"SOCIAL" RATE RESTRUCTURING AND RESIDENTIAL ELECTRICITY CONSUMPTION

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by Sanford V. Berg and William Everett Roth*

Increases in the price of fuel and capital facilities have resulted in pressure for "social" rate-making in the electric utility industry. Southern California Edison has proposed a "lifeline" subsidy for half a million low-use consumers, with the revenue deficiency recovered by increasing the charges for consumption above 300 kwh/month by .001 c/kwh. An alternative social program involves the use of fuel stamps; experiments with such a program are now being carried out in Denver and Leheigh Valley. The purpose of this paper is to compare the two redistribution policies, using the theory of the consumer under nonlinear budget constraints. Because of conflicting social goals, neither approach is ideal, although stamps appear to be a more specific, and thus cheaper, way to increase electricity consumption and/or utility of low income consumers.

1. Lifeline Rates versus the Declining Block

The declining block and lifeline rate structures shown in Figure 1 correspond to the budget lines ABCDE and A'B'C'D E', respectively in Figure 2. For simplicity the price per kwh beyond K_2 for declining blocks is the same as the average price per kwh up to K_1 for lifeline rates, making the slope of CDE (x) the same as IB. Similarly, the slope of IB (z) is the same C'D E'. As drawn, the solid budget line for

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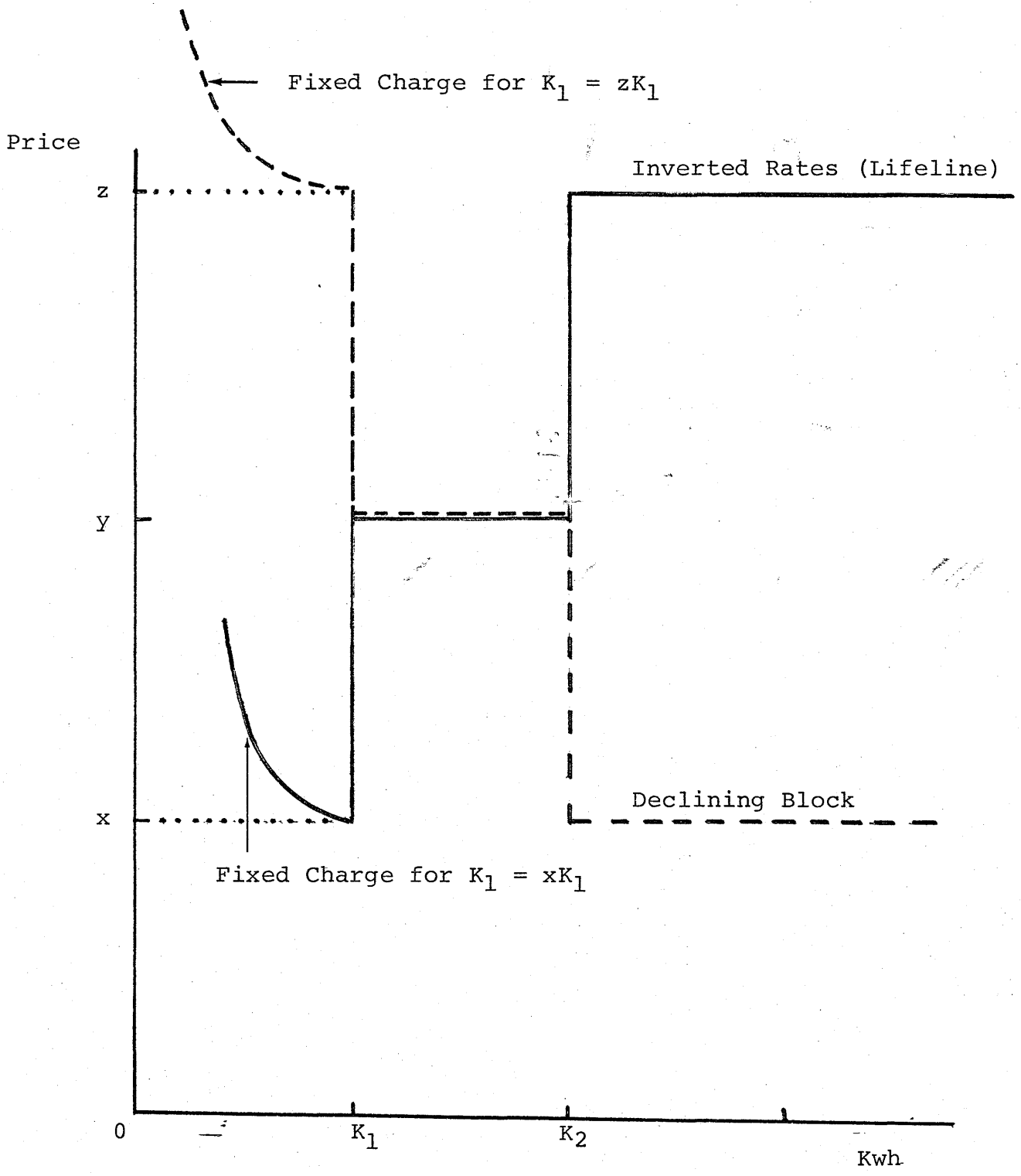

