Unemployment, Excess Capacity, and Benefit-Cost Investment Criteria

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UNEMPLOYMENT, EXCESS CAPACITY, AND BENEFIT-COST INVESTMENT CRITERIA

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I

DURING the past several years, substantial efforts seeking improvement in the design and economic evaluation of water resource (and other) public investments have been forthcoming. The issue in all of these analyses concerned both the nature of the appropriate investment criterion and the techniques for accurately estimating the parameters and variables which are its constituents.[1] While all of these contributions acknowledged the inadequacy or absence of market values in evaluating some benefits, generally all accepted the market prices of factors in computing the costs of project construction.[2] The primary rationale for this position rests on the proposition that, given full employment and factor markets which function as reasonably efficient allocative mechanisms, nominal factor prices reflect real cost and (social) worth.[3] However, even though most analysts have adopted the full-employment assumption in their own work, all have indicated the desirability of adjusting money costs so as to reflect more adequately true opportunity costs in a severe and widespread depression.[4]

While the rationale for this position has varied among economists, essentially the same information is required to correct market costs, irrespective of viewpoint. For any particular project, knowledge is required of both the direct and indirect industrial and occupational demands imposed on the economy and the correspondence of the pattern of these demands with the pattern of unemployment and idle industrial capacity. Because of the magnitude of the empirical task of tracing these sectoral demands through several layers of transactions, appropriate cost adjustments have not, in practice, been made. Indeed, the impracticality of the empirical task may explain, as much as anything, the failure of the economics profession to choose the problem as a research undertaking.

Recently, however, three basic empirical studies have been completed which enable the detailed tracing of public investment demands. In 1964, the Bureau of Labor Statistics released its study of the detailed on-site labor and materials requirements of water resource

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[1] Otto Eckstein, *Water Resources Development; the Economics of Project Evaluation* (Cambridge: Harvard University Press, 1958); John V. Krutilla and Otto Eckstein, *Multiple Purpose River Development, Studies in Applied Economic Analysis* (Baltimore: Johns Hopkins Press, 1958); Roland McKean, *Efficiency in Government Through Systems Analysis With Emphasis on Water Resources Development* (New York: John Wiley, 1958); Jack Hirshleifer, James C. DeHaven, and Jerome W. Milliman, *Water Supply: Economics, Technology and Policy* (Chicago: University of Chicago Press, 1960); Arthur Maass, Maynard Hufschmidt, *et al.*, *Design of Water Resource Systems* (Cambridge: Harvard University Press, 1962); Gilbert F. White, *et al.*, *Choice of Adjustment to Floods* (Chicago: University of Chicago Press, 1964); Allen V. Kneese, *The Economics of Regional Water Quality Management* (Baltimore: Johns Hopkins Press, 1964); Robert H. Haveman, *Water Resource Investment and the Public Interest* (Nashville: Vanderbilt University Press, 1965); and Robert Dorfman, *Measuring Benefits of Government Investments* (Washington, D.C.: The Brookings Institution, 1965).

[2] See, for example, O. Eckstein, *op. cit.*, 29, and 32–35; R. McKean, *op. cit.*, 160–162; and J. Hirshleifer, et al., *op. cit.*, 130–131.

[3] Moreover, following Margolis' classic demonstration that such public works expenditures are poor anti-cyclical measures, it was recognized that even though public investments were initiated in a recession, they might well be completed while the economy operated at full employment. See Julius Margolis, "Public Works and Economic Stability," *Journal of Political Economy*, LVII (Aug. 1949), 293–303.

[4] Some analysts appear to be more amenable than others to adjusting observed market prices when faced with significant and (presumably) persistent unemployment. See Maynard Hufschmidt, Julius Margolis, John Krutilla, with Stephen Marglin, *Standards and Criteria for Formulating and Evaluating Federal Water Resource Development*, Report of Panel of Consultants to the Bureau of the Budget (Washington, D.C.: June 30, 1961); and especially Stephen Marglin in Maass, Hufschmidt, et al., *op. cit.*

projects [5] and the Office of Business Economics completed its 1958 inter-industry relations study.[6] Of still more recent vintage is the Bureau of Labor Statistics' industry-occupation matrix,[7] which permits the analyst to trace the occupational breakdown of a given labor demand by industry in terms of 156 occupational classes.

That a technique for money-cost adjustment is pertinent can be surmised from the recent employment performance of the American economy. While, with few exceptions, employment has been high and rising during the postwar period, the level of unemployment has exceeded the purely frictional. In the 19-year period since World War II, unemployment rates were below four per cent of the civilian labor force in only five years. At all other times, unemployment exceeded this level even during periods of high and rising employment. In fact, the half-dozen years just prior to the outbreak of the Vietnam war displayed a substantial intensification of this postwar trend.

Indeed, if we decompose unemployment into those industry categories and occupational groups most significantly involved in the construction of water resource projects (see table 2), we find that over half of the industry categories and occupational groups show unemployment above four per cent consistently over the period 1957–1964.[8] Moreover, data on excess capacity by industry conforms broadly with the industry groupings showing rather high and consistent labor unemployment rates.[9]

In the postwar period, then, the years between the Korean war and the Vietnamese war possess those widespread and persistent unemployment conditions which would seem to require the adjustment of market prices to reflect the divergence of opportunity from money costs.

II

In this paper we present a model designed to relate the detailed occupational and industrial demands imposed on the economy by several types of water resource investment. This detail provides the basis for adjusting the market cost of such public investments under the employment conditions prevailing in the 1957–1965 period.

The model, presented in detail in the appendix, is a general computational model designed to estimate the primary resource requirements of any final expenditure. Knowing the commodities which are purchased by the final expenditure, the model traces each dollar of the expenditure through the chain of transactions until it becomes a payment to some original contributor to output. The categories of original contribution used in the model are: (1) employee compensation; (2) net interest; (3) capital consumption allowance; (4) corporate profits; (5) indirect business taxes; and (6) proprietor income and rent. The model yields estimates of the occupational composition of the employee compensation category and estimates of the industrial composition of the remaining categories.

