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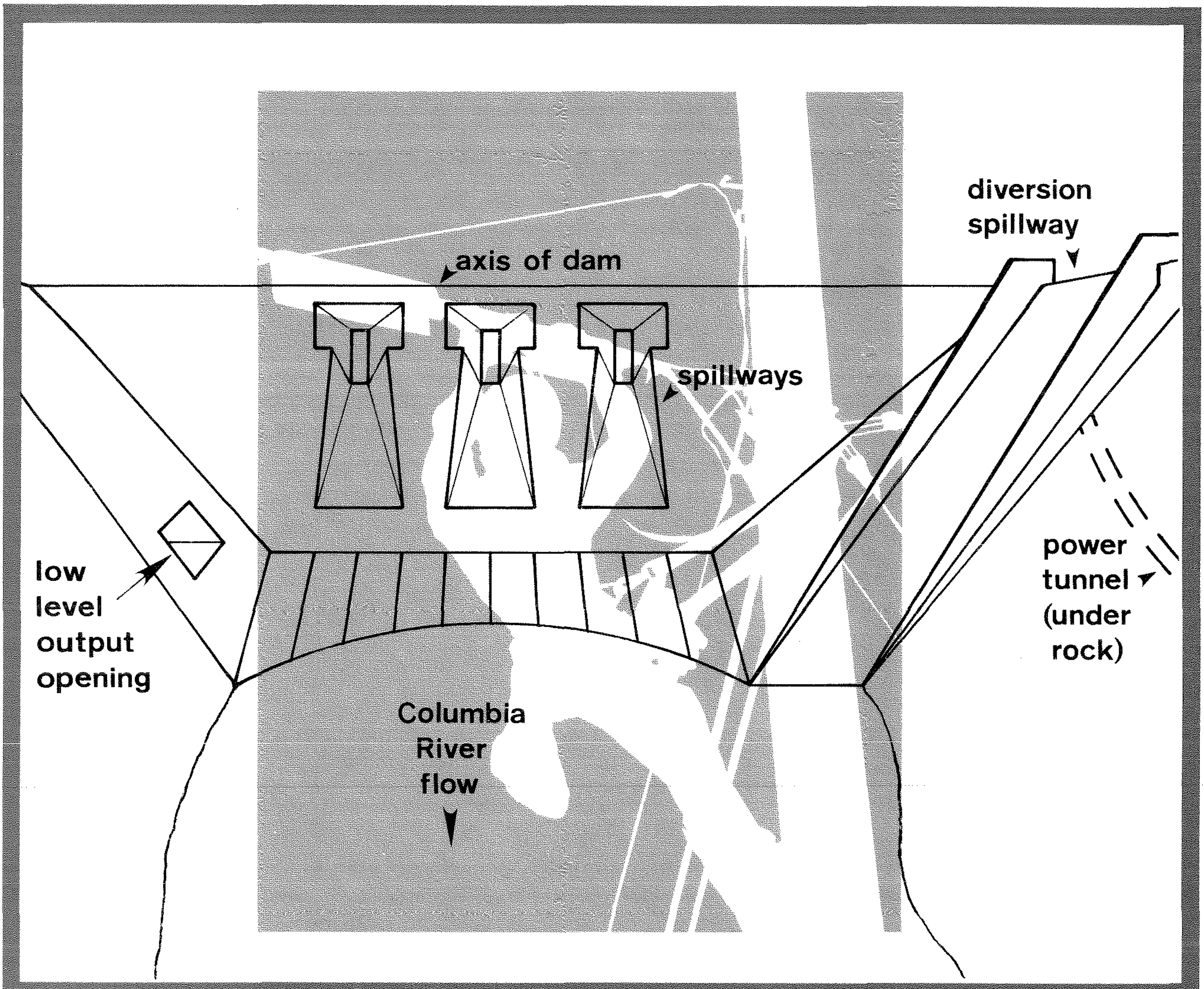

STUDIES IN LABOR MARKETS AND UTILITY PRICING

WINTER 1980

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Studies in Labor Markets and Utility Pricing

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Studies in Labor Markets and Utility Pricing

In today's uncertain inflationary environment, when the state of macro-economic forecasting appears to be in a shambles, it's important to remember that economics can still generate powerful insights into the workings of individual markets. This can be seen from the answers to several policy questions posed in this issue of the *Economic Review*. Should "discouraged workers" be counted in the labor force and therefore in the official measure of unemployment? What role does family welfare assistance play in the high rate of unemployment among young workers? And in another field, should the pricing policies of Pacific Northwest utilities be changed to forestall future shortages of electrical power?

In response to the first question, Rose McElhattan notes that discouraged workers, by reporting that they are not looking for work, are by definition left uncounted in the labor force. But some analysts claim that they should be counted because they represent a labor-force reserve—that is, individuals who are willing and available for work when they are needed. McElhattan concludes, however, that they should continue to be excluded, because large numbers of discouraged workers remain so even during periods of tight labor markets, when substantial shortages of workers exist amid rising inflationary pressures. Moreover, discouraged workers represent only a small percentage of the cyclical movement in the labor force, so that their inclusion would mean very little correction of distortions in official labor-force measures.

McElhattan follows a "job search" approach in analyzing the phenomenon of discouragement for job-market reasons, which accounts for 70 or 80 percent of all discouraged workers. That approach suggests that the individual job seeker responds not only to the availability of jobs—conventionally considered the major determinant—but also to other factors affecting job-search decisions, such as unemployment-insurance benefit payments and expected short-run changes in real wage payments. Male workers appear to be sensitive only to changes in their unemployment rates, but female workers—who account for two-thirds of all those discouraged for job-market reasons—appear to be responsive to other factors as well.

The job-search approach also helps explain why the number of discouraged workers, contrary to common belief, does not decline substantially under high-employment conditions. (At full employment, the discouragement rate for job-market reasons actually tends to remain at about 85 percent of its average level.) Workers with relatively short work horizons generally find it profitable to limit the amount of job search, which is a costly undertaking. If not finding work within that relatively short time period, they may drop out of the labor force. "Many discouraged workers thus would expect to hold jobs, once found, for relatively short durations. Or workers may search the best-paying jobs first, and not finding employment, would choose to wait for normal job turnover—because that is the most profitable choice for them to make—rather than accept lower-paying jobs."

In a second study of labor-market problems, Randall Pozdena attempts to identify the origins of the high and growing rates of youth unemployment that the nation has experienced in recent years. (In 1978, teenagers alone were responsible for more than one-fourth of total

U.S. unemployment—and those under 25 accounted for roughly one-half of all jobless workers, but for less than one-third of the entire labor force.) Pozdena notes several studies which attribute youth unemployment to developments adversely affecting labor demand; for example, minimum-wage legislation, which tends to raise the cost of unskilled labor and thereby reduces the demand for such labor. But Pozdena also notes the importance of supply-side factors; for example, family welfare programs, which tend to reduce young people's willingness to accept or keep available jobs even though they continue to report an interest in finding work.

Analyzing the results of a controlled experiment involving welfare families in Seattle and Denver, Pozdena reaches the conclusion that youths tend to respond to welfare programs by reducing labor-market activity. "Thus, young people do not appear to be insulated from the work-retarding effects of welfare programs." Secondly, the results are consistent with the argument that family welfare support contributes to measured youth unemployment. Pozdena finds that the welfare experiment had the effect on youth of delaying their employment without delaying their entry into the labor force.

Most importantly, the study highlights the relevance of considering supply as well as demand factors. "There may be considerably more volition in the pattern of youth unemployment than is generally assumed. Although it is very difficult to determine precisely the effect of supply-side factors—such as attitudes, tastes, family structure, and family economic status—those factors may contribute significantly to the trends that have been observed in youth unemployment. Policy prescriptions thus can differ considerably, depending upon whether the problem has a demand-side or supply-side genesis. The results of this study suggest that a policy to eradicate youth unemployment by making jobs more available—through public-employment programs, for example—may not be completely successful in reducing unemployment among youths from welfare families."

Turning to another subject, Yvonne Levy warns of the danger of electric-power shortages in the Pacific Northwest during the 1980's, and adds that shortages are already a reality to aluminum producers and other major industrial customers in that area. Congress is now considering new institutional arrangements to balance demand and supply. "But by failing to address the fundamental cause of the disequilibrium—namely, the present inefficient pricing policies followed by the Bonneville Power Administration and other regional utilities—this Congressional approach is unlikely to provide a permanent solution to the region's electrical-supply problems." Bonneville's role is critical, because that agency is the wholesale supplier of over one-half of the total electricity consumed in the Pacific Northwest.

Levy argues that Bonneville should base its power rates not on average cost, but rather on long-run incremental cost. (The former is total cost divided by the number of units to be sold; the latter is the cost of producing additional electricity, taking into account the need to add more fixed factors, namely plant facilities.) "This pricing approach would result in a more efficient allocation of resources, because rates would reflect the true cost of the resources expended to provide consumers with each additional block of power. It would significantly lower the future demand for Bonneville power because its price would be much higher than under the current average-cost pricing method. As a result, substantially less new generating capacity would be required than is currently forecast."

Levy adds that the arguments advanced in favor of incremental-cost pricing apply to the entire electric-utility industry, and not simply to the Pacific Northwest market. "To various degrees, the wide-spread use of average-cost pricing methods is holding electric-utility rates everywhere below those that would prevail under long-run incremental-cost pricing, spurring the growth of electrical consumption and causing too many resources to be devoted to power generation."

Should Discouraged Workers Be Counted in the Labor Force?— A Job-Search Approach

Rose McElhattan*

In the early 1960's, labor-market economists began to focus our attention on the historical correlation between movements in economic activity and the size of the labor force. They found that during economic downturns, sizable numbers of individuals either left the labor force or postponed entering the market, while during the initial phases of business recovery, unusual amounts of workers joined the labor force. These cyclical movements showed the existence of a sizable labor-force reserve, a group of workers willing and available for work according to the state of the economy.

This labor-force reserve posed a special problem for policymakers. During recessionary periods, with some individuals leaving the labor force, the official unemployment rate would not reflect the "true" cyclical amount of unemployment. During the recovery period, in contrast, greater than average increases in the labor force would produce a stickiness in the unemployment rate, preventing it from signaling an improvement in employment and business activity. Consequently, policymakers eventually tried to get better estimates of the size of this labor-force reserve, to determine whether the reserve should be included as part of the official labor force. In 1967, the Census Bureau added a list of questions to the monthly Current Population Survey, to estimate the size of this reserve of "discouraged workers." The survey counts as discouraged those who say they want a job but haven't looked recently because they believe they could not find work even after a job search. On this basis, the availability of a person for work distinguishes those in the labor-force reserve from other labor market non-participants.

Published analyses of discouraged worker survey data, however, do not provide an unequivocal answer to the question of including such workers in the official labor-force count. For instance, many workers who give personal reasons for their discouragement with job-market prospects appear insensitive to changes in the availability of jobs, and thus do not appear to represent a ready labor-force reserve. A recent study by the National Commission for Employment and Unemployment Statistics recommended that discouraged workers be counted outside the labor force until more could be learned about their availability and commitment to the job market.

The resolution of this issue has major public-policy implications. If discouraged workers were added to the labor force, they would significantly increase the official unemployment rate—from 6.0 percent to 6.8 percent in 1978, for example. Under existing laws, such as the Comprehensive Employment and Training Act (CETA), more Federal funds hence would be allocated to states and localities, as a means of meeting the government's full-employment objectives.

The purpose of this paper is to study discouraged-worker behavior within the framework provided by job-search theory, to shed some light on the job-market availability and commitment of discouraged workers. In its study, the National Commission applied a conventional unemployment model, relating discouragement to changes in the unemployment rate—a proxy for overall labor-market conditions—and a time trend, which proxies for the

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many other economic and social factors that affect workers' decisions. A job-search model also focuses upon general labor-market conditions (because they are associated with the cost of finding work), but in addition, it focuses on unemployment-insurance benefit payments and on the real wages the individual expects to receive in the market.

Section I provides a brief discussion of the survey data and characteristics of discouraged workers. This is followed in Section II by a discussion of the conventional unemployment and job-search models. Section III presents empirical results, and the final section discusses the conclusions of the study.

I. Characteristics of Discouraged Workers

Discouraged workers are persons who want jobs, but who have not looked for work recently because they believe they would be unsuccessful even if they looked for jobs. These people are not counted as part of the labor force nor of the officially unemployed, because they do not meet the necessary criterion of having actively searched for work in the last four weeks. The U.S. Department of Labor defines "actively searching" rather liberally; it includes registering for work when one collects unemployment-insurance benefits, talking to neighbors about job opportunities, and actually being interviewed.

The Bureau of Labor Statistics has been collecting data on discouraged workers since 1967, through a set of supplementary questions on the monthly Current Population Survey—the source of the basic employment and unemployment data. Questions regarding labor-force non-participation, however, are asked each month of only one-fourth of the sample, and the data are published only as quarterly averages.

For each individual who is not in the labor force during the week the Current Population Survey is taken, two key questions differentiate discouraged workers from others:

1. Does. . .want a regular job now, either full or part-time?
2. What are the reasons. . .is not looking for work?

A person is classified as a discouraged worker if he/she answers yes or maybe to the first question, if his/her major activity during the survey week was not attending school, and if he/she did not seek work because of one of the following reasons:

1. Believes no work available in line of work or area;
2. Could not find any work;
3. Lacks necessary schooling, training, skills, or experience;
4. Employers think too young or too old; or
5. Other personal handicaps (such as discrimination by employers) in finding a job.

No questions are asked regarding the type of work or the pay the individual has in mind. Since these issues are important to a job seeker, analysts generally interpret an individual's belief that no work is available as meaning a belief that no "suitable" work is available.

Other reasons non-participants give for not looking for work—although wanting work—include school attendance, ill health and home responsibilities. A person will be classified as not discouraged, even if giving reasons for discouragement, when other explanations such as home responsibilities or ill health are also given. The object of the classification scheme is to separate those workers who are available for work from those who supposedly are not, since these others have responsibilities or physical handicaps that would keep them from accepting work even if it were available. This availability is at the heart of the contention that discouraged workers should be included in the official labor force.

Most people not in the labor force during the typical survey week in 1978 did not want a job at that time (Table 1). About 5.3 million people reported wanting a job—but only a portion of these, 845,000 persons, offered reasons related to discouragement over job prospects for not seeking work. Discouraged workers represented 0.5 percent of the population in 1978, and if included in the labor force would have increased the official unemployment rate from 6.0 percent to 6.8 percent.

Discouraged workers who believed that no work was available, or who could not find any work, were classified as discouraged for job-market reasons. The others were classified as discouraged for personal reasons. The number of people giving job-market reasons for discouragement has exceeded those citing personal factors ever since the survey began, except in the very first quarter of 1967 (Chart 1). The number of discouraged for job-market reasons (but not for personal reasons) has generally reflected cyclical movements in labor-market conditions. Since the early 1970's, discouragement for job-market reasons has accounted for between 70 and 80 percent of the total.

Most discouraged workers are female; their share of that total has remained close to two-thirds over the past decade regardless of overall market conditions (Table 2). Between 35 and 40 percent of all discouraged workers are females between the ages of 25 and 59 years. The relative number of older discouraged workers, aged 60 and over, has fallen for both sexes since 1968, while the proportion of younger workers (16 to 24) has increased.

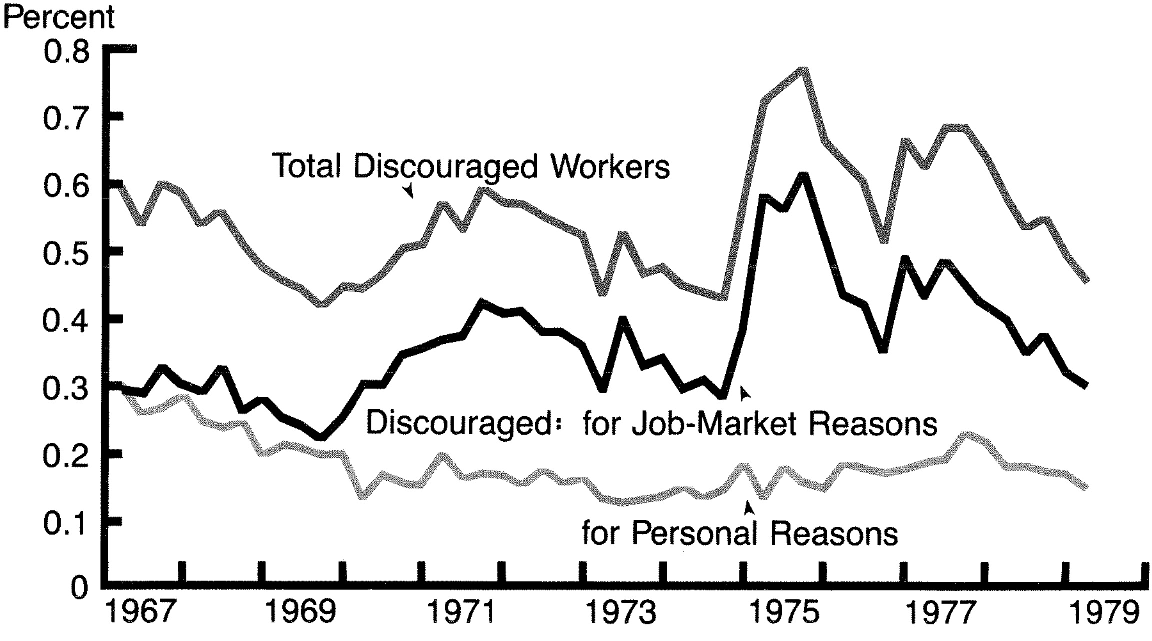
Table 1
Civilian Employment, Unemployment and Persons Not in the Labor Force, 1978
(thousands of persons)

Noninstitutional population, aged 16 and over	161,058
Total labor force	102,537
Civilian labor force	100,420
Employed	94,373
Unemployed	6,047
Not in labor force	58,521
Do not want job now	53,193
Want job now, by reason for not seeking work:	5,328
School attendance	1,374
Ill health, disability	720
Home responsibilities	1,226
Think cannot get job	845
All other reasons	1,163

Source: U.S. Bureau of Labor Statistics, *Employment and Earnings*, January 1979, Tables 1 and 39, annual averages.

Chart 1

Percentage of Discouraged Workers to Noninstitutional Working-Age Population 1967.1–1979.1



How serious are these workers about wanting a job? If, for instance, an individual has not searched for work in over a year, we could ask whether he/she actually wanted or was available for employment. The Current Population Survey does not regularly collect data which could help answer that question, except for a special list of questions added to the survey in September and October 1978.[4] This inquiry found that 44 percent of discouraged workers (and 50 percent of those discouraged for job-market reasons) had looked for work during the previous twelve months. For some people, however, the absence of recent search did not mean lack of labor-market commitment. (Some individuals go directly from employment to discouragement, as in the case of a plant shutdown which provides the major source of employment in a small community.) Adding together those reporting either recent work or search experience in the 1978 survey, 62 percent of the discouraged workers (and 70 percent of those discouraged for job-market reasons) had some form of labor-market commitment—were either employed or officially unemployed—during the prior twelve months. The evidence of labor-market attachment, coupled with the National Commission's evidence that nearly 80 percent of the discouraged contemplate searching for work in the next twelve months,[1] suggests that the duration of discouragement for many of these workers may be relatively short-lived.

Table 2
Discouraged Workers, by Age and Sex

	Thousands of Persons				Percent Distribution			
	1968	1973	1975	1978	1968	1973	1975	1978
All Discouraged Workers	667	679	1,082	845	100.0	100.0	100.0	100.0
Males, 16 and over	213	225	359	305	31.9	33.1	33.2	36.1
16-19	42	58		72	6.3	8.5	8.1	8.5
20-24	10	23	57	43	1.5	3.4	5.3	5.1
25-59	53	67	106	110	7.9	9.9	9.8	13.0
60 and over	107	77	109	79	16.0	11.3	10.1	9.3
Females, 16 and over	455	454	722	540	68.2	66.9	66.7	64.0
16-19	67	75	90	60	10.0	11.0	8.3	7.1
20-24	47	75	110	75	7.0	11.0	10.2	8.9
25-59	240	251	433	305	36.0	37.0	40.0	36.1
60 and over	101	54	88	101	15.1	7.9	8.1	11.9

Source: Employment & Earnings, selected issues.

II. Unemployment and Job-Search Models

The conventional framework for analyzing discouraged-worker behavior is an unemployment model,[1,2] which relates discouragement to the unemployment rate and time-trend variables. The unemployment rate reflects the relative availability of jobs, so that an increase (decrease) in joblessness is expected to increase (decrease) the number of discouraged workers in the population. The time-trend variable represents other economic and social determinants of discouragement about which not enough is known to explain the trends. The unemployment model has been criticized for assuming that labor-supply behavior is unresponsive to wages, and in general for not being based on principles of rational economic behavior.[9] As an alternative, we turn to a model based upon microeconomic theory, in which expected real wages and job-search costs influence job-market participation decisions.