FIGURE 1
Alternative Rate Structures

declining block pricing and the dashed line for lifeline involve fixed charges for the first K_1 units of consumption thus IA (under declining block) equals zK_1 and IA' (lifeline) equals xK_1. Were it not for this indivisibility in purchase, the budget lines in Figure 2 would originate at I, and would be represented by the dotted lines IB and IB'.

Given these correspondences, one can proceed to compare the effects on heavy and medium users of a change from (ABCDE) declining block to lifeline (A'B'C'D E') price structures. Drawing upon Taylor's discussion, it is clear that those customers who were consuming between points D and E in Figure 2 under a declining block structure would have a decrease in their consumption of electricity due to an income and substitution effect if a lifeline rate structure is imposed. However, those customers who were consuming between points B and C in Figure 2 under a declining block rate structure would increase their consumption of electricity due to an income effect if a lifeline rate structure is introduced. In some cases, the positive income effect could be partially offset by a negative substitution effect if equilibrium consumption is on C' D, where the customer faces a higher marginal price than y. The net effect on total electricity consumption would depend upon the price and income elasticity of the individual customers and upon the comparative number of customers consuming between points B and C and points C and E. If the short-run price and income elasticities are very low, then changes in consumption due to changes in the pricing structure would be minimal. If the number and total consumption of customers between points B and C were substantially greater than the customers between points C and E, it would be possible for a lifeline rate structure to result in increased total electricity consumption.