In the model, project construction is thought of as imposing two primary kinds of demands on the economy: demands for on-site labor and demands for material, equipment, and supplies. While the former category represents direct factor withdrawal, the latter results in factor withdrawal only through the several rounds of the production sequence which the final demand generates. The model assumes

[5] U.S. Department of Labor, Bureau of Labor Statistics, *Labor and Material Requirements for Civil Works Construction by the Corps of Engineers*, Bulletin 1390 (March, 1964).

[6] Morris R. Goldman, Martin L. Marimont, and Beatrice N. Vaccara, "The Inter-Industry Structure of the United States," A Report on the 1958 Input-Output Study, *Survey of Current Business*, 44 (Nov. 1964), 10–29; Norman Frumkin, "Construction Activity in the 1958 Input-Output Study," *Survey of Current Business* 45 (May, 1965), 13–24; and National Economics Division Staff, "The Transactions Table of the 1958 Input-Output Study and Revised Direct and Total Requirements Data," *Survey of Current Business*, 45 (Sept. 1965), 33–49.

[7] Harry Greenspan, "Uses of Industry-Occupational Patterns for Estimates of Employment by Occupation and Description of the BLS Industry-Employment Occupational Tables" (Febr. 2, 1966), and "Sources of Statistics on Employment by Occupation for the United States." See footnote 14.

[8] Data covering 1957–1960 from U.S. Bureau of Labor Statistics, *Employment and Earnings, Annual Supplement Issue*, 8, No. 5 (Nov. 1961), Tables SA–33 and SA–34, p. 100; data covering 1957–1960 from Special Labor Force Report #52 from U.S. Bureau of Labor Statistics, *Monthly Labor Review* (Apr. 1965), Tables F–2 and F–3.

[9] See U.S. Congress, Joint Economic Committee, *Measures of Productive Capacity*, Hearings before the Subcommittee on Economic Statistics (Washington, D.C.: U.S. Government Printing Office, 1962).

that this generated production sequence is such that: (1) all industries satisfying the final demand increase output initially by the amount of the demand; (2) all industries increase their demands on each other and on primary factor suppliers by an amount which is just sufficient to meet their output requirements; [10] (3) these additional inter-industry and factor demands are defined by an exhaustive set of current account input-output coefficients; and (4) the sequence of generated demands and output responses occurs with no time lag. Under these conditions, the model filters the total demand for material, equipment, and supplies into one of the six value added categories mentioned above.

With reference to the equations presented in the appendix, the model pursues the following sequential pattern of sectoral analysis. Having secured as basic data the detailed final demand and on-site labor vectors, equation (1), the gross industrial requirement generated by the final material demand is traced through the economy by accounting for the inter-industry demands imposed by production sectors on each other. This input-output computation, performed in equation (2), estimates the gross output required from each of 80 industries to produce the final demand. Equations (3) and (4) translate these gross industrial outputs into gross industrial man-year labor demands and, then, transform these industrial labor requirements into 156 occupational categories. In equations (5), (7), and (8), the off-site labor costs associated with the occupational demands secured in equation (4) are estimated, adjusted, and then added to the on-site occupational labor costs to yield the occupational breakdown of total labor costs. Finally, in equation (6) the remaining value added components of the bill of final goods are estimated by industry by applying the appropriate sets of value added component to gross output ratios to the gross output data obtained in equation (2). Through this sequence, total project cost is allocated among the components of value added and then each of these components is disaggregated into either occupation or industry detail.[11]

III

Data requirements for implementation of the model are of two basic types: data inputs intrinsic to the model itself and data inputs peculiar to the final expenditure to be analyzed by the model. In the first category are: (1) the coefficients describing the input-output relationship between industries in the economy (matrix A); (2) the coefficients describing the composition of occupational requirements within each industry (matrix B); and (3) the coefficients relating the components of value added to gross output for each industry (matrix C). In the second category are: (1) the detailed final demands for material, equipment, and supply inputs (vector f); and (2) the on-site employee compensation payments by occupation (vector i_2).

The input-output coefficients used in this analysis are those estimated in the recent 82-order input-output matrix of the Office of Business Economics.[12] The coefficients employed to describe the occupational structure within each industry are those contained in a 1960 occupation-by-industry employment matrix [13] constructed by the Bureau of Labor Statistics.[14]

[10] This assumption, it should be noted, eliminates inventory depletion as a substitute for increased production.

[11] Although this model estimates sectoral impact, it should be noted that a number of indirect effects lie beyond its purview. For example, it does not analyze the sectoral impact of the outputs of the investment expenditures. Similarly, the sectoral impacts of the multiplier and dynamic repercussions which emanate, respectively, from the income and output generated by the orginal final expenditure are not analyzed. To analyze such impacts requires individual commodity consumption functions for each of the household units with dissimilar spending patterns and individual capital investment functions for each production sector. For a description of work along these lines by the Inter-Agency Economic Growth Study Project, see Jack Alterman, "Studies of Long-Term Economic Growth," *Monthly Labor Review* (Aug. 1965), 983–987.

[12] See footnote 6.

[13] When the employment matrix enters the model, 1958 industry dollar values become changed to 1960 industry man-year labor requirements. This transformation was accomplished by applying a set of factors expressing 1960 industry employment in man-years per 1958 dollar of industry output. These factors were prepared by the Bureau of Labor Statistics for use with the 1958 input-output study.

[14] The ratios in the matrix were latter stage, although preliminary, estimates and have not yet been published. So far as is known, this is the first time such detailed coefficients have been used to secure an estimate of the occu-

This matrix shows the distribution of total national employment to 137 production sectors and 156 occupations.[15] Use of such a matrix implies that the occupational structure of any industry remains constant as output increases.