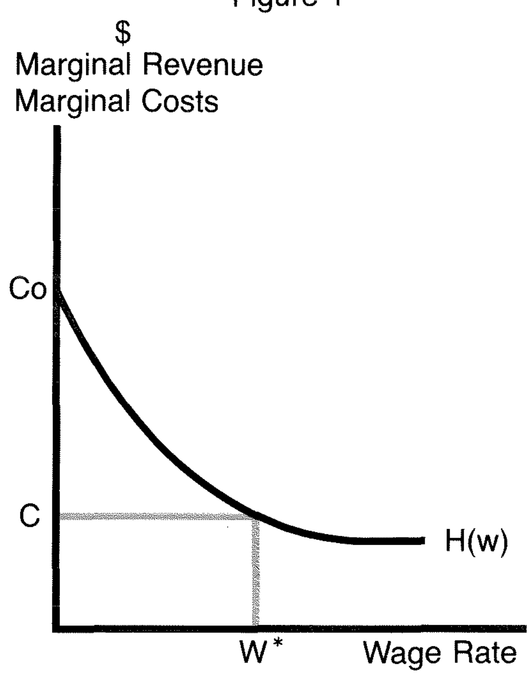
Job-search models are simplified descriptions of how rational individuals who are seeking to maximize utility go about looking for work and accepting job offers.[5,6,8] The general framework is applicable to the issue of whether to participate in the labor market, and may be employed to study discouraged-worker or nonparticipant behavior in general.[13,14] At the heart of the search model is the notion that job-market decisions must be made in the face of uncertainty, especially uncertainty about the wage that will be offered when a particular employer is contacted. This uncertainty leads the job seeker to devise an "optimal search strategy"—a search procedure designed to ensure that the individual accepts only the job offer which provides the maximum expected return (see Appendix 2 for a presentation of the model).

In constructing our job-search model, we begin with an individual who has entered the labor force, knowing that a search for work must be conducted before any offer can be expected. The job seeker presumably has accurate information about the average wage and dispersion of wages in the market for a person with similar qualifications, but is uncertain about the wage that may be offered by any individual employer. Searching for work is costly. We assume that search costs include such direct expenses as transportation and the mailing of resumes, and that those costs are duplicated for each additional job contact. In this simplified model, wages and costs incurred should be interpreted as discounted present values, and the individual is assumed to be risk neutral.

Since the job seeker has knowledge of the market distribution of wage offers and the corresponding costs of generating those offers, an estimate can be made of the maximum expected return from search—the "reservation wage." The individual's optimal search strategy, then, simply is to accept any wage offer which is equal to or greater than the reservation wage, and to reject all other offers (i.e., continue to search).

The job-search procedure alternatively can be described in terms of an optimal stopping rule. If the job seeker refuses a job offer, he/she will incur additional search costs. At the same time, the individual has an expectation of additional gains from further search; that is, an expectation of being offered a wage greater than the current offer. If the expected wage gain is greater than the marginal cost, the job

Figure 1



seeker will refuse the current job offer and continue to search. Similarly, if the expected wage gain is just equal to, or less than, the marginal cost, the current wage offer will be accepted and search terminated. In this manner, the optimal time to stop search and accept employment occurs when the expected wage gain is just equal to the marginal cost of continuing to search. At that point, the individual has been offered the maximum expected return—the reservation wage—from the job market (Figure 1).

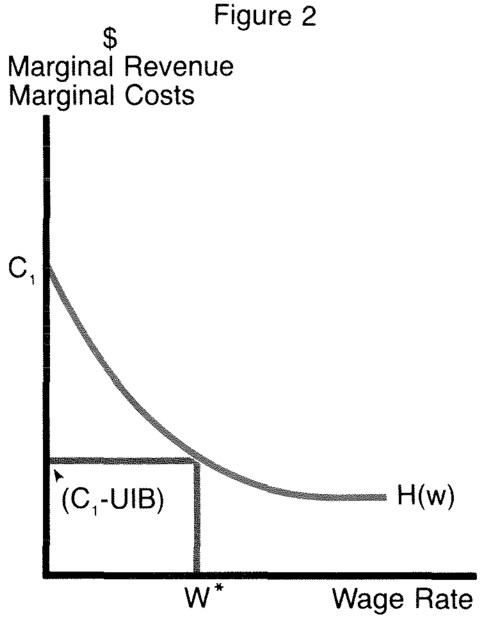
Each point on the locus, H(w), in Figure 1 gives the expected return an individual can anticipate from further search if the reservation wage corresponding to that point is adopted. At the reservation wage, W*, the expected marginal return from search is just matched by the marginal search costs. Consequently, no further gains from search are expected, and the wage, W*, represents the reservation wage the individual adopts in his/her job search.

H(w) slopes downward because the probability of being offered a wage equal to or greater than w declines the higher the current wage offer.[5] Thus these jobs will be pursued only if the marginal search cost is low.

If search costs are increased sufficiently, the individual would drop out of the labor market, because the marginal costs of finding a job are greater than the expected gains offered in the market. This occurs at a cost equal to or greater than c_0 in Figure 1. Therefore, when relatively high search costs exist, or when they increase, some individuals can be expected to leave the market before finding suitable employment.

Unemployment insurance benefits (UIB) will help to cover the direct costs of search for those individuals eligible to collect such benefits. By lowering the net costs of search, UIB can be expected to keep people in the labor force who might otherwise have dropped out because of high search costs (Figure 2). With search costs relatively high at c_1, for instance, the individual will find searching for work unprofitable. The payment of unemployment-insurance benefits, however, reduces search

Figure 2



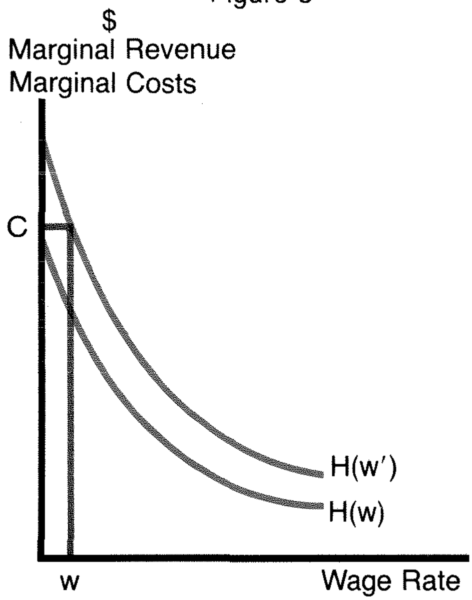
costs, depicted as the difference (c_1 - UIB). At such a level, an individual will search for employment and accept a job offer equal to or greater than W*.

Finally, an increase in the mean expected real wage (current wages adjusted for expected inflation) would tend to decrease non-participation and vice versa. An increase in the average market wage, with costs constant, shifts the H(w) line upward and to the right as in Figure 3. This shift leads to decreased discouragement, since the wage of W* now represents a net gain from additional job search.

Several qualifications should be noted, however. First, we have assumed that the individual places no value on his/her non-market time; that is, time spent in leisure, child care, home maintenance, and any other activity outside the labor force. For some individuals, non-market time carries a relatively high value, while for others the reverse is true. A meaningful solution to the labor-market participation decision exists if, and only if, the reservation wage (the maximum expected return from market work) exceeds the value the individual places on his/her non-market time.[13]

According to our search model, labor-force participation is influenced by real wages. However, the model makes no distinction between

Figure 3



permanent and temporary (or transitory) real wages, although recent theory and empirical results suggest that that distinction is important in labor-supply behavior. Milton Friedman has suggested that the supply of labor may respond differently to a wage change expected to be temporary than to one expected to be permanent, i.e., expected to continue.[3] According to this view, workers plan their time to take advantage of a temporary opportunity to earn higher-than-normal wages, and take more leisure or non-market time later. Therefore, an expected temporary change in wages is likely to have a greater absolute impact upon labor supply than a wage change regarded as permanent. Empirical results have found the distinction between temporary and permanent wages relevant in the labor-supply behavior of married women.[11] Other studies have found temporary wages to be statistically significant in explaining aggregate labor-supply participation and the labor-market decisions of major age-sex groups.[7,17] Our job-search model may be amended, then, to consider the reactions of individuals to both transitory and permanent components of real market wages.

Another question is whether a job seeker will later drop out and become discouraged if there are no changes in search costs or expected market wages. Previously we assumed that an individual would have no motivation to drop out of the labor force once he/she made the initial decision to look for work. This was because we placed no limit on the amount of time the individual would search for employment, and assumed that the individual had no prior information to differentiate among prospective employers. If either of these assumptions is relaxed, we find that the individual may indeed drop out, even in the absence of any changes in search costs or expected real wages.

If a person sets a limit on the amount of time to search for a job, then as time goes on, the chances of finding suitable employment decline. As a result, the individual will tend to lower his/her reservation wage. Since search costs are positive, and the reservation wage falls over time, a point can be reached when continued search becomes unprofitable and the person drops out fo the market. It may be argued that a person's retirement age sets an effective upper limit on the search horizon, so that senior workers are more likely to drop out of the labor market than younger people.[13]

In addition, an individual may have some information about wages that are likely to be offered by particular employers. For instance, help-wanted ads regularly indicate which firms are most likely to have vacancies. Consequently, even before contacting an employer, a job searcher may possess information which permits him/her to distinguish among firms. Under these circumstances, an optimal search strategy involves sampling specific firms in a systematic fashion, rather than randomly, as assumed above.[15] The individual first searches the firm with the highest expected return, and so on down the list, sampling his/her best opportunities first and poorer ones later. In the search process, the reservation wage declines over time, and with positive search costs, the individual may thus find at some point that additional search is no longer profitable. The person drops out of the market, discouraged with having received no suitable job offer.

Finally, income from other sources—such as the wage income of other family members—is likely to affect an individual's labor-force participation decision. All other things being equal, an increase in real wage income of other family members allows that family to have more leisure (non-market time) and more goods. In fact, a change in the average wage paid in the market reflects changes in both the individual's expected wage and the wage of other family members. In the market, then, we might observe two opposing labor flows in response to a change in average real wages. As wages increase, some individuals may leave the labor market due to the higher family income (income effect), and others will enter the market enticed by the higher salaries they can command (substitution effect). Which effect predominates will have to be answered empirically, since economic theory provides no answer to this issue. Also, in light of our previous discussion, these income and substitution effects may differ in magnitude, according to whether the individual regards the change in real wages as transitory or permanent.

The job-search model may be summarized as follows:

$$DW = f(\overset{+}{c}, \overset{-}{uib}, \overset{-}{w^p}, \overset{-}{w^t})$$

where DW = proportion of discouraged workers in the population
c = direct costs of search
uib = unemployment-insurance benefit payments
w^p = permanent wages
w^t = transitory wages

and the signs over the variables indicate the direction of expected impact upon the proportion of discouraged workers in the population. The higher costs of search will lead to higher rates of discouragement, while unemployment benefits act to decrease the net costs of search and the amount of discouragement. Wages, whether permanent or temporary, should work in the same direction although with different strengths. An increase in wage levels should lead to a decline in the discouragement rate as individuals 1) enter the labor market in expectation of higher wages, or 2) decide that they do not want a job because the consequent increase in family income enables them to engage in more non-market activities. In this latter case, a person remains a non-participant, but leaves the ranks of the discouraged for another non-participant group.

III. Empirical Results

We are now ready to apply statistical tests to estimate the influence of the variables suggested by search theory on the number of discouraged workers in the population. Previous studies, as well as our initial work, suggested little connection between changes in economic conditions and the number of workers discouraged for personal reasons.[1,2] Therefore, we have concentrated on those discouraged for job-market reasons, who have accounted for 70 to 80 percent of the total number of discouraged workers over the past decade.

According to search theory, discouragement is likely to be related to a measure of the direct costs of search, to unemployment-insurance benefit payments, and to real wages. After some experimenting, equation (1) was chosen on the basis of best fit, as measured by the higest correlation among variables. The equation was estimated not only for the total number discouraged for job-market reasons, but also for age and sex groups within that total. Finally, the equation was estimated for "other non-participants"—the total number of non-participants in the population less all discouraged workers—as a means of comparing the behavior of various classes of non-participants.

$$\left(\frac{DW}{Pop}\right)_t = a_0 + a_1U_{t-1} + a_2UIB_{t-1} + a_3W_t + a_4W_{t-1} \quad (1)$$

The "a's" are constants estimated by ordinary least-square regression techniques. The subscripts refer to the current quarter "t" and the previous quarter "t-1." The data sources are detailed in Appendix 1, and the variables are defined as follows:

DW/Pop = proportion of discouraged workers for job-market reasons in the civilian population, sixteen years and over. Separate regressions were estimated for the total, and for major age and sex classifications, divided by their respective populations.

U = unemployment rate. The unemployment rate of each age-sex category was used in the equation for the corresponding cohort of discouraged worker. In the aggregate equation, for both discouraged workers and other non-partcipants, the unemployment rate of males aged 25 to 54 was used as an indicator of overall labor-market tightness.

UIB = the ratio of maximum weekly unemployment-insurance benefits to spendable average weekly earnings of a production worker with three dependents. In estimating the net cost of job search, we assume that an individual compares unemployment-insurance benefit payments to net after-tax potential earnings, as measured by UIB.

W = measure of temporary real wages, equal to the difference between current real wages and permanent real wages (see Appendix 1). In line with previous time-series studies, we uncovered no statistically significant association between permanent wages and the incidence of discouragement.[7,17] Consequently, we dropped the permanent wage measure and included only the transitory component of real wages as a determinant of labor supply.

The two equations in Table 3 show the results of estimating equation (1) separately for the percentage of females in the working-age population who are discouraged for job-market reasons (DJOBF), and similarly for males (DJOBM). In neither case is the search framework entirely successful in explaining the discouragement rate over the past decade. For males, the unemployment rate—the proxy for overall job availability and direct costs of search—is the only statistically significant determinant of their discouragement rate. (The statistical F test also indicated that as a group the other variables did not add significantly to the determination of the male discouragement rate.) In contrast, the net cost of search—as captured by both the unemployment rate and relative unemployment-insurance benefits—is a statistically significant determinant of female discouragement. Real transitory wages, both current and lagged one quarter, are also statistically significant factors determining female discouragement. According to search theory, the level of real wages should affect the discouragement rate over time, but our estimates instead find that the *change* in transitory real

Table 3
Equations Estimating Percentage of Female and Male Workers Discouraged for Job Market Reasons*
(Sample Period 1969.1–1978.2)

DJOBF =	.286	+	.102 U_{t-1}	−	.009 UIB_{t-1}	−	1.02 W_t	+	1.14 W_{t-1}
	(1.00)		(6.45)		(−2.28)		(−2.17)		(2.17)
					Mean dependent variable				.50
					$\hat{R}^2$, corrected correlation				.66
					Durban-Watson statistic				1.56
DJOBM =	.228	+	.032 U_{t-1}	−	.001 UIB_{t-1}	−	.026 W_t	−	.123 W_{t-1}
	(1.59)		(4.76)		(−.799)		(−.110)		(−.46)
					Mean dependent variable				.25
					$\hat{R}^2$, corrected correlation				.67
					Durban-Watson statistic				1.90

DJOBF = number of female discouraged workers as a percentage of total female population, 16 years and over.

DJOBM = number of male discouraged workers as a percentage of total male population, 16 and over.

U = unemployment rate of the respective cohort

UIB = maximum unemployment-insurance benefit payments as a percentage of spendable average-weekly earnings of a production worker with three dependents.

W = Current real hourly compensation less permanent real hourly wages.

*t-statistics = statistics in parentheses.

wages over a six-month period—rather than the *level*—is the significant determinant among females. The estimated coefficients associated with the real wage terms are of opposite signs and are not much different from each other, and their sum is not different from zero. This means that any given level of real transitory wages that has persisted for at least two quarters will have no net impact, and only a change in real transitory wages remains as a determinant of the female discouragement rate.

The results suggest that the availability of work may be the sole factor influencing male discouragement with job-market conditions. Additional factors, however, are important in the participation decision of the much larger group of females, who comprise two-thirds of discouraged workers. In particular, both the liberality of unemployment-insurance benefits and the change in real transitory wages have been found to have significant effects on female discouragement decisions.

As the earlier discussion suggests, discouraged males have not been as responsive as females over the past decade to changes in labor-market conditions. Males, on average, place a relatively low value on their non-market time since, as a group, they constitute the primary source of family income. Consequently, they are more likely than females to be labor-market participants, and are less likely to leave the job market after encountering changes in real wages or net search costs. For instance, a one-percentage-point change in their own unemployment rate led to an average change of only .032 percentage points in the male discouragement rate, and to more than three times that amount (.102) in the female discouragement rate (Table 3). Other factors than relatively high non-market value

Table 4
Discouragement Rates[1] of Female and Male Discouraged Workers for Job Market Reasons, by Age‡
(Sample Period 1969.1–1978.2)

Females	Constant	U(t-1)	UIB(t-1)	W(t)	W(t-1)	T	TSQ	Mean Discouragement Rate	$\hat{R}^2$	DW
16-19	.532	.080	−.018	*	*			.64	.21	1.89
	(.614)	(2.87)	(−1.65)							
20-24	.938	.090	−.017	−3.16	2.95			.68	.23	2.50
	(1.11)	(2.58)	(−1.49)	(−2.27)	(1.89)					
25-59	.400	.134	−.009	−.997	1.03			.55	.69	1.99
	(1.21)	(6.80)	(2.06)	(−1.78)	(1.65)					
60 and over	.53	.035	*	*	*	−.025	.0003	.21	.29	1.09
	(4.13)	(2.37)				(−3.3)	(3.27)			
Males										
16-19	.586	.029	*	*	*			.56	.27	2.06
	(1.04)	(2.14)								
20-24	.428	.037	*	*	*			.36	.52	1.88
	(1.10)	(4.05)								
25-29	.058	.022	*	*	*			.15	.52	2.10
	(.540)	(3.54)								
60 and over	.41	.049	*	*	*			.29	.29	2.34
	(1.12)	(1.78)								

1 Discouragement rate is the number of discouraged workers in a cohort as a percentage of their respective population.
* Not significant at 10-percent level of significance. See Table 3 for explanation of variables. T is time (1969.1 = 1), and TSQ is time squared.
‡ t-statistics in parentheses.

may be reflected in the greater sensitivity of females to changes in unemployment conditions. For instance, job discrimination against females will mean a higher average search cost for them when overall labor market conditions change. However, our tests cannot separate out these elements, which are not necessarily mutually exclusive.

The general pattern observed for the aggregate male and female groups is also evident when the groups are broken down by age (Table 4). In particular, unemployment-insurance benefits and the change in transitory wages are statistically significant only among the various female groups. For females 60 and over, trend coefficients indicate that the percentage of discouraged workers has been declining over time, which is not true for any other age-sex group. Our results also suggest that the chances of discouragement decline with age, which is contrary to the implication of our earlier argument that years to retirement may set a significant limit on the work and search horizons of individuals. This may be because younger workers expect to work a relatively short time in a particular job, which may limit the amount of time the individual can profitably spend on search.

The various age groups also respond differently to changes in unemployment, with young workers generally, being less sensitive than others to changes in unemployment rates. For instance, a one-percentage-point change in their own unemployment rate changes the discouragement rate of females aged 25 to 59 by 24.4 percent (Table 5), compared with changes of 12.5 percent and 13.2 percent for females aged 16 to 19 and 20 to 24, respectively. To summarize, younger workers generally are more likely to become discouraged about job prospects than their older cohorts, but younger workers are relatively less sensitive to changes in the availability of jobs and therefore less likely to move out of discouragement when job opportunities improve.

Discouragement at full employment

According to a popular view, discouragement depends solely, or to a great extent, on lack of jobs available, so that the number of discouraged workers would greatly diminish under conditions of nationwide full employment. However, our statistical tests indicate otherwise. We reestimated equation (1) for each age-sex group, substituting a measure of nationwide labor-market tightness for the cohort's own unemployment rate. However, we used the prime-age male (25 to 54 years) unemployment rate for this purpose instead of the overall unemployment rate, because the latter's value as an indicator over the past two decades has become marred by various demographic and institutional changes in labor markets.

We derived estimates of the number of discouraged workers that could be expected under full-employment conditions by assuming full-employment values for each of the right-hand-side variables in equation (1)—specifically, by assuming a prime-age male unem ployment rate of 3.1 percent, a value of 73 percent (the 1979 estimate) for the relative rate of unemployment-insurance benefits, and no change in transitory real wages. Under full-employment conditions, we estimate that 523,000 individuals would be discouraged for job-market reasons, or .32 percent of the Sep-

Table 5
Responsiveness to a One Percentage-Point Change in Own Unemployment Rates among Age-Sex Cohorts (1969–78 average)

	Percentage Change in Discouragement Rates[1]
Females	
16-19	12.5
20-24	13.2
25-59	24.4
60 and over	16.6
Males	
16-19	5.2
20-24	10.2
25-59	14.7
60 and over	16.9

1 Values are calculated at the mean discouragement rate of each cohort. For instance, for female teenagers, (.080/.64) × 100 = 12.5 percent. Values are derived from coefficients of the unemployment rates and the mean discouragement rates for each cohort (Table 4).

tember 1979 population (Table 6). Just over half the discouraged at full employment would be prime-age workers (40 percent female and 12 percent male). Teenages and young adults (20 to 24) share about equally in the next largest group, comprising 35 percent of total discouraged, and senior workers make up the remaining 12 percent.

It is perplexing that so many workers would remain discouraged under conditions of nationwide labor-market tightness. Over the entire period 1967I–1978II, the discouragement rate for job-market reasons has averaged .37 percentage points. At full employment, then, the discouragement rate of .32 percent is 85 percent of its mean level, and 60 percent of the peak discouragement rate reached during the 1975 recession.

Search theory suggests several reasons for this paradox. First, an individual's work horizon sets a limit on the time he/she can profitably look for work, as long as the cost of search is positive. Consequently, those with shorter work and search horizons are more likely than others to leave the labor market. Discouraged workers, as a group, may have relatively short work horizons. Again, we may expect discouragement to persist, on average, if the job market is characterized by a dispersion of wages paid for similar skills, and individuals search systematicaly rather than sequentially for work, and so choose the "best" possibilities first. As an individual continues searching, his/her reservation wage declines. At some point it may pay the individual to leave the market for a while and wait for normal turnover to open up higher-paying jobs, rather than accept a relatively low-paying job. Similar behavior appears to be optimal under conditions in which the highest expected pay is associated with the minimum wage.[10] In that case, individuals find it profitable to queue for jobs in the covered sector rather than accept lower wages in the noncovered sector. The same type of behavior may be seen in the case of discouraged workers when they state that they plan to enter or re-enter the job market within the coming year—which suggests a tendency simply to wait for the better-paying jobs to become available.

