T(J) \ Level of Coal Cleaning U(J) =	2	3	4
0 < T(J) ⩽ 1,000,000	8,200	23,500	48,600
1,000,000 < T(J) ⩽ 2,000,000	6,800	22,000	47,300
2,000,000 < T(J) ⩽ 3,000,000	5,800	20,000	45,400

U(J) = 2: Heavy media separators

U(J) = 3: Heavy media separators and centrifuges and/or cyclones

U(J) = 4: Heavy media separators and centrifuges and/or cyclones and flotation

Part VIII: Mining Machine Prices (1980 dollars) S(1)

Continuous Miner	450,000
Cutter	250,000
Loader	180,000
Pump/Compressor	10,000
Rock Duster	50,000
Locomotive	75,000
Mine Car	40,000
Shuttle Car	250,000
Airdox Machine	150,000
Drill	150,000
Roofbolter	120,000

Data adapted from Electric Power Research Institute (1) and USBM (2).

Part IX: Deflation Index

1980	1.000	1970	0.559	1960	0.440
1979	0.940	1969	0.524	1959	0.434
1978	0.880	1968	0.490	1958	0.429
1977	0.823	1967	0.484	1957	0.423
1976	0.765	1966	0.477	1956	0.417
1975	0.731	1965	0.471	1955	0.411
1974	0.696	1964	0.465	1954	0.406
1973	0.662	1963	0.459	1953	0.400
1972	0.628	1962	0.453	1952	0.394
1971	0.593	1961	0.446	1951	0.388

Data adapted from U.S. Department of Commerce Quarterly Business Review.

APPENDIX B:

Part I: Regression analysis of cost with 9 independent variables

Correlations

	Longwalls	Cost	Depth	Mine size	Minage	Seam thickness	Productivity	Investment	Level of coal cleaning	Development cost
Longwalls	1.000									
Cost	.170	1.000								
Depth	.499	-.133	1.000							
Mine size	-.020	-.714	.449	1.000						
Minage	-.167	-.319	.191	.258	1.000					
Seam thickness	.517	-.481	.705	.549	.258	1.000				
Productivity	-.185	-.791	-.184	.457	-.072	.234	1.000			
Investment	.692	.550	.252	-.385	-.189	.144	-.446	1.000		
Level of coal cleaning	.244	.310	.051	-.128	.013	.056	-.180	.397	1.000	
Development	-.087	.535	-.396	-.658	-.291	-.468	-.164	.343	.156	1.000

Coefficients

Variable	B (Std. V)	B	Std. Error (B)	T
Longwalls	.0316	4.0141E-01	1.7618E+00	.228
Depth	-.0246	-7.9420E-04	4.3689E-03	-.182
Mine size	-.1184	-1.1703E-06	1.3221E-06	-.885
Minage	-.2239	-1.7129E-01	6.7187E-02	-2.549
Seam thickness	-.1522	-9.3005E-01	8.9985E-01	-1.034
Productivity	-.6304	-5.9982E-03	1.1168E-03	-5.371
Investment	.0808	1.0913E-01	1.9090E-01	.572
Level of coal cleaning	.1286	7.1165E-01	4.4947E-01	1.583
Development cost	.1622	5.2223E-02	3.6310E-02	1.438
Constant	0	4.8030E+01	4.7132E+00	10.191

Summary

	Multiple R	R-Square
Unadjusted	.9528	.9079
Adjusted	.9269	.8591

Std. Dev. of Residuals = 2.8368E+00
N = 27

Part II: Optimal regression model for cost with 5 independent variables

Correlations

	Cost	Mine size	Minage	Productivity	Level of coal cleaning	Development cost
Cost	1.000					
Mine size	-.714	1.000				
Minage	-.319	.258	1.000			
Productivity	-.791	.457	-.072	1.000		
Level of coal cleaning	.310	-.128	.013	-.180	1.000	
Development cost	.535	-.658	-.291	-.164	.156	1.000

Coefficients

Variable	B (Std. V)	B	Std. Error (B)	T
Mine size	-.1932	-1.9085E-06	1.0599E-06	- 1.801
Minage	-.2602	-1.9906E-01	5.7449E-02	- 3.465
Productivity	-.6639	-6.3166E-03	7.9042E-04	- 7.991
Level of coal cleaning	.1373	7.5955E-01	3.9859E-01	1.906
Development cost	.2016	6.4903E-02	3.1171E-02	2.082
Constant	0	4.4220E+01	2.6854E+00	16.466

Summary

	Multiple R	R-Square
Unadjusted	.9469	.8967
Adjusted	.9339	.8721

Std. Dev. of Residuals = 2.7028E+00
N = 27