The final set of data intrinsic to the model — the ratios of the components of value added to gross output for each industry — was secured by placing the value of the components for each industry as numerator over the gross industry output. The data required to compute these ratios were obtained for 1958 from the Office of Business Economics. The sum of these ratios within an industry equals the 1958 ratio of value added to gross output for that industry.[16]

The data inputs peculiar to the analysis of water resource investment expenditures consist of an exhaustive breakdown of all dollar costs into on-site labor costs by detailed occupations and material, equipment, and supply costs by four-digit S.I.C. categories. From the latter set of data a bill of final demand was constructed for each project type by aggregating the S.I.C. breakdown into the 82 industries of the 1958 input-output matrix. In the study, 12 project types are distinguished, representing a total of some $326 million of contract cost.[17] Some aggregated characteristics of both the labor and materials demands are displayed by project type in table 1.

Because of the "producer value" basis of the input-output study, the data on material inputs were transformed from "purchaser values" to "producer values" by applying a set of transportation and trade factors to all dollar material demands, by four-digit S.I.C. categories.[18] In addition, because of the 1958 basis of the input-output study, all of the material, equipment, and supply costs were revalued from values of the year of observation to 1958 values by applying an appropriate series of product price indices to the input data arranged in four-digit S.I.C. categories.[19] Finally, the "rental cost"[20] of heavy construction equip-

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pational labor demand resulting from an increase in industry output.

[15] While the gross output data from the input-output computation are in 82-industry detail, the BLS occupation-industry matrix contains 137 industrial sectors. Two possibilities existed of securing compatability: the occupation-industry matrix could be aggregated to 82 sectors or the gross output data could be expanded to 137 sectors. The latter alternative was chosen. First, the final demand was assigned to the appropriate occupation-industry matrix sector on the basis of the four-digit SIC classification attached to it. Second, the remainder of the gross output was distributed among the relevant occupation-industry sectors in proportion to the distribution of national employment among these industries. In the model the symbol n defines either the 82- or the 137-sector breakdown, depending on the stage of the analysis.

[16] The ratios of total value added to gross output, by industry, were obtained from the 1958 input-output study. See Morris R. Goldman, Martin L. Marimont, and Beatrice N. Vaccara, *op. cit.* The 1958 industry data on employee compensation, capital consumption charges, and corporate profits were obtained from the Office of Business Economics. Similar data on the remaining components of value added are from the substantially less detailed material in Martin L. Marimont, "GNP by Major Industries," *Survey of Current Business*, 42 (Oct. 1962), 6–18.

The proprietor and rental income category includes the surpluses less subsidies of government enterprises. Indirect business taxes include business transfer payments. Corporate profits include the inventory valuation adjustment.

In the data obtained from both sources, the number of detailed industries is less than the number of industries in the input-output matrix. For those input-output industries which were sub-industries of the more grossly defined industries in the value added component data, the ratios of the 1958 value added component (e.g., employee compensation) to 1958 value added for the entire industry were assigned to each of the sub-industries. In those cases in which the value added components failed to add up to the total industry value added published in the 1958 input-output study, indirect business taxes were estimated as residuals.

[17] These data were obtained from: (1) the Division of Productivity and Technological Developments of the Bureau of Labor Statistics, (2) the Bureau of Reclamation and, (3) the Corps of Engineers. See U.S. Department of Labor, Bureau of Labor Statistics, *Labor and Material Requirements for Civil Works Constructed by the Corps of Engineers*, Bulletin No. 1390 (March, 1964).

Whereas all of the data for the Bureau of Reclamation project (the Large Dam and Power Generating Facility) were based on actual expenditures for project construction, only the on-site labor costs of the Bureau of Labor Statistics data were so estimated. The remainder of the data were compiled from engineering cost estimates prepared in great detail for each sub-feature of the projects by engineers in the district Corps offices.

The data obtained from the Bureau of Labor Statistics have been adjusted in two primary ways and, hence, are not identical with those published in their summary report. Both of these adjustments consist of the allocation of some of their "other costs" to either costs for material, equipment, and supplies or on-site labor.

[18] These trade and transportation factors were prepared by the Office of Business Economics in connection with the 1958 input-output study.

[19] The product price deflators used were prepared by the Office of Business Economics from basic data obtained by the Division of Industrial Prices and Price Indexes of the Bureau of Labor Statistics.

[20] "Rental cost" is defined as the cost of owning (depreciation) and maintaining equipment. These estimates

TABLE 1. — TOTAL PROJECT COST AND ITS ALLOCATION TO INDUSTRIAL AND OCCUPATIONAL CATEGORIES, IN DOLLARS PER $1,000 OF TOTAL CONTRACT COST, BY PROJECT TYPE