Table 6
Estimated Discouraged Workers for Job Market Reasons Under Conditions of Full Employment*

	Thousands of Persons	Percent Distribution
Total	523	100.0
Females, 16 and over	345	66.0
16-19	49	9.4
20-24	58	11.1
25-59	212	40.5
60 and over	26	5.0
Males, 16 and over	178	34.0
16-19	44	8.4
20-24	33	6.3
25-59	64	12.2
60 and over	37	7.1
Discouragement rate, total	.32	
Average discouragement rate (1967.1–1978.2)	.37	

* Numbers of discouraged workers derived from September 1979 population estimates, with assumptions of 3.1-percent unemployment rate (male, 25-54 years) and 73-percent relative value of unemployment benefits (early 1979 value). Based on estimates from 1969.1–1978.2 sample period.

Discouraged vs. other non-participants

In its study, the National Commission asked, "Is the criterion of availability a useful one for distinguishing between a ready labor-force reserve and other non-participants?" The alleged availability of discouraged workers is at the heart of the argument that they represent unutilized and ready resources which should be considered as part of the official labor force. Yet special surveys have found that sizable numbers of individuals who had stated that they did not want a job (were unavailable although wanting to work) were in fact in the labor force one or two years later—sometimes in greater numbers than those who had said earlier that they were available for work.[1]

To shed some light on this question, we have estimated the job-search model equation (1) not only for discouraged workers for job-market reasons but also for "other non-participants," defined as total non-participants less workers discouraged for both personal and job-market reasons (Table 7). These estimates are designed to compare the responsiveness of the labor-market participation rates of both groups to changes in unemployment and other labor-market indicators. Both the one-quarter lagged and long-run responses are given for other non-participants, because our statistical estimates indicate that non-participants respond slowly over time to changes in economic variables, so that their initial response is smaller than the ultimate one. In contrast, no lagged response can be identified in the discouraged-worker group.

Our results indicate that individuals discouraged for job market reasons are more responsive than other non-participants to changes in labor-market conditions. For instance, an increase in the availability of jobs, as measured by a one-percentage-point decline in the prime-age male unemployment rate, on average, led to a 20.8-percent decline in the discouragement rate but only to a 0.7-percent long-run decline in the other non-participation rate. The estimates generally suggest that discouraged workers, as a group, show a greater willingness and availability to seek employment than the other non-participation group.

Another distinction between the two groups stems from their reaction to an acceleration or deceleration in transitory real wages. An increase in these wages is associated with a decline in the discouragement rate, and with an increase in non-participation. Some families apparently regard an improvement in real wages, and resultant rise in income, as a means of supporting more non-market time. Subsequently, some family members leave the labor force, causing an increase in the aggregate other non-participation rate. However, the same wage circumstances lead to a decline in the proportion of discouraged in the population, as these individuals, motivated by improving real wages, seek employment or leave the discouraged-worker category for other non-participation.

Because discouraged workers represent a relatively small percentage of the population, they generally fail to influence cyclical movements in the labor force. When the unemployment rate of prime-age males increases by one percentage point, the initial reaction is an almost equal increase in both the number of discouraged and other non-participants, but ultimately, the movement in the labor force is dominated by an increase in other non-participants rather than discouraged workers (Table 7, top line). However, unemployment benefit payments and changes in transitory real wages

Table 7
Response of Discouraged Workers for Job Market Reasons, and Response of Other Nonparticipants, to Various Economic Changes*

	Change (Percent)			Change (Numbers)		
	DWR‡	Other Nonparticipants		DWR‡	Other Nonparticipants	
		First Quarter	Long-Run		First Quarter	Long-Run
Increase of 1 percentage point in prime-age male unemployment rate	20.8	0.37	0.7	122,770	157,530	425,720
Increase of 1 percentage point in relative unemployment-insurance benefits*	−0.8	−0.2	−0.5	−4,780	−122,770	−331,810
Increase of .01 percentage points in the change in real wages	−1.35	0.08	0.21	−7,970	45,920	124,110

* Changes are stated in terms of an increase in each economic variable; for a decrease, the signs are reversed. The equations were estimated over the period 1967.1–1978.2. Percent changes are evaluated at the mean rates of .37 percent for discouraged workers for job-market reasons, and 37.46 percent for all other non-participants. Numbers are estimated relative to the September 1979 working-age population of 159.4 million.

‡ Discouraged workers for job-market reasons, as a percent of the civilian noninstitutional population.

also affect participation behavior, and at times can reverse the response to changes in unemployment.

The general pattern can be discerned in both of the business cycles that have occurred since discouraged-worker data first became available (Table 8). During the two recovery periods, the decline in other non-participation was responsible for between 80 and 94 percent of the cyclical increase in the labor-force participation rate—and the same was true, only in the opposite direction, during the 1970–71 downturn. However, during the more recent decline, close to 70 percent of the drop in labor-force participation was associated with an increase in discouragement about job-market prospects. This reversal can be traced largely to the fact that relative unemployment-insurance benefits play a somewhat larger role in the labor-market participation decisions of other non-participants than they do for discouraged workers. During the 1974–75 recession, these benefit payments increased substantially, and tended to keep many individuals in the labor force who would otherwise have left and been included among other non-participants. The Current Population Survey purportedly is designed to distinguish between those individuals who want work (and are available for work) and all other non-participants. The question is whether the availability criterion in fact captures the cyclical component of the labor force—the so-called labor-force reserve. We found that between 80 and 95 percent of the cyclical movement in the labor force is generally due to individuals entering and leaving the non-participation category, and not to discouraged workers. Consequently, we conclude that the availability criterion is not sufficient to capture those workers or groups of workers who actually comprise the major source of the labor-force reserve.

Table 8
Cyclical Responses of Discouraged Workers and Other Nonparticipants

	Cyclical Change in the Labor Force			
	Decline 1970.1–71.2	Recovery 1971.2–73.4	Decline 1974.1–75.4	Recovery 1975.4–76.1
Nonparticipation rate (total)	.74	−.79	.29	−.15
Nonparticipation rate excluding discouraged workers	.65	−.74	.08	−.12
Percent of total rate	(88.0)	(94.0)	(28.0)	(80.0)
Discouraged worker rate	.09	−.05	.21	−.03
Percent of total rate	(12.0)	(6.0)	(72.0)	(20.0)

IV. Summary and Conclusions

With the help of job-search theory, this paper has analyzed the behavior of workers who give job-market reasons for their discouragement—à group which accounts for 70 to 80 percent of the total number of discouraged workers. Our approach suggests that unemployment-insurance benefit payments (by reducing the cost of looking for work) and expected real wages will influence an individual's labor-force participation decisions—as well as his/her chances of finding a job. The results may be summarized as follows.

(1) Although those discouraged for job-market reasons appear more responsive than other non-participants to changes in labor-market conditions, the discouraged generally represent only a small proportion of the total cyclical movement in the labor force. Consequently, the availability criterion of the Current Population Survey apparently does not succeed in separating the labor-force reserve from other groups of non-participants.

(2) Under conditions of nationwide full employment, we should observe a relatively small percentage of discouraged workers. At least according to the popular impression, discouraged workers are readily available for work, and therefore their numbers should greatly diminish, if not disappear, under general conditions of high employment. In fact, this is the expected behavior of a labor-force reserve. However, we find that at full employment, the discouragement rate for job market reasons actually tends to remain at about 85 percent of its average level, and at about 60 percent of its peak (1975) rate. Our job-search approach suggests several reasons for this highly perplexing result. Workers with relatively short work horizons generally find it profitable to limit the amount of job search, which is a costly undertaking. If not finding work within that relatively short time period, they may drop out of the labor force. Many discouraged workers thus would expect to hold jobs, once found, for relatively short durations. Or workers may search the best-paying jobs first, and not finding employment, would choose to wait for normal job turnover—because that is the most profitable choice for them to make—rather than accept lower-paying jobs.

(3) The job-search approach was not entirely successful in explaining discouragement behavior over the past decade. That approach suggests that the individual job seeker responds to the expected market return, as estimated by the direct costs of search (proxied by the unemployment rate), the reduction in such costs (measured by unemployment-insurance benefits), and the expected real wage rate. However, we found that males, who account for one-third of the discouraged for job-market reasons, were sensitive only to changes in their unemployment rates. Females, who account for the majority of discouraged workers, in contrast were also responsive to changes in relative unemployment-insurance benefits and to changes in real wages that were believed to be above or below average (that is, a transitory real wage). Search theory suggests that it is the *level* of real wages (transitory or permanent), and not the change, which is pertinent in job-market decisions. Our results suggest, however, that factors other than the availability of jobs (the conventional determinant of discouragement) enter into the determination of discouraged workers' labor-supply decisions. Discouragement is not solely a consequence of the availability of jobs, but also of unemployment-insurance benefit payments and expected short-run changes in real wage payments.

Should discouraged workers be included in the labor force and therefore in the official measure of unemployment? Since they represent only a small percentage of the cyclical movement in the labor force, their inclusion will do very little towards correcting any distortions in official labor-force measures. Moreover, most of these individuals appear unresponsive to changes in labor-market conditions. Large numbers of discouraged workers remain so even during periods of tight labor markets, when substantial shortages of workers exist amid building inflationary pressures. This suggests that most discouraged do not fit the criterion of a ready labor-force reserve—individuals willing and available for work according to the state of the economy—and therefore should not be included in official labor-force statistics.

Appendix 1
Data Sources

The Bureau of Labor Statistics is the basic source for U.S. employment and unemployment data. Discouraged-worker data, for example, are found in the BLS publication, *Employment and Earnings.*

UIB: Maximum weekly benefits payable under the unemployment-insurance system were deflated by the consumer price index and divided by average spendable weekly earnings of production worker with three dependents. The maximum weekly benefits series was taken from the Board of Governors MPS model database, and the consumer price index and average spendable weekly earnings series were taken from the FRB San Francisco Database.

U: The unemployment rate of each age-sex category was taken from the FRB San Francisco database.

W: Employee compensation rate in nonfarm private domestic business, deflated by the GNP implicit deflator, less permanent real wages. This is estimaged as follows: for permanent wages, we assume that real wages are equal to a percentage of labor productivity. That percentage is equal to labor's share in total income produced (gross business domestic product)—a share which has trended slowly over time. The share of labor can be written as an identity:

k = total labor income/gross business domestic product, where total labor income is equal to wages times the number of workers, $W \times N$, and gross business domestic product is equal to the general price level times the amount of real output produced, $P \times Q$. We may rewrite the above as,

$$k = (W \times N)/(P \times Q), \text{ or rearranging}$$
$$(W/P) = k \times (Q/N),$$

which states that real wages are a percentage of labor productivity. We estimated permanent real wages by first estimating the trend share of labor k_t, then the trend rate of output per worker $(Q/N)_t$,

$$\text{estimate of } (W/P) = k_t \times (Q/N)_t.$$

The wage series was taken from the MPS model database of the Board of Governors.

Appendix 2
Job-Search Model of Labor-Force Discouragement

Following the discussion in the text, the dispersion of offers considered by the job searcher is incorporated into the model by assuming that there is a cumulative probability distribution, F, of wages which govern theoffers tendered. We assume that the distribution of wages is invariant over time in this simplest case (so that business-cycle effects are ignored), and that wage offers are independent random occurrences from that distribution, F. In any given search period, the probability that the individual will receive an offer of w or less is F(w), and this probability, given our assumptions, does not depend on any past offers at the time the offer is made. We further assume that the individual seeks to maximize his/her expected net benefits, which are equal to expected wages less expected costs of search.

In the following the symbols are defined as
c = cost per period of search
w = random variable denoting a wage offer
F(w) = cumulative probability distribution of w; f(w) is the probability density function.
y(w) = return from a job offer, w.

If a wage offer is accepted after the nth offer, then the return is the value of the nth offer, w_n, less the cost of search, which we assume is a constant each period, times the number of job offers.

$$y = w_n - cN$$

Let w* signify a minimum acceptable wage; the individual will accept an offer if it is equal to or greater than w*. The individual's task is to choose w* which maximizes his/her expected return. Symbolically the expected return from search is

$$E(Y) = E(w/w \geqslant w^*) - cE(N) \qquad (2)$$

The maximum, w*, is derived by maximizing E(Y), with respect to w*. To derive w*, first note that $E(w/w \geqslant w^*)$ is the mean conditional wage, it is the expected wage conditioned on that wage being equal to or greater than w*.

$$E(w/w \geqslant w^*) = \frac{\int_{w^*}^{\infty} wf(w)\, dw}{\int_{w^*}^{\infty} f(w)\, dw} = h \qquad (3)$$

Secondly, note that the expected value of N, E(N), is the expected period of search until a wage offer is equal to or greater than w*. It has a geometric distribution,

$$P(N=k) = p(1-p)^{k-1}$$

where the parameter p is the probability of "success",

$$p = \int_{w^*}^{\infty} f(w)\, dw$$

$$= 1 - F(w^*),$$

and the mean duration of search is

$$E(N) = \frac{1}{p.} \qquad (4)$$

We may rewrite (2) as

$$E(y) = \frac{\int_{w^*}^{\infty} wf(w)\, dw}{\int_{w^*}^{\infty} f(w)\, dw} - cE(N) \qquad (5)$$

$$= h - cE(n)$$

The first-order conditions for deriving the maximum expeated gain, max E(Y), is given by

$$\frac{dE(Y)}{dw^*} = \frac{d}{dw^*}(h - cE(N) = 0$$

$$= \int_{w^*}^{\infty} wf(w)dw - w^* \int_{w^*}^{\infty} f(w)\, dw - c = 0$$

$$\text{or, } c = \int_{w^*}^{\infty} (w - w^*)\, f(w)\, dw = H(w^*) \qquad (6)$$

The value w* is the wage offer which satisfies the equality in (6), The equality (6) has a familar economic interpretation. The cost, c, is the marginal cost of generating another job offer, which is equal to the expected marginal return from searching another period, H(w*)[1]. The critical value w* is also known as the reservation wage, or the minimum wage an individual will accept.

1 Note that H(w*) is a strictly decreasing function of w*t, with slope equal to $-(1 - F(w^*) = -p$, and with

$$\frac{d^2H(w^*)}{(dw^*)^2} > 0.$$

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Welfare and Youth Unemployment: Evidence From a Controlled Experiment

Randall J. Pozdena*

Joblessness among the young accounts for a substantial portion of total unemployment in the United States. In 1978, approximately half of all unemployed workers were less than 25 years old. Teenagers alone were responsible for more than one-fourth of total unemployment. In 1978, when the overall unemployment rate averaged about 6 percent, the teenage unemployment rate topped 16 percent.

Since unemployment rates critically influence the conduct of macroeconomic and labor-market policy, economists have come to realize the necessity of identifying the origins of the high and growing rates of youth unemployment that the nation has experienced in recent years. To this end, numerous studies have attempted to identify factors contributing to the adverse performance of youth in the labor market, and to determine how much of their unemployment represents a serious problem for our society.[1]

An individual is classified as unemployed if he is seeking part-time or full-time employment but is not currently working. Much of the discussion concerning youth unemployment has focused on developments which may have adversely affected the availability of work—i.e., the *demand* for youthful labor. Several studies, for example, have identified minimum-wage legislation as a major contributor to measured youth unemployment, because it raises the cost of unskilled labor and thereby reduces the demand for such labor.[2] A study by James F. Ragan suggests that as much as 4 percentage points of the increase in youth unemployment between 1966 and 1972 can be traced to increases in the minimum wage and to extension of its coverage.[3]

Other economists have suggested that the movement of industry away from the central city has made job opportunities less available to the heavy concentrations of poor urban youth. This may particularly have affected the demand for labor of minority youth.[4] Trends in general macroeconomic conditions also may have weakened the demand for youth labor. Richard Freeman concludes, for example, that employment of youth is very sensitive to the industrial composition of jobs and the general condition of the economy. Areas with heavy trade and service employment and rapid economic growth tend to have better youth employment opportunities than elsewhere.[5]

Although these and other factors affecting labor demand have undoubtedly contributed to youth unemployment, *supply-side* influences can also play a significant role. Changes in attitudes or changes in family economic circumstances over the last several decades may have reduced young people's willingness to

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supply their labor. Such changes may increase measured unemployment if they reduce young people's willingness to accept or keep available jobs even though they continue to report an interest in finding work.

In this view, youth find jobs available, but their unrealistic wage expectations or their preference for leisure cause more casual or protracted search for employment, thereby generating increases in measured unemployment. Among the factors possibly contributing to such behavior is family welfare assistance. Although the concentration of youth unemployment in areas with traditionally large welfare populations—such as central cities—is suggestive of a link between welfare and unemployment, there are problems in establishing a strong empirical case for such a relationship. When using traditional aggregate data or data from panel surveys, it is difficult to control for all of the factors which may influence behavior. Also, it is difficult to disentangle cause and effect: families may be on welfare *because* of the unemployment of their members and not the other way around.

This paper investigates the relationship between family welfare assistance and youth labor-market behavior using data from a controlled welfare experiment. Welfare policy evaluation increasingly depends on experimentation, because the economic environment of the subjects can be experimentally manipulated and thus the direction of cause and effect can be made clear. In addition, the availability of a control group permits the impact of a welfare program to be isolated from other effects (such as changing macroeconomic conditions) which might affect labor-market behavior as well. (Appendix A contains a discussion of the use of experiments in economic analysis.)

The results demonstrate the potential importance of supply-side factors in determining the labor-market behavior of youth. Although the specific data used here are not ideally suited to direct measurement of unemployment rates, the results are suggestive of an association between youth unemployment and welfare assistance. After a brief discussion of the theoretical link between these variables, the paper describes the experiments that generated the data used in the research, as well as the method of empirical analysis. The paper concludes with a discussion of the experiment's results and their policy implications.

I. Welfare and Youth Unemployment

Why should family welfare assistance influence youth labor-market behavior? To understand the circumstances under which such a linkage might exist, we must (1) review the effects of a welfare program on the economic environment of the family, (2) discuss how the effects of family assistance are transmitted to youth, and (3) examine the likely response of youth to these stimuli. Each of these points has received considerable attention in the literature.[6] Rather than attempt a survey of earlier work, we simply summarize below the key implications of earlier theoretical work.

Although the specific characteristics of existing and proposed welfare programs vary considerably, most have a number of features in common. An obvious common feature is the provision of non-wage income to recipient families through support or benefit payments. By supplementing earned income, welfare programs expand the budgetary opportunities of the affected family. A second feature of family-assistance plans is their incorporation of procedures to "phase out" support as the earned income of the family rises. This is accomplished by reducing the welfare benefits by a fixed fraction of additional earned income. In effect, this linkage of benefits to earned income is a "tax" on earned income, which reduces the perceived net wage associated with additional work. For example, in the original Aid to Families with Dependent Children (AFDC) program, this tax rate was (statutorily) 100 percent, because support was reduced one dollar for each dollar of additional earned income. In effect, the perceived net wage on the margin was zero because of the implicit 100-percent tax.

Thus welfare programs influence both the income of the family and a major price variable—the net wage. In the case in which welfare support is received by a single individual (rather than a family), the implications of these features are straightforward. The support increases the non-wage income of the individual, and the tax provisions reduce the returns to additional work on the margin. As we will show later, the individual likely will respond to these changes by increasing consumption and reducing the amount of time worked, relative to someone for whom welfare is not available.

The implications of welfare support are much more complicated, however, when we consider that such support is typically directed at a *family* rather than at an individual. That is, although the head of the family is the formal recipient of any payments, the income of *all* of the family members typically enters into the computation of eligibility for support payments. A youth's response will depend upon the manner in which the features of the welfare program are transmitted to the youth through family decision processes.

A family may behave like a single decision unit, for example, maximizing family utility subject to a budget constraint which involves the earnings of all of the family members. In effect, the youth's working behavior is determined jointly with the working behavior of all of the other family members. A welfare program that provides support to the family and taxes additional family earnings will thus directly influence the behavior of all family members, since they are all interdependent.

Under a separate method of decision-making, however, the youth may view his income as his own, so that any change in his situation as a result of welfare is at the parents' discretion. In this case, the youth's perception of his income and net wage would not automatically be affected by the family's participation in a welfare program. But we could visualize some such effect if we make certain assumptions about the way in which parental assistance to their children is likely to be affected. For example, the parents could choose to subsidize the youth's leisure or schooling, as part of their own consumption decision in response to receiving welfare support.

These examples illustrate the difficulty of stating precisely how the features of family welfare programs are transmitted to a young worker. Let us assume simply that youth experiences—to some degree—a reduction in net wages and an improvement in non-wage income as a result of the welfare program. What are the likely effects of this changed economic environment on the youth's labor-market behavior?

The simplest way to conceptualize the effects is to picture the youth making the choice between work and leisure. The trade-off is an obvious one—each additional hour of leisure results in a loss of an hour's wages. Thus, the opportunity cost or "price" of leisure is the wage; in an environment in which taxes are levied on wages, the *after-tax* wage is the price of leisure.

A welfare program can affect this choice because it increases the individual's income and—because of support "phase out" provisions—*lowers* the after-tax wage and thus the "price" of leisure. Both of these changes should increase the demand for leisure (in lieu of work). This is because individuals tend to consume more of a good (like leisure) as their income rises or as the price of the good falls. In the case of a welfare program, both effects occur and reinforce one another.

This simple argument thus suggests that a welfare program will tend to *decrease* the willingness to work on the part of the affected individuals, everything else being equal; that is, it will cause a reduction in labor supply. However, this does not lead to clearcut inferences concerning the effect of welfare on the *unemployment rate*. An increase in that rate requires withdrawal from work without an offsetting withdrawal from the labor force. The simple labor-supply model presented above cannot distinguish between these two effects.