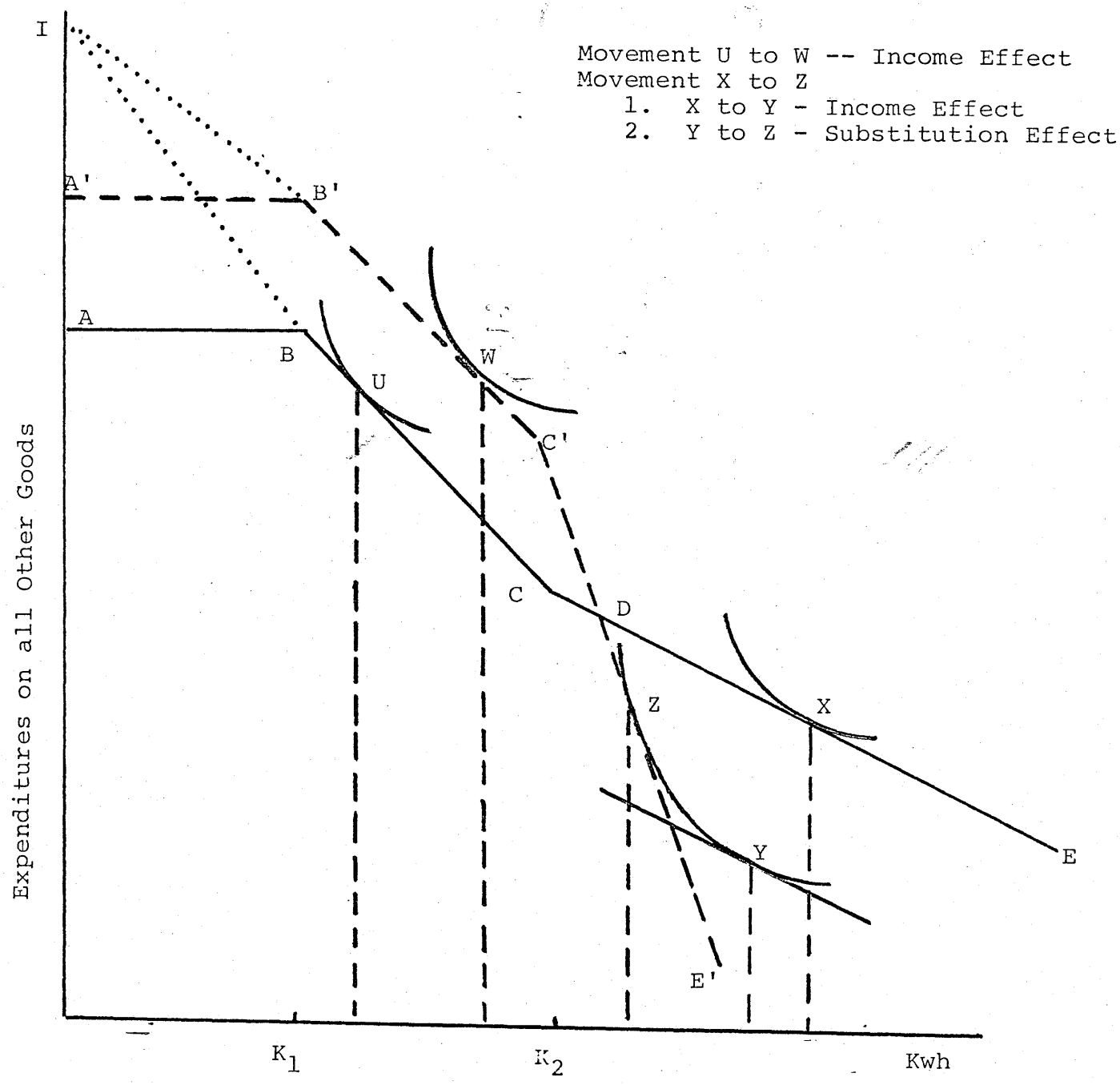

FIGURE 2
Comparison of Lifeline Rates
and Declining Block Structure

Questions are raised concerning the impact upon revenues and profits of the electric utility by the introduction of a lifeline rate structure. If the demand for electricity was price inelastic, then changes in price would not normally affect total consumption. But when there are changes in the entire price structure, the possibility of a significant income effect should be taken into account (at least in the long run). Also, if the consumption between points C and E in Figure 2 were highly sensitive to price changes, then price increases would cause a dramatic decrease in consumption, with lower revenues and profits for the utility. In addition, if the marginal cost of electricity is x, some customers will be charged prices higher than their marginal costs, resulting in a misallocation of resources.

2. Fuel Stamps as a Redistribution Technique

A fuel stamp program can take various forms. The two principle forms are shown in Figure 3: (I) Fixed fee (the purchase of x amount of fuel (in this case $60 worth) for y amount of money (in this case $30)) of (II) matching funds (a program where for every dollar the consumer spends toward fuel it is matched with $2 in actual fuel). Under program I, if those customers receiving fuel stamps were consuming between points B and C, they would increase their electricity consumption due to an income (uv), and substitution (vw) effect. Those customers consuming between points C and D receiving fuel stamps would increase their electricity consumption due to an income effect. Under program II, those customers consuming between points C and D that receive fuel stamps would increase their consumption of electricity due to both an income and substitution effect.

Program I has the advantage of keeping electricity price schedules cost-based. If the initial price schedule reflects costs, the effective price of z/2 for the last block under the matching funds program (II) results in inefficient price signals. Both programs concentrate the subsidy upon low income consumers who qualify for the program. On the other hand, objections to food stamp programs, in terms of availability and eligibility problems, also apply to fuel stamps.

3. Comparison of Lifeline Rates and Fuel Stamps.

When comparing the social programs, consideration should be given to (1) the cost of subsidization; (2) the changes in individual utility; (3) changes in electricity consumption;* and (4) the social costs of having marginal prices different from marginal costs. The difficulty in the construction of social programs involving price revisions for electricity is that the goals may be mutually incompatible. For example, achieving the social goal of increasing electricity consumption may conflict with maximization of an individual's utility for a given subsidy. Neither lifeline rates nor fuel stamps will satisfy both goals simultaneously. Similarly, taxpayers will not be indifferent to the cost of the program; the costs depend upon the number of people involved when a particular price schedule is applicable.

Again, we assume that the block structure reflected in the budget line acbde of the Taylor model in Figure 4 represents the current costs of producing electricity. This assumption rules out peak load and other problems that would unnecessarily complicate the analysis. Such parameters as the number of customers consuming along respective sections of the budget line and the price and income elasticities of individual customers will determine the impact of the social programs. Finally, it should be noted that the size of the subsidy

*Here, increasing electricity consumption can be interpreted as holding consumption to previous levels attained under the lower price structure which prevailed prior to inflation. In this context, electricity might be viewed as a "merit good."