Production Sector	Input-Output Study Sectors	Large Earth Fill Dams	Small Earth Fill Dams	Local Flood Protection	Pile Dikes	Levees	Revetments	Powerhouse Construction	Medium Concrete Dam	Lock and Concrete Dam	Large Dam and Power Generating Facility	Dredging	Miscellaneous	Total
Agriculture, Forestry, and Fisheries	1–4	*	1	*	..	*	..	*	*	1	..	..	1	
Mining (including Crude Petroleum)	4–10	*	24	41	122	73	303	8	2	66	41	*	23	
Non-Durable Goods Manufacture	14–19, 24–34	98	112	35	47	90	45	7	20	20	26	103	121	
Durable Goods Manufacture	12–13, 20–23, 35–64	278	293	278	189	109	99	659	369	450	319	250	282	
Lumber and Wood Products	20–23	8	6	12	55	1	46	12	5	5	6	*	20	
Stone, Clay and Glass Products	35–36	14	10	69	..	1	*	14	94	120	60	..	54	
Primary Metal Industries	37–38	2	4	5	4	1	4	13	33	67	35	45	36	
Fabricated Metal Products	39–42	56	31	126	16	10	9	41	83	52	77	21	5	
Machinery (except Construction and Electrical)	43–44, 46–52	15	14	3	7	1	*	255	46	57	43	1	10	
Construction Machinery	45	104	151	41	60	72	20	24	84	109	44	32	107	
Electrical Machinery	53–58	2	2	1	..	*	..	293	3	19	46	*	*	
Transportation Equipment	13, 59–61	77	75	21	47	23	20	4	21	21	6	151	50	
Miscellaneous Manufacturing	12, 62–64	*	*	*	..	*	..	3	*	..	2	*	*	
Transportation and Warehousing	65	16	31	38	88	54	193	22	19	61	39	17	35	
Wholesale and Retail Trade	69	115	116	82	69	56	73	90	84	99	61	56	106	
Services	66–68, 70–82	27	27	27	27	27	27	26	41	26	27	28	27	
Total Material, Equipment, and Supply Cost [a]		533	603	502	543	409	740	810	533	723	514	453	597	
Occupational Category														
Professional, Technical, Managerial, Clerical and Kindred Workers		37	26	29	42	51	13	25	55	27	63	132	37	
Craftsmen, Foremen and Kindred Workers		157	202	214	137	170	37	108	176	155	253	56	132	
Carpenters		18	9	45	5	1	*	26	30	28	47	..	14	
Cement finishers		3	1	10	..	..	..	2	4	4	4	..	2	
Iron and Metal Workers		3	1	29	..	*	*	13	17	6	22	..	..	
Construction Equipment Operators		51	134	80	80	90	21	8	33	47	43	4	56	
Other Building Trades		2	1	1	..	..	..	32	23	23	35	1	*	
Mechanics		18	20	9	1	27	*	*	3	11	5	4	15	
Labor Foremen		21	26	30	11	12	6	14	25	24	45	7	5	
Other Craftsmen, Foremen and Kindred Workers		41	10	10	40	40	10	13	41	12	52	40	40	
Operatives and Kindred Workers		79	51	63	84	105	35	27	60	47	28	131	78	
Truck and Tractor Drivers		49	9	36	32	54	4	3	14	24	8	1	41	
Sailors and Deckhands		..	..	..	21	18	21	..	..	1	..	68	..	
Other Operatives and Kindred Workers		30	42	27	31	33	10	24	46	22	20	62	37	
Service Workers		..	..	..	..	..	..	..	..	..	..	8	..	
Laborers		40	40	72	35	36	44	18	68	32	72	39	32	
Total On-Site Labor Cost [a]		312	320	379	298	362	127	178	358	260	416	365	278	
Total Unallocated Cost		155	77	119	159	229	133	11	109	17	70	182	125	
TOTAL PROJECT COST [a]		1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	
Total Contract Cost (in $000) [b]		11,138	5,440	6,645	1,544	2,370	1,756	7,793	16,518	9,020	249,741	10,092	4,177	326,234
Number of Projects		1	3	3	5	7	5	1	1	1	1	17	4	49

[a] Columns may not add to total because of rounding.
[b] Refers to the total cost in each category from which the detailed breakdowns were computed.
* Less than $.50 but greater than zero.

ment was assigned to the relevant equipment manufacturing industry in constructing the final demands. This procedure incorporates an implicit assumption that the owners of construction equipment behave so as to keep their equipment inventory constant.[21]

IV

Given the primary data inputs, the model yields a detailed breakdown of industrial and occupational demands of each of the 12 project types and the decomposition of their value added components. These results are shown in table 2.

The top section of table 2 shows the industrial breakdowns of the *gross output* requirements as defined by equation (2) of the model. Substantial variation in the total gross output is seen to exist among expenditure categories. The gross output called forth ranges from $824 to over twice that amount. Within individual production sectors, the variation among expenditure type is even more pronounced. Within a given industrial sector the maximum gross output called forth is typically from five to ten times the minimum. Within each expenditure category, gross output demands are relatively concentrated. Typically, over 60 per cent of the total gross output demands are required from the top ten of the 82 input-output industries.

In the middle section of the table, the total occupational impact (both on- and off-site) of each of the project types is shown. These estimates result from equations (5), (7), and (8) of the model.[22] Again, a substantial diversity is shown among project types. In all of the expenditure categories, with the exception of revetments and dredging, the heaviest labor demands are imposed on craftsmen, foremen and kindred workers. In seven out of 12 project categories over 35 per cent of the total labor cost is paid to workers in that major occupation group. Ranking second is the operatives and kindred workers category. In all cases save one, more than 20 per cent of the total labor cost accrues to workers in this category. Again, the occupational pattern of demands is concentrated. In all the project categories save one, over 60 per cent of the total labor cost is contained in ten of 156 detailed occupations.

The remainder of the table shows the breakdown of the value added components for each project type and, for comparative purposes, the 1958 breakdown of the value added components for the entire national economy. In all of the project types, labor costs are unquestionably the most important single cost item. In no case does labor represent less than 50 per cent of the total costs and in one category it absorbs nearly 72 per cent of the total contract cost.[23]

V

Having identified the pattern of industrial and occupational demands imposed by the various types of public water investments, we can address the question of the correspondence between nominal and opportunity costs. In a fully employed economy, project contract costs represent opportunity returns foregone at the margin. With unemployment, however, labor

were derived from the detailed engineering contract cost estimates developed by the Corps of Engineers. See U.S. Department of Labor, Bureau of Labor Statistics, *op. cit.*, 27–28.

[21] This assumption may, indeed, be close to reality for those large-scale projects in which pieces of construction equipment are both purchased for use on the project and are "used up" in the process of project construction. Because equipment purchases are technically capital purchases, the purchases-on-current-account-only assumption made earlier becomes modified in the treatment of the construction industry.

[22] As stated in equation (5), the occupational breakdown of the wage and salary income generated by the final demands is estimated from the man-year occupational requirements by applying an estimate of the average annual wage and salary income earned by individuals in each occupational category. See U.S. Department of Commerce, U.S. Bureau of the Census, *U.S. Census of Population*: 1960, "Occupational Characteristics," Final Report PC(2)–7A (Washington, D.C.: U.S. Government Printing Office, 1963).

[23] It should be noted that the non-labor-cost components of value added are substantially smaller than their national counterparts. There are three primary reasons for this. First, while we have captured and allocated substantially all of the labor costs, there remains a rather large body of "unallocated costs," which, if allocated, would be added to the non-labor-cost components of value added. Second, by the procedure adopted in constructing our bills of final demand, we have excluded the depreciation component of value added in the construction industry. By allocating this depreciation to the bill of final demands, its value becomes distributed among all of the value added components, including labor cost. Third, the non-labor-cost components of the projects are relatively smaller than their national counterparts because of the characteristics of the industries from which the projects draw most heavily.