Since the forces which are likely to reduce employment are also likely to reduce labor-force participation, it is not possible *a priori* to determine which effect dominates even with a more complex model.[7] Thus, although it is fairly clear that a welfare program will tend to reduce labor supply, the net effect of welfare on unemployment is theoretically ambiguous.

In sum, theory suggests that young people will reduce work in response to a welfare program if family decision processes cause them to experience a reduction in net wages and an increase in non-wage income. But the reduction in work effort may or may not increase *measured* unemployment—whether unemployment rises or falls when welfare benefits rise is an empirical issue. This paper sheds light on this issue by using data from a welfare experiment. We examine the effects of welfare support separately on the labor-force participation and job-taking behavior of youth, to provide some insight into the possible effects of welfare on unemployment. The results, as we will see, suggest that youth do respond to their family welfare situation in a way which could increase measured unemployment.

II. Welfare Experiments

Interest in experimenting with alternative welfare systems has been prompted by several criticisms of the AFDC program, the primary component of the U.S. welfare system. First, although AFDC is a Federal program, it is administered by the states, and the provisions vary state-by-state depending upon the ability and willingness of individual states to provide welfare support. Large interstate differentials in program payments have been criticized as inequitable. Second, some states restrict AFDC support to families which do not have a father present. This has led to the charge that AFDC encourages the breakup of families. Third, AFDC benefits are reduced sharply as earned income rises. This high rate of "taxation" of additional family earnings has been criticized as a work disincentive. Finally, AFDC has been criticized for not being generous enough, on the grounds that a wealthy society should do more for its poor members.

The Seattle and Denver Income Maintenance Experiments (SIME and DIME respectively) were designed to test a welfare program addressing these criticisms. The experimental program was called a "negative income tax" (NIT), reflecting the view that welfare support should be a logical downward extension of the positive tax system. However, these NIT experiments and the traditional welfare programs differed in detail rather than in concept. Specifically, the NIT embraced all households (husband-wife households as well as female-headed) and was designed to be more generous than the typical AFDC program.

Approximately 4,800 families with below-median incomes in Seattle and Denver became involved. As in a scientific experiment, some of the subjects received experimental "treatment" while some served as the control group. Those in the treatment group were eligible to receive support under one of eleven NIT programs. The control group was not eligible to receive any support through the NIT, but control families were free to enroll in the AFDC programs existing in their states. This control group was the benchmark against which the response of the treatment group to the NIT programs was measured.

The eleven experimental NIT programs of SIME/DIME represented different combinations of welfare-support levels and tax rates on earned income—the program feature which determines the rate at which benefits are reduced as earned income rises. The support level was between \$3,800 and \$5,600 (in 1971 dollars) for a family of four. The "phase out" tax rate was between 50 and 80 percent;[8] a family on a program with an 80-percent tax rate, for example, would lose 80 cents of support for each additional dollar of earned income.

In comparison with the AFDC programs then existing in the states of Washington and Colorado, these program parameters provided relatively generous welfare assistance. That is, a family in the treatment group would have a higher family income under SIME and DIME than one with the same characteristics could enjoy under the existing AFDC program.

In terms of impact on labor-supply behavior, the SIME and DIME programs unambiguously offered greater disincentives to work than the existing welfare program. This is because both the support level and the tax rates were higher under SIME and DIME than under the existing AFDC alternative.[9] By comparing the behavior of youth in the treatment group with that of the control group, we are able to evaluate the effect of these greater disincentives.

III. Empirical Analysis

The welfare experiments generated a wealth of data on the labor-market behavior of individuals in the treatment and control groups. The data were collected through a series of periodic interviews conducted at the time of enrollment and also throughout the course of the experiment. For the purposes of our study, youths were defined as individuals who were between 16 and 21 years of age, and living at home, at the time their families enrolled in the experiment.

Since we are interested primarily in the possible effects of the welfare program on measured youth unemployment, we focus on two aspects of labor-market behavior that can influence this measure. The first is labor-force participation behavior. We measure the impact of the experiment by examining the age at which the youths in the experiment first report an active search for work. By contrasting the age of first participation of the treatment group with that of the control group, we are able to obtain a crude indication of the extent to which the welfare experiment delays youth labor-force participation. The second aspect we examine is job-taking behavior. By comparing the age at which the youths in the treatment group first take full or part-time jobs with the experience of the control group, we are able to estimate the extent to which the welfare experiment delays youth employment.

We can deduce the experiment's impact on unemployment in a rough way by comparing the labor-force participation effect with the job-taking effect. If, for example, welfare tends to delay jobtaking without delaying labor-force participation, the behavior of these first-time job seekers would tend to add to measured youth unemployment. Whether the overall unemployment rate rises, however, depends upon their later behavior. If welfare causes a youth to stay in a job longer, for example, this would tend to offset the effect on the unemployment rate of delays in taking the first job. However, the unemployment of entrants into the job market is a major factor in the high youth-unemployment statistics; the unemployment rate for youths with previous employment is close to the adult unemployment rate.[10] Thus it seems likely that a further delay in employment caused by welfare support would translate into a higher overall youth-unemployment rate.

This is admittedly a very crude method for discerning the impact of the experiment on unemployment. Ideally, the unemployment rate should be studied directly, by simply measuring the percentage of young people who report themselves to be participating in the labor force but without a job at a particular point in time. By contrasting the control group's and the treatment group's unemployment rates, the effect of the experimental program could then be obtained directly. Unfortunately, however, the data available at the time of the study were not suitable to this approach, since the employment status of individuals could not be determined precisely on a day-to-day basis, making direct calculation of unemployment rates impossible.[11] Still, despite the limitations of our approach, it can provide useful indications of the way in which the youth unemployment may be affected by welfare policy.

IV. Statistical Procedures

The behavior of the treatment group is compared with that of the control group by estimating the coefficients of a simple regression equation using the cross-section of data from the youth sample. The general form of the equation is

$$H = Fc + Xb + Ce + E \quad (1)$$

where

- H = measures of labor-market behavior (i.e., age at entry into the labor force or age at which a job is taken).
- F = dummy variable which = 1 if the individual is in the treatment group and = 0 if in the control group.
- X = set of demographic variables to control for personal or family attributes which may affect labor-market behavior (see Table 1).
- C = set of variables to control for other experiment features which may affect labor-market behavior, such as schooling subsidies (see Appendix B).
- E = error component,

and c, b and e are vectors of coefficients to be estimated. This general equation was estimated for three different dependent variables: H_1, age of initial labor-force entrance; H_2, age of taking a full-time job; and H_3, age of taking a part-time job.

The experiment's effect on these measures is represented by the coefficient on the dummy variable F. Thus, if those youths eligible for welfare assistance delay the age at which they take jobs (relative to controls), the coefficient on F measures the extent of the delay (in years). The other explanatory variables (sets X and C) primarily control for other factors which may influence labor-market behavior, thereby permitting the effects of the experiment to be isolated. Table 1 lists the demographic variables (set X) which are employed to control for the effects of personal or family attributes on labor-market behavior. Appendix B discusses those variables (set C) which are used to control for the design features of the experiment; these variables are not discussed further because they are not relevant to the issues addressed in this paper.

Table 1
Demographic Variables
(Variable set X)

Variable name	Variable definition
SEATTLE	Dummy variable; takes on the value 1 if youth is from Seattle site, and 0 if from Denver
BLACK	Dummy variable; takes on the value 1 if youth is black, and 0 if otherwise
CHICANO	Dummy variable; takes on the value 1 if youth is Chicano, and 0 if otherwise
SINGLEHEAD	Dummy variable; takes on the value 1 if the youth is from a female-headed (fatherless) household, and 0 if otherwise
FAMILYSIZE	Number of family members in the youth's family at time of enrollment in the experiment
CHILDREN	Number of children younger than 5 years of age in the family at time of enrollment in the experiment
INCOME	Family income (in dollars) at time of enrollment in the experiment

The regression equations were estimated separately for the 517 males and 485 females in the sample, because the labor-market behavior of these groups differed considerably in the early years of their work experience. Appendix B provides further details of the sample and the econometric techniques employed in estimating the regression equations.

V. Results: Effects of Experiment

The coefficients on the dummy variable F measure the effects of welfare eligibility on the labor-market behavior of the youths in the sample. Table 2 summarizes these effects.

First, the experimental welfare program apparently does not significantly affect individual decisions to enter the labor force. That is, the measured delay of entry into the labor force associated with eligibility for the welfare program (row one in Table 2) is not statistically different from zero for either males or females. Those youths whose families are eligible for welfare support thus appear to enter the labor force at about the same age as youths in control families.

Second, the experimental program in contrast *does* appear to delay the age of initial full time or part-time employment. For male youths, welfare eligibility is associated with a delay of .74 years in the age of full-time employment (row two). For females, the program's effect is not significant for full-time employment but it is significant for part-time employment, where welfare eligibility is associated with a delay of .93 years. The coefficient for part-time job-taking is not significant for males, although the sign is the same as for females. The greater sensitivity of males in the full-time category and females in the part-time category could be expected, because young females tend to seek part-time employment while young males tend to be oriented toward full-time employment.

These results suggest that the expected reduction in labor supply from the welfare program primarily comes about because of delays in accepting employment, rather than delays in entering the labor force. These effects generate increases in measured unemployment among youths just beginning their labor-market experience. As mentioned earlier, the available data are not sufficient to measure the effect on unemployment rates, *per se,* but this finding underscores the importance of considering supply-side factors when investigating youth-unemployment phenomena.

Table 2
Effects of Experimental Welfare Program

Delay (in years)	Males	Females
In joining the labor force	−.127 (.287)	.149 (.208)
In taking a full-time job	.739** (.267)	.183 (.143)
In taking a part-time job	.565 (.402)	.929* (.370)

Note: The delay experienced by those eligible for the experimental welfare program is measured relative to the behavior of the controls. Standard errors are in parentheses.

*Coefficient differs from zero at the 5-percent level.
**Coefficient differs from zero at the 1-percent level.

VI. Results: Other Factors

The coefficients on the various demographic control variables, (variable set x), while not relevant to an evaluation of the welfare experiment, usefully illustrate how other factors can affect labor-market behavior. The coefficients associated with these variables are presented in Table 3.

The dummy variable SEATTLE indicates the location of an individual in the sample, whether Denver or Seattle. The coefficient on this variable thus captures *differences* in labor-market behavior in the two cities. Although such differences could indicate either demand or supply differences, in the present context the coefficient most likely captures differences in the *demand* for labor.

At the time of the experiments (early to mid-1970's), the Seattle economy was severely depressed because of a decline in the locally-important aerospace industry. As a result, we would expect the demand for labor of all kinds to be lower in Seattle than in Denver, and for this to lead to delays in finding work. (It could also discourage youths from entering the labor force.) The expectation is borne out in the positive sign of the Seattle dummy variable. This implies that the age of labor-force entry and (for females) the age of job-taking tended to be higher in Seattle than Denver. Males in Seattle, for example, took 1.47 years longer to find a full-time job than their Denver counterparts. The fact that *both* the entry age and the employment age were higher in Seattle illustrates the earlier point that the participation decision and the employment decision tend to be affected by the same factors and to move in the same direction. The unemployment impact depends upon the net effect of these factors. In the present case, the employment age apparently is delayed by more than the entry age as a result of Seattle residency; this would tend to make measured unemployment higher there than in Denver.

The coefficients of the race variables BLACK and CHICANO in Table 3 measure the *difference* in behavior between non-white and white youths. The coefficients suggest a relationship between labor-market behavior and race that is consistent with aggregate unemployment statistics. Black males, for example, enter the labor force .80 years later than whites, and take full-time jobs and part-time jobs 1.53 and .96 years later, respectively. The greater delay in job-taking than in entry is qualitatively consistent with the higher rates of black youth unemployment that are typically observed in aggregate statistics. This phenomenon may, of course, be a manifestation of either demand or supply-side factors.

Among the Chicanos in the sample, the greatest effect is observed among males. Relative to white youth, they experience delay in full-time job taking of .80 years and in part-time job taking of 1.03 years. The relative delay in entering the labor force is not significant for males, but it is significant for Chicano females.

The coefficients on the variables that describe family characteristics suggest that family composition influences the participation and job-taking decisions of youth as well. The dummy variable SINGLEHEAD, for example, indicates which youths come from female-headed households. The negative sign on this variable, for both males and females, suggests that this family structure is associated with earlier labor-force participation and earlier employment. However, the effects are only significant for females.

The number of family members (measured by FAMILYSIZE) appears to be negatively related to the age at which youths enter the labor force. An additional family member lowers the age of labor-force entry by .22 and .15 years for males and females, respectively. However, for female youths, the presence of

Table 3
Coefficients Associated With Various Control Variables

Dependent variable	Age of Entry into Labor Force		Age of Taking Full-time Job		Age of Taking Part-time Job	
	Males	Females	Males	Females	Males	Females
Independent variable						
SEATTLE (0,1)	.024	.444*	1.475***	.603***	.277	.539
	(.306)	(.231)	(.296)	(.269)	(.441)	(.414)
BLACK (0,1)	.809***	.209	1.526***	.962***	.924***	.359
	(.310)	(.225)	(.294)	(.267)	(.443)	(.404)
CHICANO (0,1)	.558	.767***	.805**	.336	1.034*	.688
	(.433)	(.323)	(.366)	(.366)	(.621)	(.564)
SINGLEHEAD (0,1)	−.545	−.517**	−.128	−.458	−.522	−1.011**
	(.341)	(.262)	(.327)	(.311)	(.488)	(.477)
FAMILY SIZE (number)	−.218**	−.150*	.019	.061	0.226	−.108
	(.103)	(.079)	(.098)	(.096)	(.147)	(.146)
CHILDREN (number)	−.260	.677***	−.029	.209	.268	.735
	(.405)	(.254)	(.365)	(.317)	(.555)	(.474)
INCOME ($1000)	.025	.008	−.052	−.063	−.044	.002
	(.050)	(.036)	(.046)	(.044)	(.075)	(.007)

***Coefficient differs from zero at the 1 percent level.
**Coefficient differs from zero at the 5 percent level.
*Coefficient differs from zero at the 10 percent level.

small children in the household (CHILDREN) tends to delay labor-force participation, presumably because young females perform child-care services in the home.

Family income (INCOME) appears to have no statistically significant effect on youths' participation and job-taking decisions. The signs of the coefficients generally suggest delayed entry but earlier job-taking, but the low level of statistical precision suggests that these results may be spurious. Other observers have noted the poor association between income and youth unemployment, but in this study the problem is compounded by the use of family income to assign individuals to the welfare experiment (see Appendix 3).

The statistical importance of many of these demographic variables clearly indicates the variety of factors accounting for observed patterns of labor-market behavior. Thus, no single factor is likely to explain satisfactorily the level and changes in youth-unemployment rates that the United States has experienced in recent years. Even after controlling for these demographic factors, however, an important association appears to exist between the experimental welfare program and delayed youth employment.

VII. Conclusions

It has not been possible to measure the impact of a welfare program on youth unemployment directly. Nonetheless, the results observed in this study are consistent with the notion that youths respond to welfare programs by reducing labor-market activity. Thus, young people do not appear to be insulated from the work-retarding effects of welfare programs.[12]

Secondly, the results are also consistent with the argument that family welfare support contributes to measured youth unemployment by delaying employment without delaying entry into the labor-force. Despite our inability to calculate the precise effect of the experimental welfare program on unemployment, we can see that the delay in job-taking is large and significant. For males taking full-time jobs, for example, the delay caused by the experiment is roughly the same as the delay associated with being Chicano (rather than white). Since Chicano unemployment rates are several percentage points greater than white unemployment rates, the effect of the welfare program may be of that same order of magnitude.

Finally, and most importantly, the study highlights the relevance of considering supply as well as demand factors in studying the youth-unemployment problem. There may be considerably more volition in the pattern of youth unemployment than is generally assumed. Although it is very difficult to determine precisely the effect of supply-side factors—such as attitudes, tastes, family structure, and family economic status—these factors may contribute significantly to the trends that have been observed in youth unemployment. Policy prescriptions thus can differ considerably, depending upon whether the problem has a demand-side or supply-side genesis. The results of this study suggest that a policy to eradicate youth unemployment by making jobs more available—through public-employment programs, for example—may not be completely successful in reducing unemployment among youths from welfare families.

Unfortunately, we cannot use the results of this study to infer how the *existing* welfare program affects youth labor-market behavior. Although the experimental welfare programs were *more* conducive to creating unemployment than the existing (AFDC) program, their effects were measured against the effects of the existing program since the control group remained eligible for AFDC. Therefore, our results may either over- or under-state the effects of the existing program (vs. no welfare program). However, the results do suggest qualitatively that the existing welfare program contributes to youth-employment problems.

Much remains to be learned about the causes of joblessness among the young. The problem is a multifaceted one, and no single factor can be held responsible for the trends that have been observed in youth labor-market behavior. Still, our results emphasize one potential source of youth unemployment that policymakers should consider and explore further.

Appendix A: Experimentation in Economics

Although experimental research is commonplace in laboratory sciences such as chemistry and pharmacology, it is unusual in economics. Economists do not, in general, have the opportunity to manipulate economic variables in a controlled manner and observe the consequences on individual firms or households in the economy. Economics is, by its very nature, a *social* science, and most economic research involves observation of behavior in the natural state of the economy. The relationships between economic variables are normally inferred from observed patterns of behavior in the context of a model, utilizing a set of statistical procedures that are consistent with the assumptions of the model.

What is an economic experiment?

In contrast to the "arm's length" nature of most economic analysis, economic experimentation involves direct manipulation of economic variables. In the typical economic experiment, a site for the experiment (usually a community or area) is selected, and part of the population of the area is enrolled to participate in the experiment. The participants are assigned to either a "treatment group" or a "control group." The economic environment

Table A-1
Recent Experiments in Economic Policy

Experiment	Site(s)	Objectives
1. Income maintenance	New Jersey; Pennsylvania (1968); Gary, Indiana (1970); Iowa; North Carolina (1969); Seattle, Washington; Denver, Colorado (1971)	To evaluate the effects of a negative income tax on aggregate labor supply.
2. Health insurance	Dayton, Ohio; Seattle, Washington; selected counties in Massachusetts and South Carolina (1973)	To evaluate the response of health-care demand to changes in the price of health-care services.
3. Supported work	Fifteen different cities and rural areas (1975)	To test the effectiveness of job-training programs on individuals with traditionally poor records of employability, such as ex-offenders and former drug addicts.
4. Employment service	Minneapolis, Minnesota; Salt Lake City, Utah; West Palm Beach, Florida (1975)	To evaluate the effect of job counseling on the labor-market experience of the unemployed.
5. Housing allowances	Various sites including Pittsburgh, Pennsylvania; Phoenix, Arizona; Green Bay, Wisconsin; and South Bend, Indiana (1976)	To evaluate the effect of cash housing allowances on the demand and supply of housing.
6. Electric power rates	Six utilities in various states (1976)	To evaluate the effect of different electricity-rate schedules on the consumption of electric power, with particular emphasis on time-of-day pricing.
7. Medicare coverage	Entire state of Colorado (1976)	To evaluate alternative coverage plans on the use and cost of mental-health services.
8. Public employment	Thirty sites in various states (1979)	To evaluate the effect of a large-scale public-employment program on employment and wages through the use of treatment and control sites (demonstration project combined with policy experiments).
9. Youth employment subsidy	Detroit, Michigan (in the planning stage)	To evaluate the effect of wage subsidies on youth employment.

of the treatment group is manipulated as part of the experiment, while the control group is simply a source of "baseline" data. The comparison of the behavior of the treatment and control groups measures the effect of the experimental program. (The use of a control group distinguishes an *experiment* from a *demonstration;* the latter is simply a test of the administrative feasibility of a project, and cannot provide a precise evaluation of its effects.)

Economic experiments have been conducted in a wide range of policy contexts. Experiments have involved manipulation of such economic variables as electricity prices, housing rentals, health-care costs, education costs, and the generosity of welfare programs. (See Table A-1 for a partial list of recent economic experiments.)

Experimental vs non-experimental

Although the non-experimental mode of analysis has served the economics profession well, the available theory or data are not always sufficient to provide the information necessary to resolve practical problems. Simple parameters such as the elasticity of labor supply with respect to the wage rate, for example, have been disturbingly difficult to estimate using non-experimental procedures. As a result, economic analysis has provided little help to policymakers interested in accurately predicting the labor-market effects of proposals such as a negative income tax, wage subsidies, public-employment programs, and so on.

Experimentation offers several advantages for policy evaluation. First, the direction and magnitude of the effect of one economic variable on another can potentially be measured with considerable precision, because the policy variable can be exogenously manipulated in a measurable way. The price of a commodity, the income of an individual, or the quality of a product can be manipulated at will, independent of other variables. In the non-experimental environment, these changes usually occur in concert with other changes, making it difficult to isolate the effects of individual factors and the direction of causality.

Second, experimentation offers the opportunity to examine a variety of social effects of a policy—often beyond that which economic modelling and analysis is capable of doing with non-experimental data. For example, the effect of a policy on the child-bearing or marital behavior of a family is very difficult to predict precisely with existing economic models and data. Yet these effects may be very important to policymakers and may have important economic implications as well. An experiment can be designed to monitor these effects.

Finally, experimentation permits programs with complex economic and administrative features to be evaluated. It is often very difficult to model these features and evaluate the response without making many questionable assumptions. By putting the policy into practice on an experimental basis and observing the consequences, the effects of a specific program can be directly evaluated.

Appendix B: Technical Details of the Model and Sample

Econometric Considerations

Estimation of the relationship in equation (1) encounters a number of econometric problems. First, the data on the dependent variables (H_1, H_2, and H_3) suffer from "censoring" because of the relatively short observation period. To understand this problem of censoring, suppose, for example, that a youth never takes a full-time job during the course of the observation period. What age should then be used to construct H_2? The only available datum is the youth's age at the time when he was last observed. This age is clearly less than the true age at which he ultimately takes a job, however; that is, the measure is "censored" from above. Similarly, if a youth already has labor-market experience when first enrolled in the experiment, the only information we have is his age at that time; these observations are censored from below.

The econometric implication is that the distribution of the error term in equation (1) does not have the properties assumed in the classical regression model. Without appropriate treatment of this effect, the estimated coefficients are biased. However, with a procedure developed by James Tobin (called Tobit), we are able to obtain unbiased estimation under the conditions created by censored data.[13] The procedure uses the age at which the observation was censored along with the information about the type of censoring experienced (i.e., from above or below). The program employs maximum likelihood techniques to derive the necessary estimates, but the coefficients may be interpreted in the normal manner.

A second major statistical concern involves defining the independent variables so that the effect of the experiments is not commingled with variables which we are using for control purposes. For example, the experiment could conceivably affect the family's childbearing behavior. Thus, if the variable FAMILYSIZE is measured during the experiment, it may contain some effects of the experiments, thereby biasing the measure of the experimental effect obtained with the variable F. The approach taken here to limit this bias involves using pre-experimental measures of all of the control variables. This ensures that these measures are unaffected by the experiment. Although this method introduces measurement error—since the pre-experimental values may be imprecise measures of the relevant value—it is assumed that these effects are less serious than the problem of commingling experimental and control variables.

Table B-1
Sample Characteristics

	Male	Female
Age at enrollment (%)		
16	28.8	33.6
17	28.6	29.7
18	17.4	18.6
19	12.2	11.3
20	9.3	5.6
21	3.7	1.2
Race (%)		
Black	46.8	44.1
White	33.5	37.7
Chicano	19.7	18.1
Hours worked per week		
at enrollment	6.4	4.5
2½ years into experiment	16.9	15.5
School registration (%)		
at enrollment	73.9	79.9
2½ years into experiment	27.8	27.2
Outside labor force (%)		
at enrollment	51.3	62.9
2½ years into experiment	44.0	57.5
Family type at enrollment (%)		
Husband-wife	44.1	43.3
Female head	55.9	56.7
Treatment status (%)		
Eligible for experimental welfare program	52.4	51.1
Seattle residency (%)	39.5	48.5
Persons in family (No.)	4.8	4.6
Young Children in family (No.)	.1	.2
Family income ($)	6,511.0	6,680.0
Sample size	517	485

Additional control variables

In addition to the variables reported in Table 1, two additional types of variables were included in the variable set C in order to control for features of the experiment which would influence the behavior of the individuals in the sample. First, in addition to the welfare provisions of the experiments, certain families were eligible for manpower programs that provided subsidies for training and educational activities. To control for these effects, the regressions contain dummy variables for each manpower program. The coefficients of these variables were not significantly different from zero, and are not reported here because these programs are not of direct interest to our discussion.

A final consideration involves the need to control for the way in which families were assigned to the control group vs. the "treatment" group. As is typical in many experimental designs, the assignment was not completely random because of cost considerations; in particular, each family's pre-enrollment income was one of the characteristics used to assign experimental treatment. This non-random assignment can cause bias in the measurement of the coefficients.[14] The simplest approach to minimize this bias is to include (as we do) a dummy variable in the regression which indicates which income-classification group the family was placed in for purposes of assignment to experimental treatment. (Because the coefficients on these dummy variables have no policy interpretation, they are not discussed in this paper. However, it should be noted that the use of two "income" variables—the control dummies and INCOME—makes it difficult to interpret the latter's coefficients.)

Description of sample

The individuals chosen for use in this study were between 16 and 21 years of age at the time that their families agreed to participate in the experiment. The sample was confined to the sons, daughters, grandsons, granddaughters, stepsons or stepdaughters of the head of the household. All were living with their families at the time of enrollment in the experiment.

The experiments did not enroll families headed by a single male, but over half of the sample was composed of female-headed households. The families in the experiment were chosen with incomes at or below the 1971 median income. In order to permit estimation of effects by race, black and Chicano families were heavily sampled. Table B-1 contains selected statistics which describe the sample.

FOOTNOTES

1. The literature on youth unemployment is extensive. A broad and useful introduction to the topic is available in **The Teenage Unemployment Problem: What are the Options?** Congressional Budget Office (October 1976).

2. See, for example, Welch (1974), Gramlich (1976) and Ragan (1977).

3. Ragan (1977).

4. This argument has been put forth by Moynihan (1968), for example.

5. See Freeman (1979).

6. See, for example, Ashenfelter and Heckman (1979), Killingsworth (1976), and MacDonald and Stephanson (forthcoming).

7. Seater analyzes labor-force behavior in the context of an optimal-control model which permits simultaneous determination of the optimal paths of time allocation to labor, job search and leisure over the life cycle. He concludes, "The response of unemployment [to exogenous changes] is ambiguous because unemployment is a "middle" state between employment and nonparticipation. Changes which tend to induce some people to leave unemployment for employment also tend to induce other people to leave nonparticipation for unemployment, leaving the net change in unemployment ambiguous." Seater (1977), p. 369.

8. Six of the programs employed fixed tax rates of either 50, 70 or 80 percent. The other five programs employed a rate which was initially at one of these levels, but declined with increasing income. These declining tax-rate programs were designed to determine if the work disincentive effects of the NIT could be eased by a smoother transition between NIT tax rates and the tax rates of the normal (positive) income-tax system.

9. At the time of the experiments, the **statutory** tax rate embodied in the AFDC program was 67 percent. However, as Halsey (1978) has shown, when the integration of AFDC with other welfare programs (housing and food-stamp programs) and the positive income-tax system is properly analyzed, the **effective** tax rate is around 47 percent, a lower rate than the effective tax rates employed in the SIME and DIME programs.

10. Freeman (1979), Table 2.

11. The construction of the spell-oriented data file necessary for this computation is feasible, however, using the raw SIME and DIME data. The construction of such a data file may be undertaken by SRI International in 1980.

12. Although we are interested in the effects on measured unemployment **per se,** from a long-run policy point of view, the delays in job-taking need not be wholly deleterious. For example, youth may be spending more time in school as a result of family welfare support. The evidence on this from the SIME and DIME programs is not very encouraging, however. West (1979) found that the experiments were **not** associated with significant increases in school-going propensity.

13. See Tobin (1958). The program used in this analysis was written by Arden Hall of SRI.

14. The seriousness of the bias caused by non-random assignment has been the subject of considerable debate. In this research, the results were not noticeably changed when the variables designed to correct for assignment were omitted from the regression specification. For a discussion of experimental assignment procedures and their effects, see Conlisk and Watts (1979) and Keeley and Robins (forthcoming).

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Pricing Federal Power in the Pacific Northwest: An Efficiency Approach

Yvonne Levy*

Recent forecasts of electric-power demand and supply in the Pacific Northwest suggest the possibility of serious shortages during the decade of the 1980's. The projected imbalance reflects the inefficient pricing policies prescribed by law and regulatory commissions for the Bonneville Power Administration (BPA) and other regional electric utilities.[1] Bonneville is the wholesale marketing agency for hydroelectric power generated at some 30 Federal dams along the Columbia River and for some purchased thermal (coal and nuclear) power supplies. Indeed, BPA is the wholesale supplier of over one-half of the total electricity consumed in the Pacific Northwest. Thus, its pricing practices profoundly influence the general level of electric rates faced by ultimate consumers in that region.

A conflict over BPA supplies has developed among Bonneville's various customer groups, with private utilities being denied contracts for firm Federal power—assured supplies—since the early 1970's. This reflects the agency's attempts to assure the needs of its statutory preference customers—the publicly-owned retail power agencies that have first priority for Federally-generated wholesale power. Private utilities have had to make up for that loss as well as meet the growth of demand on their own, generally from more expensive thermal supplies. The consequence is a wide disparity in retail rates to ultimate consumers served by the two classes of utilities. In recent months, Bonneville's industrial customers have suffered a loss of that portion of their contracted supplies subject to interruption. Moreover, these customers face a possible cutoff of all Federal supplies when their contracts expire in 1983. The industries involved employ about 15,000 persons with an annual payroll of about $355 million, and supply 30 percent of the nation's primary aluminum, 100 percent of its ferronickel, and substantial quantities of other key materials.

The Pacific Northwest Electric Power Planning and Conservation Act, which has been introduced into Congress to deal with the allocation problem, would rely on new institutional arrangements to balance demand and supply. But by failing to address the fundamental cause of the disequilibrium—namely, the present inefficient pricing policies followed by Bonneville and other regional utilities—it is unlikely to provide a permanent solution to the region's electrical-supply problems.

In this article, we argue that Bonneville should base its power rates not on average cost but rather on long-run incremental cost. The former is total cost divided by the number of units to be sold; the latter is the cost of producing additional electricity, taking into account the need to add more fixed factors, namely plant facilities. Long-run incremental cost approximates the cost of electricity produced from new plant. This pricing approach would result in a more efficient allocation of resources, because rates would reflect the true cost of the resources expended to provide consumers with each additional block of power. It would significantly lower the future demand for Bonneville power because its price would be much higher than under the current average-cost pricing method. As a result, substan-

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tially less new generating capacity would be required than is currently forecast.

Section I discusses the economic-efficiency argument for pricing on the basis of long-run incremental cost. As noted there, electric utilities traditionally have not followed that method because their operations presumably have been characterized by decreasing long-run average and incremental costs due to economies of scale. Under such conditions, pricing on the basis of incremental cost would fail to recover average cost, resulting in a loss. But as Section II indicates, this long-run incremental cost in actuality is far higher than the average cost reported by Bonneville. In Section III, we attribute part of the gap between the two to present average-cost accounting methods, but also to rising long-run incremental costs resulting from the exhaustion of economies of scale. Section IV discusses some of the sub-optimal long-run incremental cost pricing methods that have been proposed to avoid surplus revenues, and argues that true long-run incremental cost pricing is preferable.

It is important to note that while Bonneville's pricing policies have been singled out for study in this article, the arguments advanced in favor of incremental-cost pricing apply to the entire electric-utility industry. To various degrees, the wide-spread use of average-cost pricing methods is holding electric-utility rates everywhere below those that would prevail under long-run incremental-cost pricing, spurring the growth of electrical consumption and causing too many resources to be devoted to power generation.

I. Rationale for Different Pricing Methods

Bonneville Power Administration—like other electric utilities throughout the nation—traditionally has followed an average-cost pricing method for establishing the level of its power rates.[2] Under this method, the utility first determines its *revenue requirement.* This refers to the total costs that must be recovered through rates during a given period to compensate the utility for all the expenses incurred in supplying the product, including a return on invested capital.[3] Under present statutes, total revenues must exactly equal total costs, a requirement known as the budgetary constraint. Dividing total costs by the number of units expected to be sold in a given period yields the average unit cost—and thus the price—of electricity.

Economic theory demonstrates that the price per unit should be equal not to average cost but to marginal cost. Marginal cost is the change in total cost resulting from an additional unit of output—that is, the cost of producing one more unit of a good or service, or alternatively, the cost that would be saved by producing one less unit.

In economic theory, the distinction between short and long-run is based on whether or not plant size is fixed. Short-run cost calculations show how a firm's costs will vary in response to variations in output within the limits of a given amount of fixed plant. Long-run cost calculations show how costs will vary during a planning period long enough to permit adjustment of the scale of productive facilities.

Electric-power rate decisions thus depend upon whether or not the scale of plant is to be increased. If new plant is scheduled during the planning period encompassed in the rate calculation, long-run incremental (marginal) cost is the appropriate basis for pricing, i.e., price per unit should be equal to long-run incremental cost.[4] Long-run incremental cost equals the cost of electricity produced from the next block of new generating facilities scheduled to be added. Under that pricing method, the price per unit thus reflects only the cost of electricity produced from new productive facilities—in contrast to average cost pricing, which also reflects the cost of electricity from older facilities.

The rationale for pricing on the basis of incremental cost is simply efficiency. A fundamental precept of economics states that optimum welfare and efficiency are achieved under conditions of perfectly competitive markets. A perfectly competitive firm, which by definition has no control over the price of its product, maximizes profits by selecting an output level where the price of its good or service equals its marginal cost. Under such conditions, resources would be channelled into their most efficient uses.[5] This is because each price would reflect the value of the resources required to supply each particular good or service, and because consumers therefore would be provided with the proper price signals to make the choices that would yield society the most efficient use of resources. If price were less than marginal cost, consumers would be induced to consume an additional unit, even if the benefits were less than the marginal commitment of society's resources to produce that unit.

Equality of price and marginal cost leads to optimal welfare and efficiency only if it applies to all goods and services throughout the economy. Pricing as many goods as possible at marginal cost does not necessarily provide a "second best" solution. It might actually make allocation less efficient, particularly in situations where close substitutes are priced above or below marginal cost. But while this problem complicates the application of marginal-cost pricing, it does not necessarily invalidate its use in particular situations. Care simply must be taken to consider the ramifications on both the market in question and the markets of other close substitutes and complementary products.

In the Pacific Northwest situation, electric power is being priced far below marginal cost, whereas close substitutes such as oil and natural gas are being priced closer to marginal cost. Given the relatively high cost of substitutes, adoption of long-run incremental-cost pricing by electric utilities probably would lead to a reduction in overall energy use rather than a shift to alternate fuels.

Note on Terminology

This article addresses the issue of the appropriate method to be followed by Bonneville in establishing the *level* of its electric-power rates. The level of rates determines the overall revenues to be realized by the agency in any given period, as distinguished from the structure of rates charged for various classes of customers or service. For that reason, the terms "demand" and "capacity" are used in a general sense as they are understood by economists, rather than in reference to peak operations alone as they are used by electric-utility rate makers. Demand refers to the total quantity that will be purchased at a given price at a particular period of time. Capacity refers to production potential, i.e., plant and equipment. "Additions to capacity" may be used in connection with the expansion of baseload as well as peak generation facilities.

Dilemma of incremental pricing

The goal of the regulatory authorities should be to price as close to the perfectly competitive model as possible. Why then haven't they done so? The reason is the regulators' assumption that electricity generation involves decreasing long-run average costs over the output range relevant to a given market. Decreasing long-run costs are the result of increasing returns to scale. These economies of scale, in the regulatory context, refer to a situation in which unit production costs decline for the individual firm as the size of its plant is increased. The economies are internal to the operation of the individual firm, in contrast to external economies which arise out of the growth of the entire industry.[6]

"Plant" in this context may consist of a single production facility or a group of production facilities comprising a system. In electric-power generation, regulators assume that the size of plant required to achieve lowest unit cost is so large that it justifies only one firm for any given market. Because of this assumed inherent tendency to decreasing long-run average cost over the relevant output range, the electric-generating industry traditionally has been characterized as a "natural monopoly." To enable consumers to benefit from these

Background on Bonneville

Functions

Bonneville Power Administration (BPA) was created by Congress in 1937 to market and transmit electric power from the Federally-owned Bonneville Dam. The agency's authority subsequently has been expanded to include the marketing of hydroelectric power from other Federal dams since constructed in the Pacific Northwest. As of the end of 1978, there were 30 Federal dams with an installed capacity of 16,441 megawatts under Bonneville's marketing authority (Figure 1).

BPA does not build dams or generating plants, but serves instead as a marketing agency for power generated at Federal facilities built and operated by the U.S. Army Corps of Engineers and Bureau of Reclamation. The agency, however, is responsible for designing and constructing the vast transmission network required to supply its market area. That area consists of Washington, Oregon, Idaho, Western Montana, plus small portions of adjacent states. The Federal power facilities in the Pacific Northwest, together with the transmission system, are known collectively as the Federal Columbia River Power System (FCRPS).

Role in hydro-thermal development

Until the 1960's, the Pacific Northwest depended on hydro-electric generation to meet nearly all of the region's electrical requirements. But by that time, most of the economically and environmentally feasible damsites had been developed, and it then became evident that thermal plants would have to be added to meet the growth of regional electrical requirements. As a result, BPA and over one hundred public and privately-owned utilities entered into an agreement—known as the Hydro-Thermal Program—to meet the projected growth of demand over the 1970–90 period. Under this program, the Federal government agreed to develop the remaining hydro-electric power potential of existing dams to meet the growth of peak demands. The government also agreed to construct the necessary high-voltage transmission lines to accommodate the growth in regional power deliveries. Non-Federal utilities in the region agreed to build and operate numerous new thermal (coal and nuclear) operating plants to meet the growth of baseload (steady) energy requirements. Thermal construction lagged during the 1970's, contributing to power "shortages," and Bonneville purchased small but increasing amounts of thermal power from non-Federal utilities.

Contribution to Pacific Northwest electric supplies

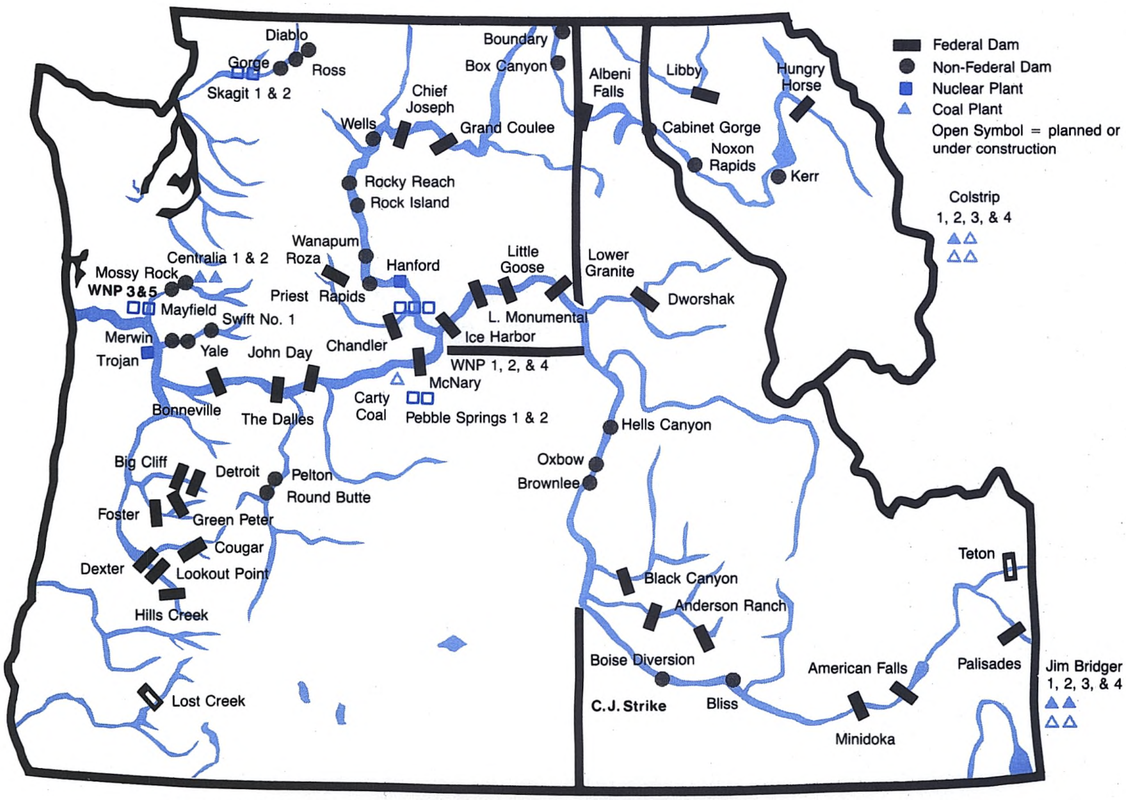
In fiscal 1978, BPA supplied about 87 billion kilowatt-hours of electricity, equivalent to about 54 percent of the total electric power generated in the Pacific Northwest. Private investor-owned utilities generated another 26 percent, while non-Federal publicly-owned utilities produced the remaining 20 percent.

BPA's customers

Bonneville Power Administration is a wholesale supplier of electricity. The agency's customer groups consist of publicly-owned utilities, private investor-owned utilities and direct-service industries. Under existing law, publicly-owned utilities—i.e., utilities owned by public entities such as municipalities, cooperatives and public utility districts—have preference or priority in the purchase of Federal power. Since the early 1970's, BPA has denied private investor-owned utilities access to all but small amounts of "firm" power—assured contract supplies—to enable Bonneville to meet the requirements of its preference customers.

Figure 1

Pacific Northwest Electric Generating Plants



Pacific Northwest Electric Generating Capacity and Output, 1978

Ownership	No. of Plants	Capacity[1] Megawatts	Capacity[1] Percent of Total	Output Billions of Kilowatt-Hours	Output Percent of Total
Federal Columbia River Power System	30	16,442	48.7	87.0[2]	54.2
Hydro	(30)	(16,442)	(48.7)		
Non-Federal Publicly-Owned Utilities	52	7,954	23.6	31.5	19.7
Hydro	(39)	(6,217)	(18.4)		
Thermal	(13)	(1,735)	(5.1)		
Privately-Owned Utilities	106	9,332	27.7	41.9	26.1
Hydro	(88)	(4,020)	(11.9)		
Thermal	(18)	(5,312)	(15.8)		
All Owners	188	33,728	100.0	160.4	100.0
Hydro	(157)	(26,679)	(79.1)		
Thermal	(31)	(7,047)	(20.9)		

1 Name-plate rating as of December 31, 1978; actual capability is about 12 percent higher on average than name-plate rating.

2 Includes power purchased from the Hanford and Trojan nuclear plants and the Centralia coal-fired plant owned by non-Federal utilities.

Source: Bonneville Power Administration, *Financial and Statistical Summary* (Fiscal year 1978), page 6, plus information supplied directly by agency.

economies of scale, governments have granted private firms exclusive franchises to serve given market areas, or have assumed direct public ownership of generation and transmission facilities. At the same time, governments have regulated utility rates to prevent the extraction of monopoly profits (Appendix A).