TABLE 2. — GROSS OUTPUT REQUIRED TO YIELD FINAL DEMANDS, BY PRODUCTION SECTOR, TOTAL LABOR COST, BY OCCUPATIONAL CATEGORY, AND BREAKDOWN OF TOTAL PROJECT COST INTO VALUE ADDED COMPONENTS, IN DOLLARS PER $1,000 OF CONTRACT COST AND PER CENT OF TOTALS,[a] BY PROJECT TYPE.

Production Sector	Percentage of 1958 National Gross Output	Large Earth Fill Dams	Small Earth Fill Dams	Local Flood Protection	Pile Dikes	Levees	Revetments	Powerhouse Construction	Medium Concrete Dam	Lock and Concrete Dam	Large Dam and Power Generating Facility	Dredging	Miscellaneous
Agriculture, Forestry, and Fisheries	(6)	10(1)	11(1)	10(1)	19(2)	6(1)	18(1)	13(1)	9(1)	11(1)	8(1)	7(1)	14(1)
Mining (including Crude Petroleum)	(2)	61(5)	81(6)	81(8)	159(15)	131(16)	356(26)	42(2)	38(3)	118(8)	77(7)	71(7)	100(8)
Construction [b]	(6)	9(1)	11(1)	10(1)	12(1)	9(1)	19(1)	11(1)	10(1)	13(1)	9(1)	8(1)	11(1)
Non-Durable Goods Manufacture [c]	(20)	187(16)	218(17)	112(11)	130(12)	154(19)	149(11)	113(7)	102(9)	126(9)	103(10)	174(18)	225(18)
Durable Goods Manufacture	(21)	514(45)	549(43)	480(47)	367(34)	229(28)	265(20)	1113(65)	609(55)	742(51)	539(51)	447(45)	497(40)
Lumber and Wood Products	(2)	15(1)	12(1)	21(2)	83(8)	5(1)	68(5)	23(1)	12(1)	12(1)	13(1)	10(1)	33(3)
Stone, Clay, and Glass Products	(1)	24(2)	21(2)	87(8)	14(1)	10(1)	27(2)	29(2)	115(10)	151(10)	78(7)	7(1)	71(6)
Primary Metal Industries	(3)	90(8)	96(6)	93(9)	56(5)	42(5)	41(3)	190(11)	134(12)	184(13)	129(12)	126(13)	108(9)
Fabricated Metal Products	(2)	85(7)	61(5)	150(15)	34(3)	24(3)	23(2)	79(5)	110(10)	82(6)	100 (9)	48(5)	29(2)
Machinery (except Construction and Electrical)	(2)	48(4)	55(4)	26(2)	32(3)	22(3)	21(2)	345(20)	82(7)	103(7)	75(7)	28(3)	42(3)
Construction Machinery	*	112(10)	163(13)	47(5)	71(7)	81(10)	37(3)	37(2)	92(8)	123(8)	52(5)	36(4)	117(9)
Electrical Machinery	(2)	16(1)	16(1)	12(1)	10(1)	7(1)	8(1)	359(21)	18(2)	37(3)	64(6)	15(1)	11(1)
Transportation Equipment	(5)	120(11)	120(9)	40(4)	65(6)	36(4)	36(3)	37(2)	40(4)	42(3)	20(2)	173(18)	82(7)
Miscellaneous Manufacturing	(3)	5(*)	4(*)	4(*)	3(*)	2(*)	3(*)	14(1)	6(*)	6(*)	7(1)	4(*)	5(*)
Transportation and Warehousing	(4)	48(4)	68(5)	71(7)	122(11)	79(10)	238(17)	65(4)	54(5)	109(7)	72(7)	48(5)	75(6)
Wholesale and Retail Trade	(11)	146(13)	152(12)	112(11)	102(9)	78(9)	114(8)	141(8)	117(11)	144(10)	93(9)	85(9)	140(11)
Services	(29)	166(15)	182(14)	154(15)	169(16)	138(17)	225(16)	204(12)	174(16)	200(14)	152(14)	146(15)	184(15)
Total Gross Output Required [d]	(100)	1141(100)	1273(100)	1030(100)	1080(100)	824(100)	1383(100)	1701(100)	1114(100)	1463(100)	1054(100)	986(100)	1246(100)
Occupational Category	**Per Cent of Total National Labor Cost**												
Professional, Technical, and Kindred Workers	(16)	60(10)	47(7)	41(6)	48(8)	49(9)	34(7)	83(12)	73(11)	52(8)	72(10)	55(9)	56(9)
Managers, Officials and Proprietors	(13)	59(10)	74(11)	61(9)	67(11)	55(10)	70(13)	82(12)	63(9)	81(12)	66(9)	139(22)	66(11)
Clerical and Kindred Workers	(13)	49(8)	52(8)	43(6)	39(7)	34(6)	47(9)	76(11)	47(7)	59(9)	46(6)	38(6)	51(9)
Sales Workers	(7)	13(2)	14(3)	11(2)	9(2)	8(1)	10(2)	15(2)	11(2)	14(2)	10(1)	8(1)	13(2)
Craftsmen, Foremen and Kindred Workers	(19)	219(36)	275(42)	276(41)	202(34)	218(38)	120(23)	222(32)	245(36)	250(36)	319(44)	126(20)	199(33)
Carpenters	(2)	20(3)	11(2)	48(7)	8(1)	3(1)	4(1)	29(4)	32(5)	31(5)	49(7)	5(1)	16(3)
Cement Finishers	(*)	3(1)	1(*)	10(2)	**(*)	**(*)	**(*)	2(*)	4(1)	4(1)	4(1)	**(*)	2(*)
Iron and Metal Workers	(*)	3(1)	1(*)	29(4)	1(*)	1(*)	1(*)	14(2)	17(3)	6(1)	22(3)	4(1)	**(*)
Construction Equipment Operators	(1)	53(9)	137(21)	84(13)	85(14)	93(16)	31(6)	7(1)	36(5)	53(8)	48(7)	6(1)	60(10)
Other Building Trades	(3)	7(1)	7(1)	9(1)	7(1)	5(1)	8(2)	39(6)	29(4)	32(5)	41(6)	12(2)	7(1)
Mechanics	(4)	9(2)	10(2)	9(1)	9(2)	7(1)	12(2)	14(2)	10(2)	14(2)	9(1)	8(1)	10(2)
Labor Foremen	(3)	32(5)	39(6)	41(6)	23(4)	20(4)	21(4)	38(6)	38(6)	41(6)	58(8)	17(3)	17(3)
Other Craftsmen, Foremen and Kindred Workers	(7)	92(15)	69(10)	46(7)	69(11)	89(16)	43(8)	79(11)	79(12)	69(10)	88(12)	74(12)	87(14)
Operatives and Kindred Workers	(19)	149(24)	133(20)	138(21)	164(27)	160(28)	156(30)	158(23)	138(21)	159(23)	108(15)	185(30)	158(26)
Truck and Tractor Drivers	(3)	59(10)	21(3)	51(8)	51(9)	65(11)	36(7)	16(2)	28(4)	47(7)	22(3)	9(1)	56(9)
Sailors and Deckhands	(*)	**(*)	**(*)	**(*)	21(4)	18(3)	22(4)	**(*)	**(*)	2(*)	**(*)	68(11)	**(*)
Other Operatives and Kindred Workers	(16)	90(15)	112(17)	87(13)	92(15)	77(13)	98(19)	142(21)	110(16)	110(16)	86(12)	108(17)	102(17)
Service Workers	(6)	7(1)	8(1)	7(1)	7(1)	5(1)	10(2)	11(2)	7(1)	10(1)	7(1)	15(2)	8(1)
Laborers, except Farm	(4)	55(9)	57(9)	89(13)	60(10)	46(8)	66(13)	40(6)	87(13)	58(8)	89(12)	54(9)	51(9)
Farmers and Farm Workers	(3)	2(*)	3(*)	2(*)	4(1)	1(*)	3(1)	3(*)	2(*)	2(*)	2(*)	2(*)	3(1)
Total Labor Cost (Income) [d]	576(100)	612(100)	662(100)	667(100)	600(100)	576(100)	517(100)	691(100)	674(100)	685(100)	719(100)	621(100)	605(100)
Net Interest	15	8	9	7	9	7	13	10	8	10	7	7	9
Depreciation	87	49	56	45	51	41	73	63	48	66	46	42	58
Indirect Business Taxes	91	49	55	46	48	37	68	66	47	63	45	37	54
Corporate Profits	92	61	70	57	55	45	71	94	65	83	59	50	70
Proprietor and Rental Income	139	41	44	35	47	42	77	33	28	44	30	36	49
Net Imports	..	22	25	21	31	22	47	29	19	29	21	22	28
Unallocated Costs [e]	..	155	77	119	159	229	133	11	109	17	70	182	185
TOTAL COST (INCOME) [f]	1000 [g]	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000