But this assumed tendency to decreasing long-run average cost also has provided the rationale for pricing on the basis of average cost. Under such conditions, if rates were to be established on the basis of long-run incremental cost, average cost would not be recovered, and the result would be an operating loss.

Chart 1 illustrates the concept of economies of scale as it applies to the individual firm. Here plant size is not fixed, and the comparison is between average production costs of plants of various capacity. Economies of scale in the electric-power industry refer to the fact that relatively larger generation and transmission systems have lower unit costs than relatively smaller systems. The concept is defined for a particular point in time, which means a given state of technology.[7] Economies of scale would exist if, say, the cost per kilowatt-hour associated with a 10,000 megawatt generating system were lower than the average production costs associated with a 7,500 megawatt system, with both alternatives being considered within the same planning period.

In Chart 1, the long-run average cost curve (LRAC) envelops a family of short-run cost curves, each short-run curve (SRAC) corresponding to a different plant scale. Each point on the LRAC curve, being a point of tangency with a SRAC curve, represents the least cost at which a given level of output can be achieved. The firm experiences increasing returns to scale—that is, lower average unit costs for plants of increased size—up to output level Q_3 corresponding to $SRAC_3$, after which diseconomies serve to increase unit costs.

Chart 1

Decreasing Long-Run Cost Curve for a Utility Facing Economies of Scale

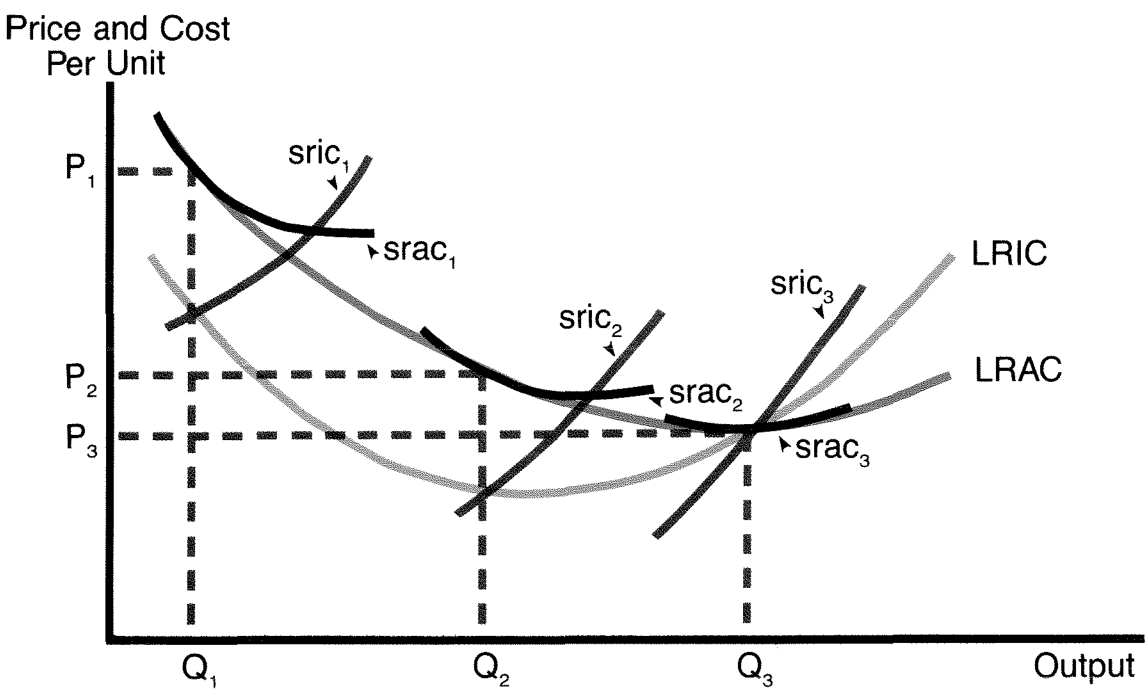


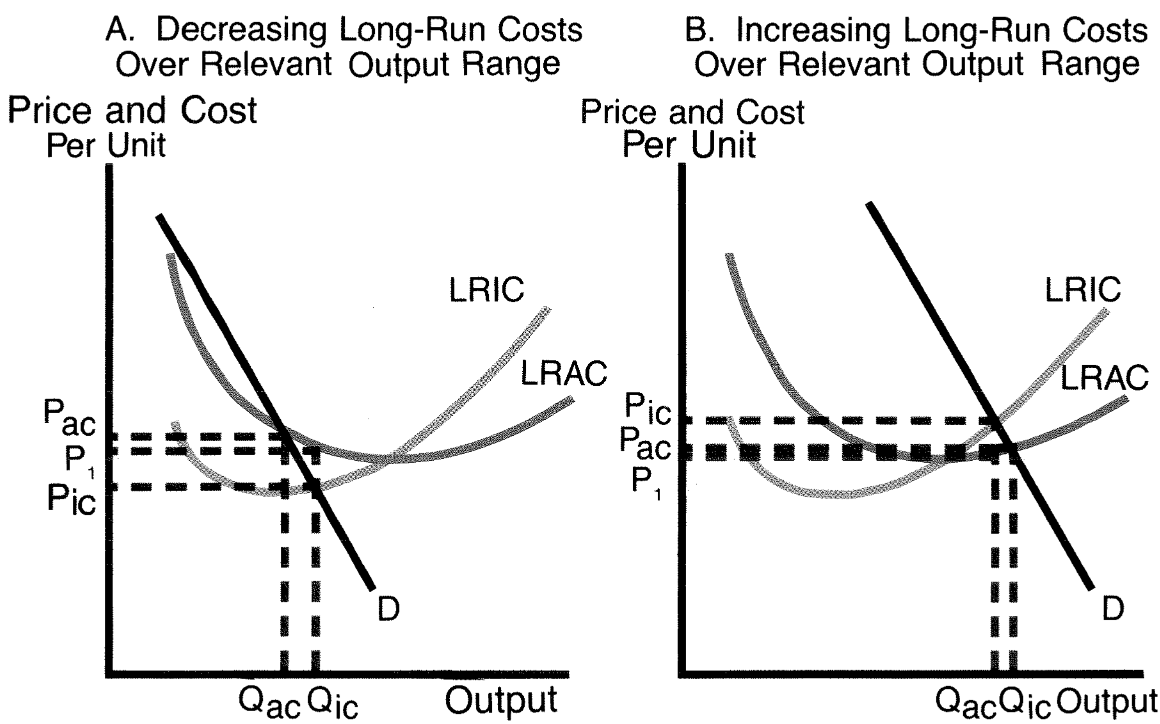
Chart 2-A shows the pricing alternatives facing regulatory authorities in a situation where the utility is operating in a range of decreasing long-run average costs. To achieve the most efficient allocation of resources possible under regulated-monopoly conditions, the regulatory authorities would have to mandate incremental-cost pricing. Under that method, the legal (ceiling) price (Pic) would be determined by the cost of production of the last unit, that is, by the intersection of the demand schedule (D) and the long-run incremental-cost curve (LRIC). But setting the unit price at Pic would generate losses for the regulated firm under conditions of decreasing long-run average costs, in that the cost of the last unit of output would be less than the average cost per unit. These losses would be represented by the area, $(P_1 - \text{Pic}) \times \text{Qic}$.

To avoid the necessity for public subsidies to offset these losses, rate-setting commissions have followed an average-cost pricing method, incorporating in the average cost a rate of return on invested capital. Under this method, the maximum price per unit is set at (Pac), the intersection of the demand schedule (D) and the long-run average cost curve (LRAC). Under conditions of decreasing long-run average cost, this method of pricing results in a higher unit price and lower level of output than the more efficient long-run incremental cost method. This is because long-run average cost is above long-run incremental cost under such conditions.

Chart 2-B illustrates the price and output combinations that would result under alternative pricing methods if the utility were operating in a range of increasing long-run average

Chart 2

Pricing Alternatives in a Regulated Monopoly Situation



costs. Under such conditions, pricing on the basis of long-run incremental cost results in a price (Pic) and output level (Qic). That price would yield a profit beyond the return incorporated in average cost, in that the cost of the last unit of output would be more than the average cost per unit. The *excess profit* would be represented by the area, (Pic - P_1) × Qic. To avoid excess profits, regulators might prefer to follow the average-cost method, which would result in price (Pac) and output level (Qac). But average-cost pricing under conditions of increasing long-run average costs, results in an under-pricing of the product and a correspondingly greater and uneconomic amount of resources devoted to its production.

II. Bonneville's Long-Run Incremental Cost

The Pacific Northwest's electric-power system currently relies primarily on hydro-electric generation. But thermal (coal and nuclear) plants will have to provide most of the new energy or baseload requirements of regional consumers, i.e., electricity which is required on a steady basis. This is because the region contains few undeveloped dam sites. However, Congress has not authorized any Federally-built coal or nuclear plants in the region. Instead, under the Hydro-Thermal Program underway since the late 1960's, Bonneville has been purchasing increased amounts of thermal power from other publicly-owned utilities for transmission over Federal lines. In addition, Bonneville has been adding new hydro generating capacity at existing Federal dams to meet the peaks in demand that exceed its steady baseload requirements. To estimate the agency's overall long-run incremental cost of power, it is therefore necessary to include estimates of the cost of both new thermal baseload and hydro-peaking facilities.

In micro-economic theory, the concept of

Table 1
Incremental Baseload Capacity and Cost, Washington Public Power Supply System, Nuclear Plants 1, 2, and 3

	Scheduled Additions to Baseload Capacity[1]		Scheduled Additions to Output[2]		Levelized Total Costs[3]		Present Value (1980)[6]		
Year	Annual	Cumulative	Annual	Cumulative	Annual[4]	Cumulative	Factor[5]	Annual Cost	Output
1982	1,100	1,100	7,227	7,227	188.3	188.3	.834	157.0	6,027
1983	—	1,100	—	7,227	—	188.3	.762	143.5	5,507
1984	1,250	2,350	8,213	15,440	234.1	422.4	.696	294.0	10,746
1985	—	2,350	—	15,440	—	422.4	.635	268.2	9,804
1986	868	3,218	5,703	21,143	159.9	582.3	.580	337.7	12,263
							Total:	1,200.4	38,326

Incremental Unit Cost = (Σ present value total cost)/(Σ present value kwh generation) = 1,200.4/38,326 = 3.13 cents/kwh

1 Net to Bonneville Power Administration, in megawatts.

2 In millions of kilowatt hours. Based on annual capacity factor (operating rate) of 75 percent. Annual output = capacity × factor × hours in year (8,760).

3 In millions of dollars. Levelizing reduces a stream of unequal future costs over a period n to a series of n equal payments. (See Appendix B, Table 1).

4 Total costs (both fixed and variable).

5 Assumes a discount rate of 9.5 percent; discounted to 1980.

6 Annual cost in millions of dollars. Output in millions of kilowatt hours.

Source: Computed by the author on the basis of output and cost data provided by Bonneville Power Administration.

long-run has no specific time dimension. But in applying theory to rate determination, the utility is faced with the problem of defining the long-run. The length of that period determines the amount of new generating capacity to be included in the estimate of long-run incremental cost, and thus the amount of total revenues to be received. For relative stability in rates, the period selected should be long enough to prevent frequent rate changes.

Fortunately, it is not difficult to delineate the next well-defined block of baseload energy to be acquired by Bonneville. The agency has contracted with the Washington Public Power Supply System (WPPSS) to purchase nearly all of the output from three nuclear plants scheduled for completion over the 1982-86 period. We have defined that block as the next baseload increment, and have developed an estimate of the consequent long-run incremental cost of energy, discounted back to the year 1980 (Table 1).

Long-run incremental cost per kilowatt-hour may be defined for computational purposes as the present value of all future costs associated with the output from scheduled additions to capacity, divided by the present value of that incremental output.[8] Long-run incremental unit cost thus can be estimated by determining: 1) the scheduled additions to capacity and resultant output over the planning horizon, 2) total levelized annual costs, fixed and variable, associated with that output, and 3) the present value of these costs and additions to output.

"Levelizing" is a method for reducing a stream of unequal future costs over a given period to a series of equal costs. It eliminates the year-to-year fluctuations in costs to provide a more representative figure of the annual costs and revenues required to produce that increment of output. Application of that procedure to WPPSS nuclear-plant costs is shown in Appendix B, Table 1. The present-value calculation converts expected costs to their present value today. In the present case, we discount to the year 1980 at a 9.5-percent rate, in keeping with the practice of some of the investor-owned utilities in the region. Thus, we estimate the long-run incremental cost of power produced from these three nuclear plants at about 3.13 cents/kwh.

Power from the new hydro-peaking facilities will cost much less per kilowatt hour. But because thermal plants will account for the bulk of the new generation capability, the overall incremental unit cost of electricity still will approximate 3 cents/kwh.[9] This compares with the average cost of .412 cents/kwh recovered by Bonneville in 1979.

Bonneville's efficiency would improve if it priced its total power supplies on the basis of incremental cost. (This would require Congressional authorization, however.) In planning rates for any given future period, Bonneville would set the unit price equal to the long-run incremental cost of the appropriate block of scheduled capacity. If it did so, regulatory commissions might follow suit and encourage Bonneville's utility customers to make a similar switchover to long-run incremental cost pricing, thereby providing retail electricity customers with the price signals required to allocate available supplies more efficiently. In contrast, under BPA's present average-cost pricing method, the cost of the last and more expensive increment would be combined with the costs associated with the older facilities, so that wholesale and retail customers would not be aware of the economic value of the resources required to supply additional increments. Consequently, too many resources would be devoted to the production of electricity.

III. Differential Between Long-Run Incremental and Average Cost

As we have seen, the estimated long-run incremental cost of power to be acquired by Bonneville far exceeds its latest reported average-cost figure. Consequently, it seems doubtful that the introduction of long-run incremental cost pricing would fail to recover the agency's total costs. Several factors help explain this wide differential between estimated long-run incremental and reported average cost. First, Bonneville, in interpreting the laws governing its selling price, has failed to recover the true average costs—i.e., opportunity costs—actually incurred by the Federal government in producing, purchasing and transmitting electricity. Second, the average-cost methodology employed by the electric-utility industry *in general* fails to fully reflect inflation, because it determines capital charges on an original-cost basis, whereas long-run incremental cost reflects the present value of the future inflated costs associated with additional new plant. Third, the economies of scale associated with the Federal Columbia River Power System have been exhausted with regard to baseload generation, raising incremental cost in a static sense above average cost.

Understated average costs

Bonneville is required by law to set wholesale power rates so as to produce sufficient revenues to recover the cost to the Federal government of producing, purchasing and transmitting electricity.[10] Evidence suggests, however, that the agency has not been recovering its true total and average costs, because it is also required to set power rates sufficiently low "to encourage widespread use of electric energy and provide the lowest possible rates to consumers consistent with sound business principles."[11]

For more efficient resource allocation, Bonneville power rates should be based on long-run incremental rather than average-cost pricing methods. But if the latter method must be employed, the revenue requirement should be determined on the same basis as it is in the private-utility sector. That would call for an "opportunity-cost" approach—one that would assure the general taxpayer a rate of return on invested capital equal to that earned on average in the private-utility sector were investment there to be financed solely through long-term debt. This assumes little difference in risk between the Federal and private-utility sectors, since the latter is regulated to ensure a reasonable rate of return.

To show Bonneville's underestimation of the actual economic costs incurred by the Federal Columbia River Power System (FCRPS) over the 1947–79 period, the author re-estimated average unit costs incurred by that system on the basis of the methodology employed by privately-owned electric utilities.[12] The adjustments included the addition of imputed property and income taxes, as well as the recalculation of interest charges and amortization on Congressional appropriations for FCRPS investments. Other FCRPS costs were accepted as measured by Bonneville. Appendix C contains the computations, plus technical notes.

Taxes: Bonneville pays no taxes—other than payroll taxes—to Federal, state or local governments. In contrast, private utilities over the 1947–79 period paid annual property taxes averaging about 2.3 percent of their total investment in plant, and income taxes averaging about 9.0 percent of their operating revenues. Addition of imputed property and income-tax costs of that magnitude thus would have raised the total unit cost (and price) of FCRPS electricity by 1979 to .606 cents per kilowatt hour (Table 2). This represents a 47-percent increase over Bonneville's reported cost of .412 cents per kilowatt hour (Table 3).

Interest: Over the 1937–77 period, the interest rates on BPA borrowings ranged from 2½ to 6⅛ percent, with 3¼ percent being the 1977 weighted average for all debt outstanding.[13]

These interest rates appear to be inordinately low, however. Some critics claim that the appropriate interest rate to be applied to those Congressional appropriations should be the prevailing average yield on long-term Treasury bonds at the time the debt is incurred.[14] But the author would go even further and use the average rate paid by private electric utilities for new long-term borrowings in the bond market. The author contends, in other words, that the appropriate comparison should be between the Federal and private utility sectors, and not between the Federal utility sector and the Federal government sector in general. On that basis, the public would earn as great a return on funds invested in the Federal utility sector as it could earn from purchasing private-utility bonds. Over the 1947–79 period, the interest payments that should have been recovered through rates imputed on this basis would have raised the average unit cost for Bonneville-marketed power to .831

cents/kwh by 1979 (Table 2)—102 percent more than the cost and corresponding price actually calculated by Bonneville (Table 3).

Amortization: Bonneville is required by law to repay each dollar borrowed for investment in Federal generating projects within 50 years after the project becomes revenue producing, and each dollar investment in transmission equipment within 40 years after those facilities are placed in service. However, the agency has not repaid such borrowings on a systematic basis, as it would if it were operating as a private utility with a given depreciation schedule. In fact, BPA has set its rates so low that it was unable to pay anything back to the Treasury in the past three years, but instead only increased its outstanding debt.

With adjustments made for imputed taxes, interest and amortization costs, the Federal Columbia River Power System actually incurred an average unit cost of at least 1.018 cents/kwh in 1979 instead of the .412 cents/kwh actually reported. Had rates been raised to reflect true average costs, the price for Bonneville power in 1979 would have been 147 percent higher than the amount actually charged

Table 2

Reconciliation of Reported and Imputed Unit Cost, Federal Columbia River Power System, 1947–79

(cents per kilowatt hour)

	Unit Cost[1]	Plus Imputed Cost Differential Cumulatively Added[2]					Constant Dollar Unit Cost[6]	
Fiscal Year	As Reported By Bonneville +	Taxes +	Net Interest +	Net Amortization[3]	Unit Cost As Imputed By Author[4]	Wholesale Price Index[5]	As Reported	As Imputed
1947	.265	.356	.360	.289	.289	37.81	.701	.765
1949	.232	.315	.327	.247	.247	43.22	.538	.572
1951	.240	.337	.366	.274	.274	46.93	.511	.584
1953	.238	.340	.373	.330	.330	46.44	.512	.711
1955	.238	.360	.403	.382	.382	46.30	.514	.826
1957	.235	.353	.390	.383	.383	48.85	.481	.784
1959	.239	.375	.413	.445	.445	50.20	.476	.888
1961	.247	.393	.431	.488	.488	50.20	.491	.972
1963	.247	.463	.503	.550	.550	50.12	.493	1.097
1965	.242	.374	.409	.432	.432	50.50	.480	.855
1967	.256	.377	.415	.412	.412	52.98	.484	.778
1969	.265	.395	.486	.489	.489	53.23	.479	.886
1971	.270	.402	.524	.561	.561	59.35	.455	.945
1973	.273	.394	.512	.604	.604	66.41	.411	.910
1975	.361	.519	.721	.762	.762	90.16	.400	.845
1977	.362	.557	.838	1.027	1.027	100.00	.362	1.025
1979	.412	.606	.831	1.018	1.018	120.61	.497	1.228

1 Derived on the basis of average-cost pricing method. For derivation see Appendix C, Table 1.

2 For derivation of the various imputed-cost components, see Appendix C, Table 2. The differentials between the various imputed- and reported-cost components were derived, and then added to (or subtracted from) total unit costs (as reported by Bonneville) on a cumulative basis.

3 From 1947-57, Bonneville repaid more of its borrowings than would have been called for under the author's imputed-amortization schedule. Imputed amortization was less than the amount actually recovered, and thus reduced the unit cost.

4 Derived on the basis of average-cost pricing method. For derivation see Appendix C, technical notes and Table 2.

5 Fiscal year 1977 = 100.

6 Cents per kilowatt hour, in constant 1977 dollars.

(Table 3). As reported by Bonneville, the average cost of power remained virtually constant over the entire 1947–67 period, as sales rose from 8.3 to 51.9 billion kilowatt hours, but then began to increase in 1969–79 as sales rose from 51.8 to 72.0 billion kilowatt hours. On an imputed basis, in contrast, the average cost rose almost without interruption throughout the entire period, with the rate of increase accelerating during the sales expansion of the 1970's (Chart 3). In constant dollars, unit costs as reported by Bonneville trended downward over time, whereas imputed costs in real terms trended upward (Chart 4).

Low Federal power rates undoubtedly helped contribute to the periodic electrical shortages of the 1970's. During the 1947–70 period, with virtually stable BPA rates, the Pacific Northwest's electric-power consumption rose at a 7½-percent annual rate. In contrast, consumption growth slowed to a 3½-percent annual rate over the 1970–77 period as a result of the 1974–75 recession and supply problems—as well as rising rates. But during the past two years the growth rate accelerated once again. As a result, the region's per capita electrical-energy consumption continued to be almost double the national average.

Impact of inflation

The average-cost figure of 1.02 cents/kwh, as calculated here on an opportunity-cost basis, is still less than one-third as large as the estimated long-run incremental cost of 3.13 cents/kwh. Part, if not all, of this differential may be due to the failure of the utility industry's average-cost methodology to reflect the full effects of inflation.

The electric utility industry (including Bonneville) determines the capital costs to be recovered through revenues on the basis of the historical (original) cost of plant and equipment. These capital charges include such items as depreciation, interest, and property taxes. But during periods of rapid inflation, when rising prices push the cost of new equipment far beyond the original cost of equipment acquired in the past, the average-cost procedure yields much lower figures than the long-run incremental-cost procedure, which includes discounted future capital costs. In particular, if depreciation is calculated on a straight-line ba-

Table 3
Imputed Unit Cost as a Percent of Reported Unit Cost

Fiscal Year	Unit Cost as Reported by Bonneville	+	Plus Imputed Cost Differentials, Cumulatively Added: Taxes	+	Net Interest	+	Net Amortization[1]
1947	100.0		134.3		135.8		109.1
1949	100.0		135.8		140.9		106.5
1951	100.0		140.4		152.5		114.2
1953	100.0		142.9		156.7		138.7
1955	100.0		151.3		169.3		160.5
1957	100.0		150.2		166.0		163.0
1959	100.0		156.9		172.8		186.2
1961	100.0		159.1		174.5		197.6
1963	100.0		187.4		203.6		222.7
1965	100.0		154.5		169.0		178.5
1967	100.0		147.3		162.1		160.9
1969	100.0		149.1		183.4		184.5
1971	100.0		148.9		194.1		207.8
1973	100.0		144.3		187.5		221.2
1975	100.0		143.8		199.4		211.1
1977	100.0		156.6		231.8		283.7
1979	100.0		147.1		201.7		247.1

1 From 1947–57, Bonneville repaid more of its borrowings than would have been called for under the author's imputed-amortization schedule. Imputed amortization was therefore less than the amount actually recovered, and thus reduced the unit cost.

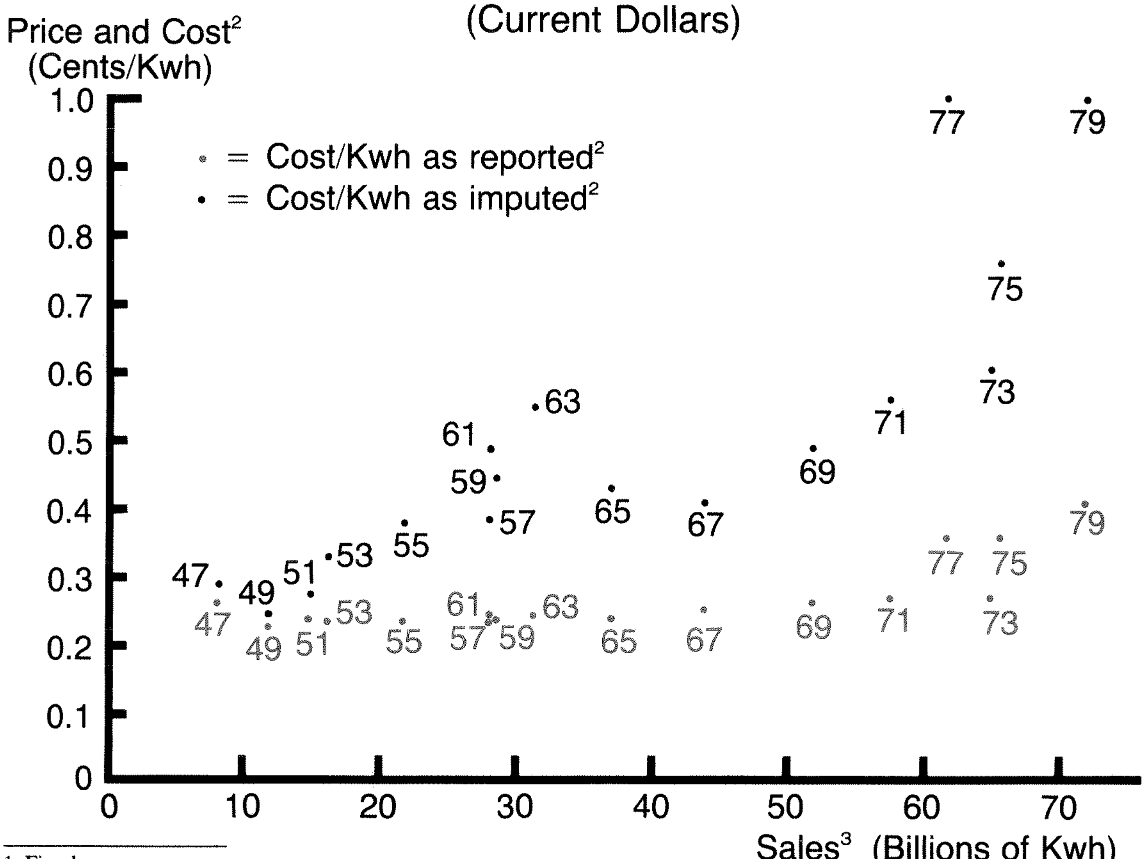
sis, the average-cost method overestimates the loss of value in the early life of the plant. An annual-average depreciation charge for plant and equipment of various ages calculated on an historic-cost basis bears no relation to current value. Similarly, interest rates used in calculating average cost are historic rates, whereas the incremental-cost procedure includes both current and future rates for long-term bond financing of scheduled plant and equipment.[15]

Decreasing returns to scale?

The above discussion relates to the behavior of costs *over time*. In contrast, the theoretical concepts of decreasing returns to scale and increasing long-run average cost depict cost and output alternatives facing a firm *at a moment of time* under the assumption of constant technology and factor prices (Chart 2-B). The average-cost concept as defined in economic theory is a statement of how average costs vary for systems of varied scale built today. A firm would be operating in an output range associated with increasing long-run average costs if expansion to a larger scale plant (or system) built from scratch today entailed higher average costs than a smaller plant built today.

Even in this static sense, the Federal Colum-

Chart 3
Federal Columbia River Power System Costs,
As Reported And On
An Imputed Private-Utility Cost Basis, Biennially 1947–79[1]
(Current Dollars)



1 Fiscal year

2 Determined on the basis of the average-cost pricing method. Under that method, total costs are divided by the number of units sold in a given period to obtain the unit cost and therefore the average price of electricity.

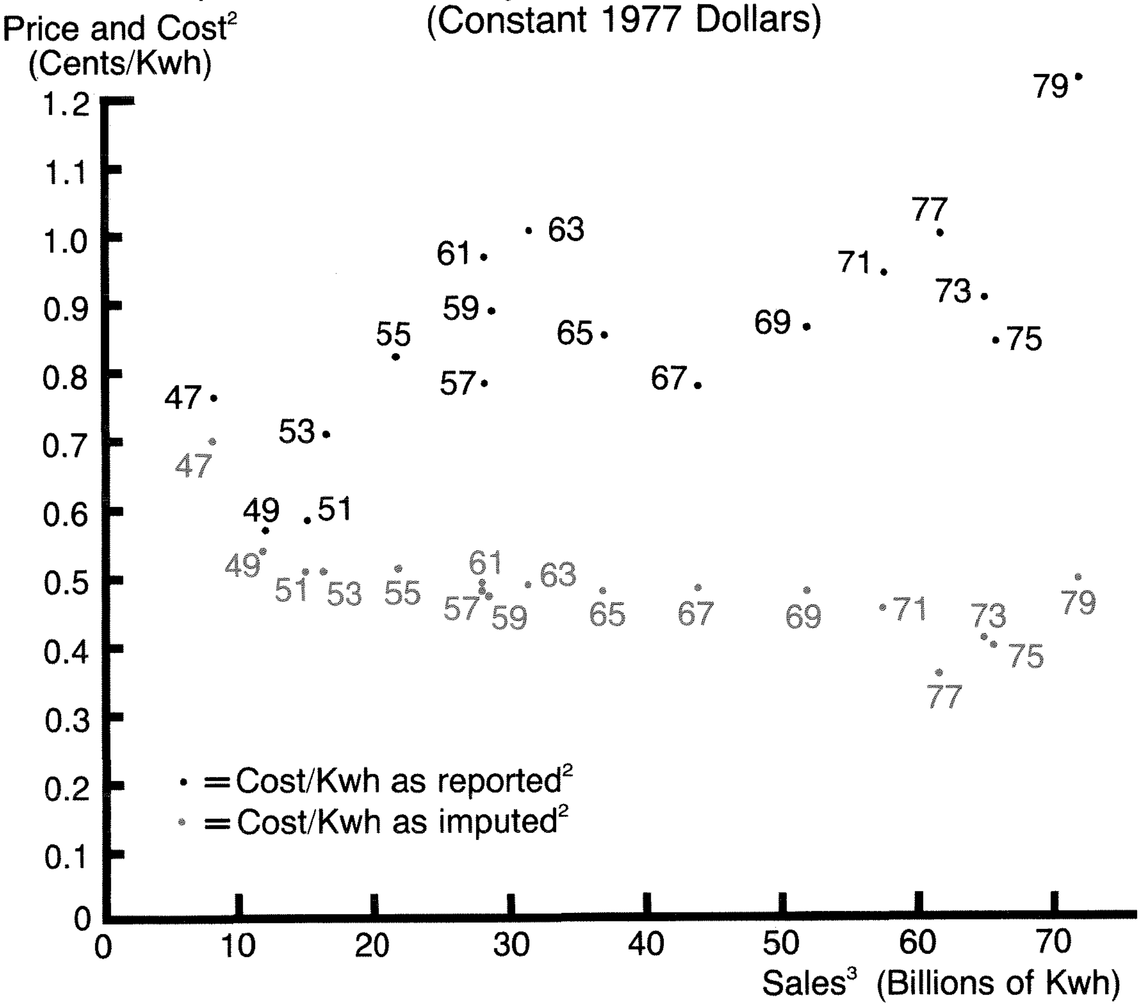
3 Sales equal the amount of power generated in a given period (output) minus transmission and other losses.

Source: See Appendix C, Tables 1 and 2.

bia River Power System may be facing increasing long-run average costs due to the exhaustion of economies of scale in baseload generation. Bonneville's decision to purchase thermal power rather than to develop the hydroelectric potential of the system to meet baseload growth suggests the exhaustion of such economies of scale. That is, even if the system were rebuilt from scratch today, long-run incremental cost might be higher than average cost. Some evidence also suggests that economies of scale for nuclear power at the plant level have been exhausted.[16]

Chart 4

Federal Columbia River Power System Costs, As Reported And On An Imputed Private-Utility Cost Basis, Biennially 1947–79[1] (Constant 1977 Dollars)



1 Fiscal year

2 Determined on the basis of the average-cost pricing method. Under that method, total costs are divided by the number of units sold in a given period to obtain the unit cost and therefore the average price of electricity.

3 Sales equal the amount of power generated in a given period (output) minus transmission and other losses.

Source: Table 2, developed from data shown in Appendix C, Tables 1 and 2.

IV. Strict Incremental or Sub-Optimal Incremental Pricing?

Whatever the reasons, Bonneville faces a situation where its long-run incremental cost is higher than its calculated current average cost. Strict application of long-run incremental-cost pricing would conflict with the agency's statutory requirement that total revenues equal total costs. One possible solution would be to utilize a sub-optimal approach to incremental-cost pricing known as the inverse-elasticity rule (IER), which involves price discrimination among customer groups with different price elasticities of demand. Under this method, prices charged certain customer groups closely approximate incremental cost, while prices charged other customers may be higher or lower than incremental cost, depending on the relationship of incremental and average cost.

Bonneville's current incremental cost is higher than its reported average cost. In this case, the proper approach would be to charge customers with higher price elasticities of demand higher rates, i.e., rates closer to incremental cost. Revenues from such customers would tend to decrease (as their demand is price elastic), lowering total revenues. Using the inverse-elasticity rule, customers with more elastic demand would be charged incremental cost, while customers with less elastic demand would be charged prices closer to average cost. The objective is to charge prices approximating long-run incremental cost to as many customers as possible.

The customer groups that ultimately determine the quantity of electricity demand in a region are the end-users, namely the residential, commercial and industrial customers. Therefore, in order to implement the inverse-elasticity rule, Bonneville would have to estimate the price elasticities of demand of these customer groups.[17]

Elimination of the legal budgetary restrictions on the use of long-run incremental cost pricing would remove the difficult practical problem of estimating these elasticities, and would also remove the need to discriminate among customer groups.[18] The price per unit for sales to all customer groups could then be set equal to long-run incremental cost, which would represent the most efficient way of allocating scarce resources.

Recent studies of the demand for electric power suggest that residential and commercial demand are price elastic, both over short- and long-term periods.[19] Since these groups consume about 60 percent of the Pacific Northwest's total electricity, sharply higher prices probably would reduce projected consumption significantly. A large number of the twelve nuclear and coal-fired generating plants scheduled for completion during the 1980's thus would not be needed.

Surplus funds collected by Bonneville either could be returned to the U.S. Treasury or could be used to finance conservation projects or research-and-development projects in the use of renewable resources for electrical generation in the Pacific Northwest. In the former case, regional consumers would be helping to repay the past subsidies they have received for Federal power in the past. In the latter case, regional consumers would be helping to finance their own conservation and electrical-supply programs.

As long as the price charged for electric power continues to be below the market-clearing price, apparent "shortages" are going to persist. The Pacific Northwest Electric Power Planning and Conservation Act will not provide an effective allocation mechanism, despite its establishment of a conservation program to reduce consumption. Consumers are not likely to be convinced of the need to conserve when the price they pay fails to provide proper signals regarding the true value of the resources required to bring them additional power. Efforts to shift available supplies among competing groups will not solve the fundamental problem of disequilibrium. The only lasting solution is through higher prices. Even with the sharp increase in power rates implemented by Bonneville in early 1980 as a result of the averaging in of the costs of scheduled thermal power, the agency's average price for power still remains far below the long-run incremental cost that would represent an efficient use of society's scarce resources.

V. Summary and Conclusions

Traditionally, the electric-power industry has presumably been characterized by decreasing long-run average costs over the output range relevant to a given market. To permit consumers to benefit from the assumed economies of scale inherent in electricity generation, governments have granted private firms monopoly status to serve given markets under regulated conditions. Social control also has taken the form of public ownership of generation and transmission facilities. Regulatory agencies, on the basis of this assumed characteristic of decreasing long-run average costs, also have prescribed the average-cost pricing method for setting the level of rates. Under such cost conditions, setting price equal to incremental cost would result in a financial loss.

For a more efficient allocation of resources, Bonneville should base its power rates on long-run incremental cost rather than average cost. Moreover, the agency should follow a strict, rather than sub-optimal, approach to long-run incremental cost pricing. Average price per unit should equal long-run incremental cost. The result is efficient resource allocation, because rates then reflect the true cost of the resources expended to provide consumers with each additional block of power.

The long-run incremental cost of the next block of power to be acquired by Bonneville is far above the agency's reported average cost. This may reflect 1) Bonneville's failure to recover the true average costs of the Federal system as determined on an opportunity-cost basis and 2) the failure of the utility industry's historical-cost accounting methods to fully reflect the impact of inflation. But it also may reflect the exhaustion of economies of scale.

Congress should remove legal budgetary restraints to enable Bonneville to set the average level of its rates equal to long-run incremental cost. By its sharp impact on power rates, that approach should significantly reduce Pacific Northwest electric-power consumption—and thereby reduce the need for many of the coal and nuclear generating plants now scheduled for construction during the 1980's. Surplus revenues could be returned to the U.S. Treasury or used for a loan program to foster regional electrical conservation and renewable electrical-energy development programs. Legislation designed to re-allocate available supplies among competing consumer groups will not correct the basic disequilibrium between demand and supply created by the average-cost pricing method. Instead, regulatory authorities must give increased emphasis to the role of price as a balancing mechanism.

APPENDIX A:
Natural Monopoly and Utility Regulation

The electric-power industry traditionally has been considered a "natural monopoly,"—an industry where free-market conditions allegedly lead to a structure which is both monopolistic and capable of achieving lowest production costs. Theorists argue that the technological conditions inherent in the generation and transmission of electricity favor the granting of monopoly status to firms serving given market areas. At the same time, legal authorities claim that it is proper for government regulatory commissions to regulate these "public utilities," where monopoly is considered as "natural" or inevitable due to "technical conditions," so as to prevent the extraction of monopoly profits.

Social control of these utilities has taken two forms: 1) establishment of public regulatory authorities with power to investigate utility finances and operations and to set "just and reasonable" rates; and 2) direct public ownership of generation and transmission facilities. On a nationwide basis, regulation of privately-owned enterprises is the more common form of organization, but in the Pacific Northwest, publicly-owned utilities play an important role, sharing the retail market almost equally with privately-owned utilities. Publicly-owned utilities not only own their own generating plants, but also purchase wholesale power from the Bonneville Power Administration.

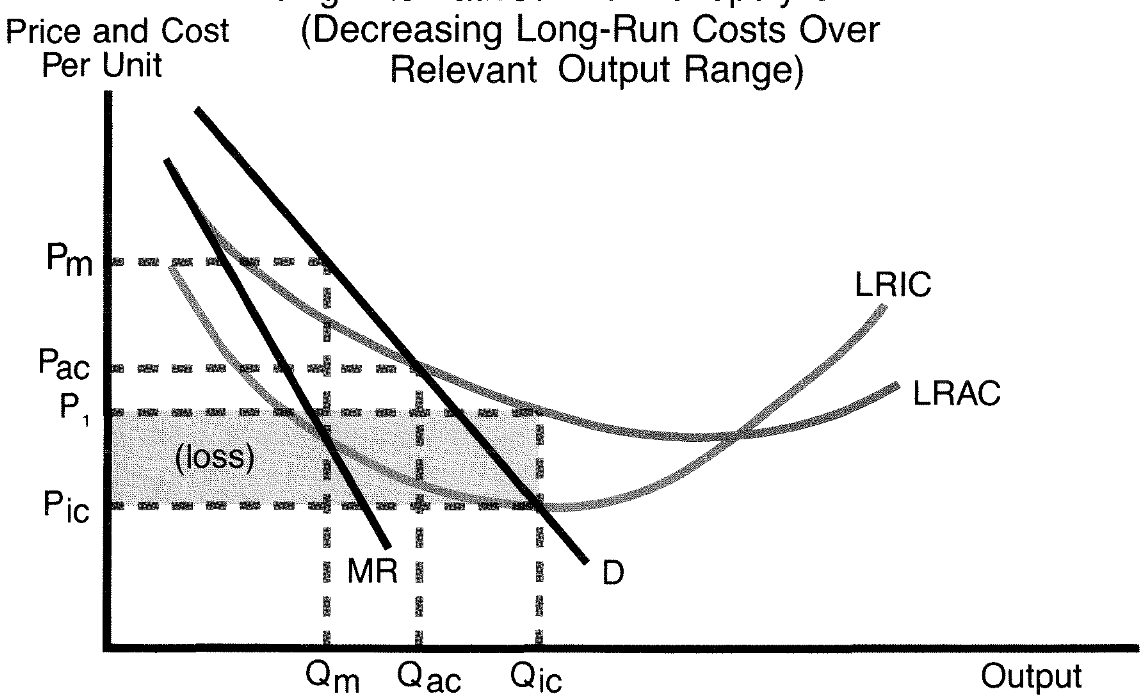
Legal justification for regulating certain privately-owned business firms developed from English common law, as modified in a series of landmark judicial decisions over the 1877–1943 period.[20] These decisions determined the legal criteria for a public utility to be: 1) a business whose activities are essential to the public welfare, i.e., in legal terms, "affected with a public interest;" and 2) one where regulation is required to protect the public. But economists have struggled for years to determine which characteristics qualify an industry as a natural monopoly and justify the granting of exclusive franchises under regulated conditions.

Some have mentioned heavy fixed costs as a necessary prerequisite.[21] They point out that supplying electricity requires very costly capital equipment, resulting in a high proportion of fixed to variable costs. Effective utilization of this equipment requires that the facilities be operated as close to full capacity as possible, thus dividing the total fixed cost of those facilities among the maximum number of units of output. Similarly, in this context, duplicate facilities—such as would be present in the usual competitive situation—would result in substantially higher unit costs. These characteristics translate into short-run declining average costs. That is, once the investment in plant is made and plant size is fixed over the short-run, average unit cost declines as output is expanded.

Other economists have argued that the incidence of heavy fixed costs is not a sufficient criterion for "natural monopoly." In industries with a heavy proportion of fixed to variable costs, production may still be carried on efficiently by a large number of firms. Duplication would be inefficient only in situations where there are economies of scale, or decreasing

Chart A.1

Pricing Alternatives in a Monopoly Situation (Decreasing Long-Run Costs Over Relevant Output Range)



P_m = Unregulated monopoly price under profit maximization
P_{ac} = Regulated monopoly price under average-cost pricing
P_{ic} = Regulated monopoly price under long-run incremental-cost pricing

long-run average costs, over the entire extent of the market. In such situations—but only in such situations—it would be inefficient for more than one producer to supply a given market. According to these economists, economies of scale are the indispensible feature of natural monopoly.[22]

Unregulated, the monopolist maximizes profits by equating marginal revenue (MR) to long-run incremental cost (LRIC) and pricing at a level P_m which corresponds to an output level Q_m (Appendix A, Chart I). Because price per unit exceeds average cost per unit, the monopolist enjoys a substantial economic profit. Moreover, because price exceeds long-run incremental cost—the cost of the last block of production—there is an under-utilization of resources, i.e., too few resources are devoted to this product. This socially undesirable option is normally prevented through the regulatory process, with the adoption of an average-cost pricing method. This approach results in a lower price, Pac, than the unregulated monopoly price, P_m. Similarly, it results in an output level, Qac, which is greater than the unregulated monopoly level of output, Q_m. It does not lead to as low a price and high an output level as would exist if price were determined by the cost of production of the last unit, that is, by the intersection of the demand curve and the long-run incremental cost curve. But under long-run decreasing average-cost conditions, the result is a price, Pie, that fails to cover average costs, so that without public subsidy the firm would be forced out of business.