[a] The percentage of total figures are stated in parentheses to the right of the absolute dollar values.
[b] Refers only to maintenance and repair construction. In the 1958 Input-Output study, new construction is treated as a final demand.
[c] In all of the project types, the overwhelming supplier in the Non-Durable Goods sector is the Petroleum and Related Products industry.
[d] Columns may not add to total because of rounding.
[e] Ideally, all of these costs could be allocated to one of the other value added categories if the raw data were sufficiently detailed. It is presumed that the substantial majority of these unallocated items falls into the corporate profits, proprietor income, and indirect business taxes categories.
[f] Columns may not add to total because of (1) rounding and (2) the compounding of rounding errors in successive multiplications.
[g] It should be noted that the breakdown of the contract cost into its value added components is not conceptually identical with the value added breakdown of G.N.P. Contract cost is defined to include the cost of imported goods and services. G.N.P. is defined net of imports. To make them comparable, imports could be subtracted from the contract cost and then a new value added breakdown computed on this new cost figure. See also footnote e.
* Less than .5 per cent but greater than zero.
** Less than $.50 but greater than zero.

drawn from the idle pool has no comparable opportunity cost.[24] Similarly, the opportunity rate of return on otherwise idle capital drawn into use by project construction is zero. However, because capital services are largely storable, depreciation charges are a real cost properly imputed to project construction even when otherwise idle industrial capacity is drawn into use.

Accepting our data on the industrial and occupational breakdown of the total money costs of project construction into their value added components, we shall modify the employee compensation and corporate profits plus net interest market values to the extent that the units of labor and capital represented would have been otherwise idle. The capital consumption allowance will be maintained as an estimate of the social cost of capital use even in the presence of unused capacity. The remaining value added components will be assumed to draw labor and capital in a pattern similar to the pattern which we have traced. We shall, therefore, adjust the sum of these components in the same direction and to the same extent as we adjusted the sum of the traceable labor and capital costs.

In estimating the extent to which any labor and capital demand employs otherwise unused resources, we assume that the levels of occupational unemployment and industrial excess capacity are significant variables. While, for example, an increase in the demand for labor at low levels of unemployment will simply shift workers among jobs without reducing unemployment below the frictional minimum, as the rate of unemployment rises so too does the probability that the incremental demand will hire otherwise unemployed labor. In the absence of existing knowledge on the response of labor and capital markets to increments of demand at different levels of unemployment, we offer a set of synthetic response functions relating the probability that a given increment in the demand for labor and capital will be drawn from otherwise unemployed resources to the level of occupational unemployment and industrial excess capacity. In figures 1A and 1B alternative linear and semi-logarithmic labor response functions are shown. Figure 2 depicts similar alternative response functions for capital.

Figure 1A. — Linear Labor Response Functions

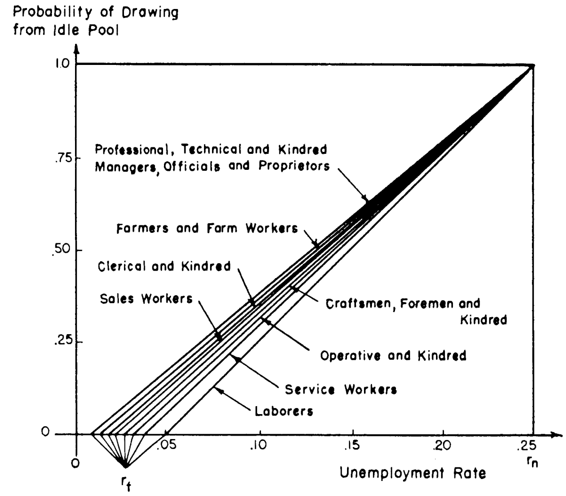
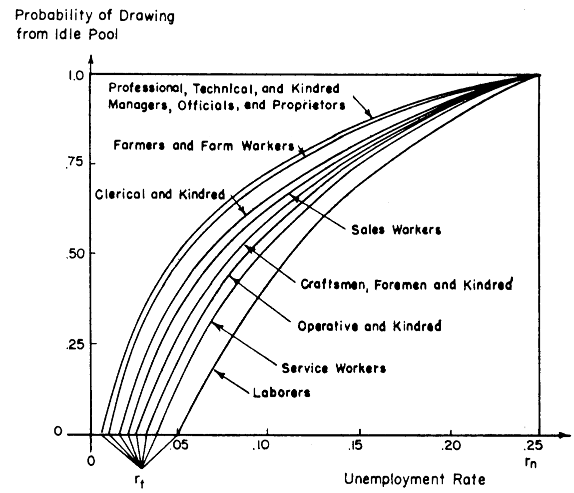


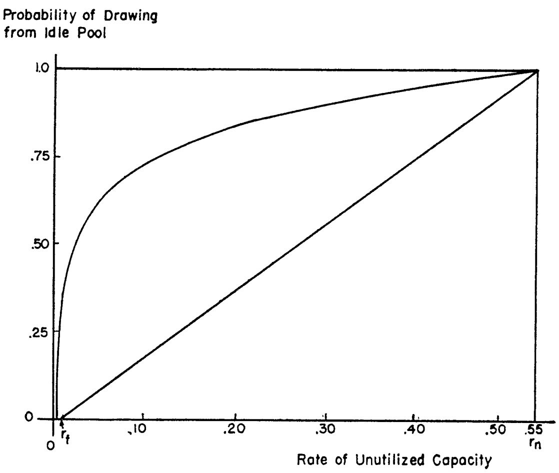
Figure 1B. —
Semi-Logarithmic Labor Response Functions



In figures 1A and 1B, the intercepts on the abcissa are defined by the national unemployment rate experienced by each occupational group in 1953 — the most recent year in which the economy was fully employed. The probability becomes unity at .25, the rate of unemployment existing at the height of the Great Depression. We assume all would agree that increments to the demand for labor are satisfied with no displacement of alternative outputs under such a set of economic conditions. The response functions pictured in figure 2

24 Implicit is the position that involuntary leisure has a zero benefit.

FIGURE 2. — LINEAR AND SEMI-LOGARITHMIC CAPITAL RESPONSE FUNCTIONS



intercept the abcissa at a very low level of excess capacity and reach the point of unitary probability at a level of excess capacity of .55. This benchmark again refers to conditions at the height of the Great Depression.[25] Because of the expected behavior of industrial markets, the semi-logarithmic capital response function reflects a greater probability of involving idle capacity at lower levels of unutilized capacity than do the labor response functions. For both labor and capital, the linear functions are assumed to be the minimum boundary between the rate of unemployment and the probability of drawing factor services from idle pools.

Assuming now the conditions which obtained by detailed industry and occupation in 1960, what sort of adjustments to contract costs are required, based on the industry and occupational distribution of the capital and labor demands made by water resource projects? [26]

[25] See Donald C. Streever, *Capacity Utilization and Business Investment* (Urbana: University of Illinois Bureau of Economic and Business Research, 1960), 40 and 64. Full capacity is defined as the preferred operating rate.

[26] Unemployment rates for 156 occupations were computed from the 1960 Census of Population. U.S. Department of Commerce, U.S. Bureau of the Census, *op. cit.* The industrial utilization rates were the mean of the two least extreme estimates by industry obtained from the Wharton School Econometrics Unit, The National Industrial Conference Board, McGraw-Hill, and Bert G. Hickman for 1960. See Daniel Creamer, *Capital Expansion and Capacity in Post-War Manufacturing*, Studies in Business Economics, No. 72 (New York: the National Industrial Conference Board, 1961), U.S. Congress, Joint Economic Committee, *op. cit.*, and Bert G. Hickman, *Investment Demand and U.S. Growth* (Washington: The Brookings Institution, 1965). The NICB, McGraw-Hill, and Hickman estimates were adjusted to assure analytical comparability.

The answer to this question is shown in table 3.

TABLE 3. — ESTIMATED SHADOW COSTS PER $1,000 OF TOTAL CONTRACT COSTS BY PROJECT TYPE FOR SEMI-LOG AND LINEAR RESPONSE FUNCTIONS

	Opportunity Cost per $1,000 of Contract Cost		
Project Type	Semi-Log	Linear	Mean
Large Earth Fill Dams	$680	$855	$768
Small Earth Fill Dams	640	827	734
Local Flood Protection	620	809	715
Pile Dikes	646	823	735
Levees	655	830	743
Revetments	660	840	750
Powerhouse Construction	674	860	767
Medium Concrete Dams	657	839	748
Lock and Concrete Dams	665	848	757
Large Dam and Powerhouse	662	838	750
Dredging	587	782	685
Miscellaneous	668	846	757

Examination of the data suggests that the opportunity cost of project construction in 1960 — and by inference from 1957 to 1965 — is between 65 and 85 per cent of nominal money cost depending upon which of the synthetic response functions more accurately mirrors reality. Hence, even under our most conservative assumptions concerning the behavior of factor markets, water resource projects bearing an unacceptable benefit-cost ratio of from 0.85:1 to 0.99:1 when evaluated under full employment assumptions are deemed efficient given the pattern of unemployment existing in 1960.