APPENDIX B:
Table 1
Five-Year Levelized Annual Costs, Washington Public Power Supply System Nuclear Plants 1, 2, and 3
(cost data in thousands of dollars)

Year	Fixed Cost[2]	Variable Cost[2]	(Credits)[3]	Total Cost	Present Value Factor[4]	Present Value of Total Costs	Levelizing Factor[5]	Levelized Annual Cost
WPPSS #2								
1982[1]	163,320	23,670	(−4,280)	182,710	.913	166,814		
1983	164,860	25,190	(−4,280)	185,770	.834	154,932		
1984	167,940	27,440	(−4,280)	191,100	.726	138,739		
1985	169,690	30,410	(−4,280)	195,820	.696	136,291		
1986	172,460	32,640	(−4,280)	200,820	.635	127,521		
					Total	724,297	× (.26)	= 188,317
WPPSS #1								
1984[1]	192,550	37,750	(−4,910)	225,390	.913	205,781		
1985	198,180	38,660	(−4,910)	231,930	.834	193,430		
1986	200,170	42,830	(−4,910)	238,090	.726	172,853		
1987	203,840	46,190	(−4,910)	245,120	.696	170,604		
1988	203,480	49,560	(−4,910)	248,130	.635	157,563		
					Total	900,231	× (.26)	= 234,060
WPPSS #3								
1986[1]	133,410	26,800	(−3,750)	156,460	.913	142,848		
1987	132,540	29,700	(−3,750)	158,490	.834	132,181		
1988	133,420	33,180	(−3,750)	162,850	.726	118,229		
1989	134,340	34,930	(−3,750)	165,520	.696	115,202		
1990	135,320	36,120	(−3,750)	167,690	.635	106,483		
					Total	614,943	× (.26)	= 159,885

1 Initial year of full operation.
2 Costs include expected increases in input prices.
3 Interest earnings on reserves.
4 Assumes a discount rate of 9.5 percent.
5 Levelizing factor = $i/(1-v^m)$, where i = interest rate, m = number of periods, and $v^m = 1/(1+i)^m$.
Source: Computed by the author on the basis of cost data provided by Bonneville Power Administration.

APPENDIX C:
Adjustment of Bonneville's Reported Average Costs to Reflect Opportunity Costs

The following technical notes describe the methodology used by the author to adjust Bonneville's reported average unit costs for the 1947–79 period to include the major cost items and methodologies employed by private-owned utilities. The reported and imputed costs appear in Appendix C, Tables 1 and 2, respectively.

Taxes: Annual property-tax payments were imputed by applying the average property-tax rate for the U.S. private-utility sector in any given year to the Federal Columbia River Power System's total electrical plant in service as of that year, valued on an historical-cost basis. Income-tax payments for the system were imputed through a similar procedure, by applying the income-tax rate for the U.S. private-utility sector in any given year to the total electric-power revenues received by FCRPS as of that year.

Interest: Interest payments on an opportunity-cost basis were imputed for any given year n by the formula:

$$P_n = \sum_{y=1939}^{n} i_y A_y$$

Appendix C, Table 1
Federal Columbia River Power System Costs, 1947–79
As Reported by Bonneville[1]
(cost data in millions of dollars)

Fiscal Year	Variable Costs: Operation & Maintenance	Variable Costs: Purchase and Exchange Power	Variable Costs: Total	Fixed Costs: Interest	Fixed Costs: Amortization[2]	Fixed Costs: Total	Total Costs	Sales[3]	Unit Cost[4]
1947	6.01	.34	6.35	5.16	10.38	15.54	21.89	8.26	.265
1949	5.69	.74	6.43	5.86	15.53	21.39	27.82	11.97	.232
1951	8.11	.55	8.66	5.53	22.00	27.53	36.19	15.08	.240
1953	10.25	.76	11.01	9.34	18.60	27.94	38.95	16.39	.238
1955	12.01	.48	12.49	15.94	23.55	39.49	51.98	21.83	.238
1957	15.34	.49	15.83	24.02	26.42	50.44	66.27	28.21	.235
1959	18.39	.52	18.91	30.14	19.42	49.56	68.47	28.66	.239
1961	21.69	.70	22.39	32.82	14.49	47.31	69.70	28.28	.247
1963	23.17	1.28	24.45	34.63	18.62	53.25	77.70	31.49	.247
1965	27.05	1.62	28.67	35.22	26.22	61.44	90.11	37.20	.242
1967	28.98	9.64	38.62	35.55	38.66	74.21	112.83	43.99	.256
1969	34.09	12.53	46.62	43.32	47.34	90.66	137.28	51.88	.265
1971	44.59	12.81	57.40	59.14	39.14	98.28	155.68	57.61	.270
1973	53.44	48.26	101.70	69.32	6.32	75.64	177.34	65.04	.273
1975	71.32	19.35	110.02	89.18	37.95	127.13	237.15	65.73	.361
1977	94.79	23.72	118.51	118.49	−13.41	105.08	223.59	61.75	.362
1979	123.15	25.20	148.35	168.00	−19.79	148.21	296.56	72.02	.412

1 These costs reflect Bonneville's interpretation of its repayment responsibility. That is, they represent the amounts the agency believes it must recover in the form of revenues during any given year to cover all the costs incurred by the Corps of Engineers, the Bureau of Reclamation and the Bonneville Power Administration in purchasing, generating, transmitting and marketing electric power, including the amortization of the Government's investment in power facilities with interest. The repayment accounting method constitutes the basis for establishing the average power rate.

2 Amortization, unlike the other cost data, is not reported by Bonneville. Rather, it is a residual amount left over from total revenues after all other costs have been subtracted. This policy arises from the agency's interpretation of its repayment responsibility. Although it is required by law to repay in full all Congressional appropriations within fifty years after the investment becomes revenue producing, Bonneville does not interpret this requirement to mean that it must repay the borrowings on a straight-line or otherwise consistent basis. In fiscal years 1977 and 1979, total revenues were insufficient to permit any repayment of debt to the U.S. Treasury.

3 In billions of kilowatt hours.

4 In cents per kilowatt hour, derived on the basis of the average-cost pricing method. Unit cost equals total cost divided by the number of units (kwh) sold in a given period. Unit cost and average cost are thus synonymous under the average-cost pricing procedure.

Source: U.S. Department of Energy, Bonneville Power Administration, *Annual Report* (various issues) and *Financial and Statistical Summary.*

Appendix C, Table 2
Federal Columbia River Power System Costs, 1947–79, As Imputed on a Private-Utility Cost Basis[1]
(cost data in millions of dollars)

	Variable Costs			Fixed Costs							
Fiscal Year	Operation & Maintenance	Purchase and Exchange Power	Total[2]	Property Tax[3]	Income Tax[4]	Depreciation[5]	Reconciliation Depreciation & Amortization[6]	Interest[7]	Total	Total Costs	Unit Cost[8]
1947	6.01	.34	6.35	5.94	1.59	3.76	.75	5.49	17.53	23.88	.289
1949	5.69	.74	6.43	7.69	2.21	5.01	1.00	7.27	23.18	29.61	.247
1951	8.11	.55	8.66	10.36	4.23	6.80	1.36	9.89	32.64	41.30	.274
1953	10.25	.76	11.01	11.89	4.86	9.62	1.93	14.84	43.14	54.15	.330
1955	12.01	.48	12.49	20.28	6.24	15.86	3.18	25.39	70.95	83.44	.382
1957	15.34	.49	15.83	26.41	6.91	20.46	4.10	34.36	92.24	108.07	.383
1959	18.39	.52	18.91	32.44	6.43	23.91	4.79	41.20	108.77	127.68	.445
1961	21.69	.70	22.39	33.37	8.05	25.50	5.11	43.52	115.55	137.94	.488
1963	23.17	1.28	24.45	59.44	8.74	27.74	5.56	47.21	148.70	173.15	.550
1965	27.05	1.62	28.67	39.46	9.55	28.96	5.81	48.20	131.98	160.65	.432
1967	28.98	9.64	38.62	42.13	10.70	31.06	6.23	52.64	142.76	181.38	.412
1969	34.09	12.53	46.62	55.85	11.71	40.99	8.22	90.41	207.18	253.80	.489
1971	44.59	12.81	57.40	68.53	7.25	50.06	10.04	129.67	265.55	322.95	.561
1973	53.44	48.26	101.70	73.33	5.87	55.03	11.03	145.95	291.21	392.91	.604
1975	71.32	19.35	90.67	98.59	5.22	70.50	14.13	221.82	410.26	500.93	.762
1977	94.79	23.72	118.51	123.08	3.58	85.44	17.13	286.44	515.67	634.18	1.027
1979	123.15	25.20	148.35	134.66	5.25	95.87	19.22	329.79	584.80	733.15	1.018

1 These costs represent the author's interpretation of the amounts that should have been recovered by Bonneville in the form of revenues in any year had it been operating as a private investor-owned electric utility. These consist of the variable costs as actually measured and reported by Bonneville, plus recomputations of fixed costs to include imputed property and income-tax payments, interest charges reflecting the opportunity cost of capital in the private-utility sector, and a straight-line depreciation and amortization charge to repay all outstanding debt on a consistent and continuous basis.

2 The author took no exception to total system variable costs as measured by Bonneville. Variable costs are thus as reported in Appendix C, Table 1.

3 Derived by applying the average property-tax rate for the U.S. private-utility sector in any given year (property taxes paid as a percentage of total electric plant) to the Federal Columbia River Power System's (FCRPS's) total electric plant in service as of that year.

4 Derived by applying the average income-tax rate for the U.S. private-utility sector in any given year (Federal and other income taxes paid as a percentage of total revenues) to the total electric-power revenues received by the Federal Columbia River Power System as of that year. Income tax is considered a fixed cost by private investor-owned utilities in that some payment is assured by the regulatory process.

5 Private utilities recover their long-term borrowings for capital investment through their depreciation charges. Depreciation is usually calculated on a straight-line basis, by applying the average life of service of the equipment to the total value of the plant in service, measured on a historical (original) cost basis as is customary in the private-utility industry. Bonneville estimates the average service life of its plant to be 60 years. For any given year, depreciation thus has been calculated here as 1/60th of the total value of the plant in service, measured on an historical-cost basis.

6 Depreciation is calculated on an average 60-year basis, whereas Bonneville is required by law to amortize (pay back) its borrowings within 50 years after they become revenue producing. The "reconciliation" charges represent the difference between 1/50th and 1/60th of the value of plant in service.

7 Derived on an "opportunity cost" basis; total interest payments in each year equal the product of new debt and the current Moody's average Aaa interest rate for public (private investor-owned) utilities, plus the product of old unamortized debt and the interest rate in effect when that debt was incurred. Debt is reduced (amortized) on a straight-line basis by 1/50th each year after it is incurred. A consistent series showing Congressional appropriations to the FCRPS was not available. Total value of plant in service was used as a proxy in determining outstanding debt, under the assumption that borrowing was for capital investment.

8 In cents per kilowatt hour, derived on the basis of the average-cost pricing method. Unit cost equals total cost divided by the number of units (kwh) sold in a given period. Unit cost and average cost are thus synonymous under the average-cost pricing procedure.

Source: For data pertaining to the private-utility sector: Federal Power Commission, *Statistics of Privately-Owned Electric Utilities in the United States* and Moody's Investors Services, *Moody's Public Utilities Manual*. For reported data pertaining to the Federal Columbia River Power System: Bonneville Power Administration.

where: P_n = total interest payment in year n

i_y = Moody's Aaa interest rate on public (private investor) utility issues in year y

A_y = unamortized portion of appropriations received in year y as of year n

This formula simply states that total interest payments in any given year, P_n, equal the sum of all interest payments on outstanding FCRPS debt in that year. In other words, total interest payments equal new debt times the prevailing interest rate, plus any unamortized old debt multiplied by the rate(s) in effect when the debt was incurred. The first debt was assumed to be incurred in 1939, the earliest date for which data were available. Each increment in debt was amortized on a straight-line basis by 1/50 each year after it was incurred, in line with the 50-year payback period specified by law. Note that Moody's Investor Service refers to private investor-owned utilities as public utilities, using that term in a general sense.

A consistent series showing annual Congressional appropriations to the FCRPS was not available. A proxy for "new debt" was developed by taking the total value of plant in service; i.e., the capital stock, and calculating the annual change, or new investment added each year. That proxy was used under the assumption that borrowing was for capital investment.

Amortization: Amortization costs were imputed annually for the 1947–79 period by developing a systematic straight-line depreciation schedule. Depreciation was calculated by applying the average life of service of the equipment to the total value of the plant in service, measured on an historical (original) cost basis. This amortization procedure follows that used by most private utilities. Bonneville estimates the average service life of its plant and equipment to be 60 years. For any given year, depreciation thus was calculated as 1/60th of the total value of plant in service. Since depreciation is calculated on a 60-year basis, whereas Bonneville is required by law to amortize borrowings within 50 years, depreciation charges thus calculated would fall short of meeting Bonneville's repayment responsibilities. A reconciliation charge therefore was calculated, representing the difference between 1/50th and 1/60th of the value of the plant in service. (The fact that transmission investment must be paid back in 40 rather than 50 years was ignored, i.e., the payment period was assumed to be 50 years, the same as for generating investment.)

FOOTNOTES

1. Perhaps the most widely-used source is the long-term forecast of Pacific Northwest electric-energy loads and resources developed annually by the region's utilities. For a summary of the latest findings, see U.S. Department of Energy, Bonneville Power Administration, **Power Outlook Through 1989–90** (Portland: Bonneville Power Administration, May 1979). Bonneville's marketing area includes Washington, Oregon, Idaho and Western Montana.

2. For a description of the average-cost pricing methodology followed by private investor-owned utilities in establishing the level of rates, see Edison Electric Institute, **Economic Growth in the Future: The Growth Debate in National and Global Perspective** (New York: McGraw-Hill Book Company, 1975), pp. 259–266.

3. For Bonneville, the return on invested capital includes interest to be paid to the U.S. Treasury for long-term borrowings for investment in the Federal Columbia River Power System. These funds are acquired through Congressional appropriation and, for financing transmission facilities, through the sale of revenue bonds to the Treasury. For private investor-owned utilities, the return consists of three components: 1) interest payments on bonded indebtedness, 2) dividends on preferred stock, and 3) a return to common-equity holders, a residual amount which becomes available to these owners only after all other legitimate claims of the company have been settled. The first two are specified exactly on the bond indenture and the preferred-stock certificates.

4. In a perfect-competition model, there is one situation in which short and long-run marginal (incremental) costs are equal—that is, in long-run competitive equilibrium. In this situation, plant capacity has been adjusted to its optimum size for achieving a given level of output, as shown in Chart 2 at output Q_3. It is assumed that a firm starts from scratch in planning its optimal-size production facility. In reality, this optimum is never realized. Instead, firms operate with plants of various ages, and must make decisions with regard to adding new capacity, either for replacement or growth purposes. Pricing on the basis of short-run costs would not necessarily recover the capital costs associated with this new plant.

With regard to the distinction between marginal and incremental cost, marginal cost—strictly speaking—refers to the additional cost of supplying a single, infinitesimally small additional amount. Incremental cost refers to the average additional cost of a larger finite addition to production. Since rate changes are relatively infrequent, additions to output for which costs must be recovered are of an incremental rather than marginal magnitude.

5. For proof that marginal-cost pricing of all goods and services leads to optimum welfare, see Edward Berlin, Charles J. Cicchetti and William J. Gillen, **Perspective on Power, A Study of the Regulation and Pricing of Electric Power,** A Report to the Energy Policy Project of the Ford Foundation (Cambridge: Ballinger Publishing Company, 1975), pp. 127–130.

6. The cost curves for an individual firm are drawn under the assumption that the firm has no influence on the prices of the factors of production it uses. Internal economies therefore are those enjoyed by a firm apart from any change in factor prices. When an industry as a whole expands its output, the prices of factor inputs may be affected. External economies affect the slope of the industry supply curve.

7. For a discussion of the distinction between economies of scale, i.e., decreasing long-run average costs, and decreasing short-run average costs attributable to spreading of overhead, see Edward Berlin, Charles J. Cicchetti and William J. Gillen, **op. cit.,** pp. 6–7.

8. There are numerous studies devoted to the methodologies for determining long-run incremental costs and rates in the electric-utility industry. See, for example, Charles R. Cicchetti, William G. Gillen and Paul Smolensky, **The Marginal Cost and Pricing of Electricity: An Applied Approach** (Cambridge: Ballinger Publishing Company, 1977); Charles R. Scherer, **Estimating Electric Power System Marginal Costs** (Amsterdam: North-Holland Publishing Company, 1977); National Economic Research Associates, Inc., **A Framework for Marginal Cost-Based Time-Differentiated Pricing in the United States,** Topic 1.3, prepared for Electric Utility Rate Design Study (New York: National Economic Research Associates, Inc., 1977); and Ralph Turvey, **Optimal Pricing and Investment in Electricity Supply, An Essay in Applied Welfare Economics** (Cambridge: Massachusetts Institute of Technology, 1968). All of these studies are inordinately complex because they deal not only with the level of rates, but also with the structure, and the time and seasonal differentiation of rates.

9. According to Bonneville, thermal capacity will account for 92 percent of the total new generation name-plate capacity scheduled for the 1978–86 period. See U.S. Department of Energy, Bonneville Power Administration, **BPA Long-run Incremental Cost of Service and Rate Study** (Portland: Bonneville Power Administration, July 1979), Table 4. The author did not accept BPA's calculations of long-run incremental thermal and hydro-power costs, but did take into consideration that the agency's incremental-cost estimate for hydro-peaking capacity was far lower than its estimate for baseload thermal energy.

10. The legal requirement to recover costs is found in Section 7 of the Bonneville Project Act (50 Stat. 731, approved August 20, 1937); Section 5 of the Flood Control Act of 1944 (58 Stat. 887), which applies to the marketing of power from all Corps of Engineers' projects; and Section 9 of the Federal Columbia River Transmission Act (approved October 18, 1974; 88 Stat. 1376). See Bonneville Power Administration, **The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System, op. cit.,** Appendix C, pp. II–34–38.

11. Bonneville Power Administration, **The Role of the Bonneville Power Administration in the Pacific Northwest Power Supply System, ibid.,** Appendix C, p. II–9.

12. Major cost items were included only if appropriate. For example, the return to equity owners was excluded because Bonneville is financed solely through Congressional appropriations and sales of revenue bonds to the U.S. Treasury.

13. Bonneville Power Administration, **Interest Rate Policy** (Unpublished paper, February 15, 1978), p. 5.

14. See Edison Electric Institute, **A Study of the Bonneville Power Administration, The Marketing Agent for the U.S. Columbia River Power System** (New York: Edison Electric Institute, 1963), p. 2; and David L. Shapiro, "Bonneville Agency Pricing and Electric Power Utilization," **Quarterly Review of Economics and Business** (Winter 1976), p. 22. In these studies, the opportunity-cost principle for selecting the appropriate interest rate was not discussed.

15. Since Bonneville purchases power only from publicly-owned utilities, the sale of long-term bonds is the only method of funding. For private utilities, the return on equity capital is adjusted for inflation, since the regulatory process permits the return on old equity to equal the rate of return on new equity. However, this adjustment pertains only to the return on equity capital.

16. Numerous utility experts have noted the increased maintenance problems and higher forced outage rates associated with nuclear plants above about 600 MW capacity. See, for example, C. C. Boone, "The Financial Impact of Outages," paper presented at 31st Annual Meeting of the American Power Conference, April 1969; also, Louis H. Roddis, Jr., "Address to the 1972 Atomic Industrial Forum."

17. Since electricity is crucial to the aluminum industry—by far Bonneville's largest industrial user—and is presently priced very low relative to other regions, the industrial sector's demand schedule may be less elastic than that of the utility sector. If so, industrial users would pay less for power under the inverse elasticity rule than utility customers, although both groups would pay far more than they are paying under current average-cost pricing methods. Since industrial customers are willing to take a certain amount of interruptible power, that differential might be acceptable to all parties.

18. Strict long-run incremental-cost pricing also would eliminate the need for the preference clause, because with overall consumption declining, sufficient resources would be available to meet the quantity demanded by all customer groups.

19. See J. W. Wilson, "Residential Demand for Electricity," **Quarterly Review of Economics and Business** (November 1979), pp. 7–22; K. P. Anderson, "The Demand for Electricity: Econometric Estimate for California and the United States," **RAND R-905-NSF,** Santa Monica, Cali-

fornia, 1972; R. Halvorsen, "Residential Electricity: Demand and Supply," presented at the Sierra Club Conference on Power and Public Policy, Vermont, January 1972.

20. For a summary of the constitutional history and the criteria for regulation, see Alfred E. Kahn, **op. cit.**, pp. 3–8; also, Dexter Merriam Keezer and Stacy May, **The Public Control of Business** (New York: Harper and Brothers, 1930), Chapter 5.

21. Ely observed, for example, that natural monopolies will exist in the presence of the following three conditions: a high degree of price sensitivity by consumers, the technical and economical impracticality of a large number of producers, and a high proportion of fixed to variable costs. Clemens, many years later, listed the following necessary conditions: conditions of space and geography, large capital investments, economies of decreasing costs, technical limitations of the market, and exclusive franchises. Richard T. Ely, **Outlines of Economics,** 6th Ed. (New York: MacMillan Company, 1937), p. 628, Eli W. Clemens, **Economics and Public Utilities** (New York: Appleton-Century-Crofts, Inc., 1950), pp. 26–28.

22. For example, Kahn, in his analysis of natural monopoly, emphasizes that it is not the fact of "duplication alone that makes for natural monopoly, but the presence of economies of scale or decreasing costs in the provision and utilization of their facilities," and that this will be the case only "when the economies achievable by larger output are internal to the individual firm." See Kahn, **op. cit.,** Vol 2, pp. 119 and 121.

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