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From this discussion, it should not necessarily be concluded that every water resource project which has been rejected because of benefit-cost ratios between .85 and .99 should be undertaken when the unemployment rate rises above four per cent. The conclusion to be drawn is that there is now an operational model and a computer program by which to reevaluate projects in terms of their opportunity costs when unemployment rates depart from minimum levels. Moreover, to avoid biasing public expenditures in the direction of a single program, all public investments (including tax cuts) should be similarly analyzed to determine what, if any, differences exist among them. To be sure, only through substituting real rather than nominal contract costs in the investment criterion can the analyst isolate expenditures which both are intrinsically economic and are substantial employment generators. Through such analysis the shelf of public works can become a reservoir toward which a more discriminating judgment can be applied than hitherto possible.

It should be pointed out also that the occupational and industrial demands isolated here can be allocated regionally by an intra-national (or inter-regional) inter-industry relations model. Such a model would yield geographically more discriminating information of substantial use in formulating public investment policy in the chronically depressed, high unemployment, or declining areas of the nation. Preliminary results from such models suggest a versatile mechanism for analyzing the consequences of public works expenditures under conditions of less than full employment, hitherto not available to the profession and public decision makers.

Notational Appendix: The Model of Sectoral Demand

The model of sectoral demand can be stated symbolically as follows: Let there be z occupational categories and n industries each of which produce a homogeneous output by combining factor inputs with purchased inputs from other sectors. Let all exchanged commodities and services be measured in physical units and evaluated at base-year prices. In the following notational glossary, capital letters represent matrices and lower case letters represent vectors. Matrix and vector dimensions are stated in parentheses.

x — total cost for project construction.

u — row vector consisting of all ones.

f — column vector ($n \times 1$) of final demand for materials, equipment, and supplies required from each industry as inputs into project construction.

i_2 — column vector ($z \times 1$) of total labor cost for on-site project construction by occupational category.

y — contractor's profit and overhead and other project costs not included in either on-site labor cost or expenditures for materials, equipment, and supplies.

g — column vector ($n \times 1$) of the gross output level of each industry required by the final demand.

A — square matrix ($n \times n$) containing input-output coefficients which define the source and volume of inputs to each industry per dollar's worth of output from that industry.

E — diagonal matrix ($n \times n$) with man-year to output ratios which define the total man-year labor requirements per dollar's worth of gross output in each industry entered on the principal diagonal in the same order as the industries in f and g.

d — column vector ($n \times 1$) of total man-year labor requirements for each industry required by the final demand.

B — rectangular matrix ($z \times n$) containing labor coefficients (in man-years) which define the volume of occupational requirements in each industry per unit of man-year labor requirements in that industry.

m — column vector ($z \times 1$) of total man-year labor requirements for each occupational category required by the final demand.

W — diagonal matrix ($z \times z$) with average annual wage and salary income entered on the principal diagonal in the same order as the occupational categories in m.

i_1 — column vector ($z \times 1$) of total labor cost generated by the final demand by occupational category.

G — diagonal matrix ($n \times n$) with the gross output level of each industry required by the final demand entered on the principal diagonal in the same order as the industries in f and g.

e, r, c, t, p, and q — six column vectors ($n \times 1$) of ratios of value added components (respectively, employee compensation, net interest, capital consumption allowance, indirect business taxes, corporate profits, and proprietor and rental income) to gross output by industry.

e_1, r_1, c_1, t_1, p_1, and q_1 — six column vectors ($n \times 1$) of value added components (respectively, employee compensation, net interest, capital consumption allowance, indirect business taxes, corporate profits, and proprietor and rental income) generated by the final demand by industry.

C — rectangular matrix ($n \times 6$) defined by $[e, r, c, t, p, q]$.

D — rectangular matrix ($n \times 6$) defined by $[e_1, r_1, c_1, t_1, p_1, q_1]$.

$i_1{}^*$ — column vector ($z \times 1$) of total employee compensation generated by the final demand by occupational category.

i — column vector ($z \times 1$) of total labor income generated in each occupational category by project construction.

The total expenditure for project construction is divided into (a) on-site employee compensation, (b) final expenditures for materials, equipment, and supplies, and (c) contractors' profit, overhead, and other project costs not included in (a) and (b).

$$x = ui_2 + uf + y. \tag{1}$$

The gross output of each industry generated by the final demand is defined by the product of the final demand for materials, equipment, and supplies by industry and the inverse of the inter-industry technical coefficient matrix.

$$g = (I - A)^{-1} \cdot f. \tag{2}$$

The set of man-year labor requirements by industry is given by the product of the gross output and the industrial man-year-output ratios.

$$d = E \cdot g. \tag{3}$$

The occupational breakdown of the man-year labor requirement by industry is obtained by multiplying the total industry man-year labor requirements by the set of industry occupational coefficients.

$$m = B \cdot d. \tag{4}$$

The occupational breakdown of generated labor income is obtained by multiplying the occupational man-year labor requirements by the average annual occupational wage and salary income payment.

$$i_1 = W \cdot m. \tag{5}$$

The values of the value added components generated by the final demand for materials, equipment, and supplies by industry are the product of the gross industrial outputs and the appropriate value-added-component-to-gross-output ratios.

$$D = G \cdot C. \tag{6}$$

To equate the estimates of total labor income obtained through the occupational man-year procedure (5) with the estimates of labor income obtained through the value added component procedure (6), the occupational breakdown obtained in (5) is adjusted by the ratio of the total employee compensation figure secured in (6) to the total wage and salary income figure generated through (5).

$$i_1{}^* = (u \cdot e/u \cdot i_1) \cdot i_1. \tag{7}$$

The total employee compensation generated by the expenditure for project construction, by occupational category, is the sum of the occupational distribution of on-site and off-site employee compensation.

$$i = i_1{}^* + i_2. \tag{8}$$

By the definitional accounting identities, the value of a final expenditure is equal to the sum of the value added components which enter its production.

$$uf = ue_1 + ur_1 + uc_1 + ut_1 + up_1 + uq_1. \tag{9}$$

$$uf = ui_1{}^* + ur_1 + uc_1 + ut_1 + up_1 + uq_1. \tag{10}$$