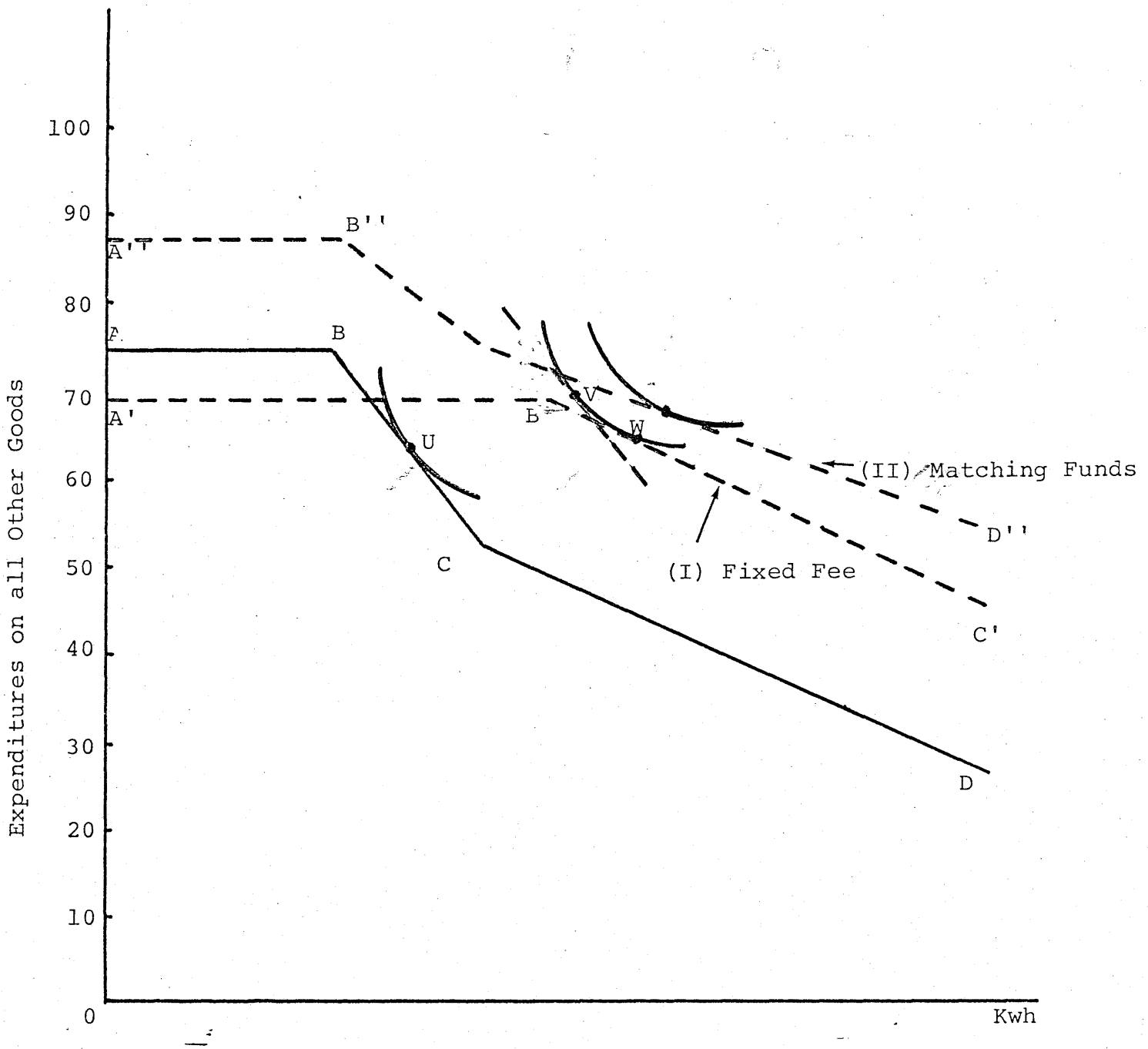

FIGURE 3
Fuel Stamp Programs
(I) Fixed Fee and (II) Matching Funds

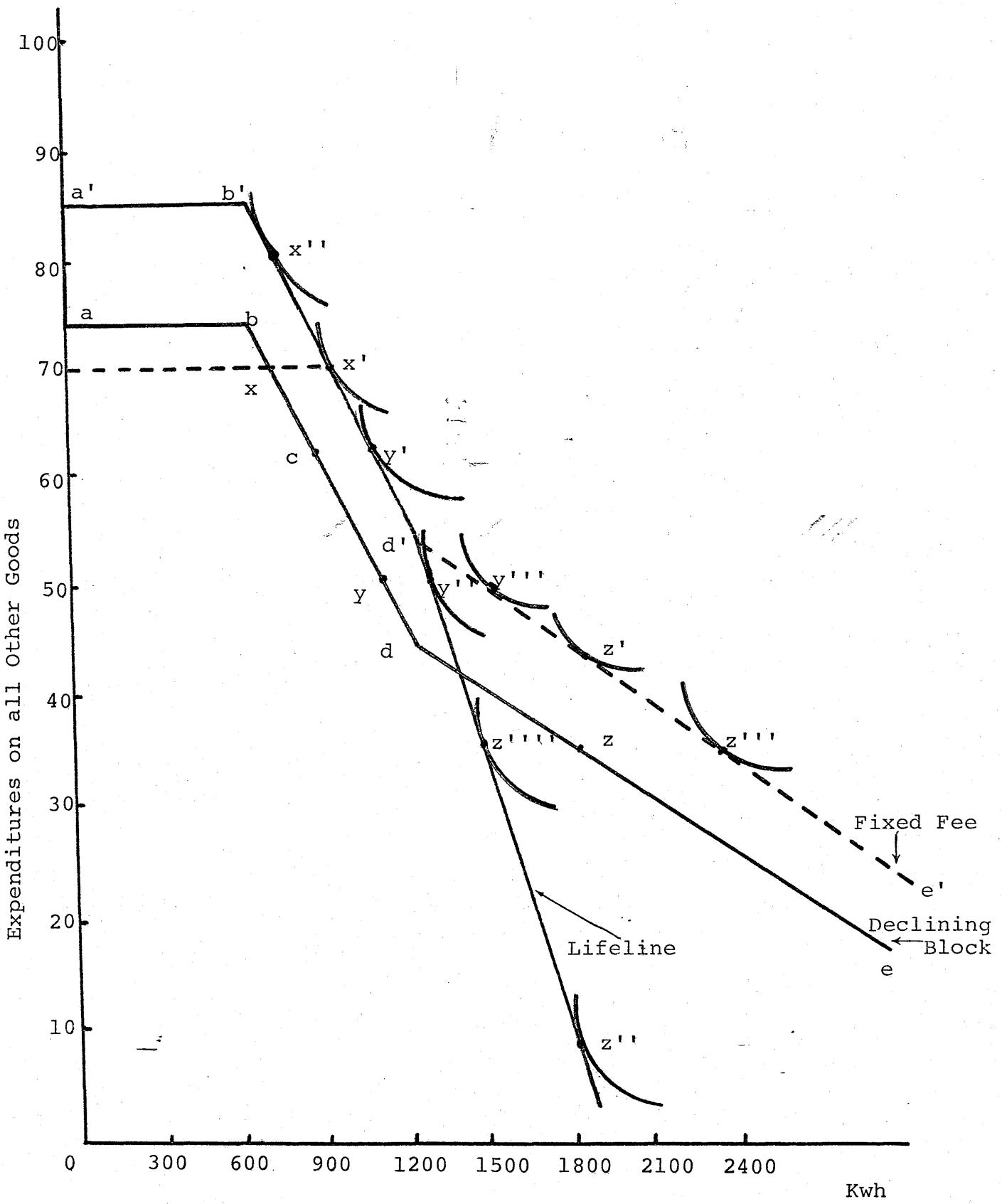

FIGURE 4
Comparison of Lifeline and the
Fixed Fee Fuel Stamp Program

for each program can be varied, thus affecting the comparison.

Figure 4 provides an example for the comparison of a possible lifeline rate structure and fixed fee fuel stamp program (I) identified earlier. The impact of each social program can be identified for customers consuming along the original budget line abcde. To illustrate the determination of the impact of the lifeline rates or fuel stamp program, we identify customer x who orginally was consuming along abc, customer y who was originally consuming along cd and customer z who was originally consuming along de of the budget line abcde.

Customer x faces the following situation, if he qualifies as a low income consumer then he may purchase 900 kwh of electricity for $30 under the fixed fee fuel stamp program. Customer x is provided with an additional 300 kwh of electricity at no additional cost to him since he was originally spending $30 for 600 kwh. The government would be providing a subsidy of $10 for the additional 300 kwh consumed by customer x.

Under the lifeline rate structure, customer x, regardless of his income level, would have greater flexibility in deciding upon the amount of electricity he consumes. For example, if the income effect is zero, he would consume at x" and stay at his present 600 kwh consumption level and pay only $20 with a subsidy of $10. A different preference map could cause customer x to increase his consumption along b'c'd'. Under the lifeline rates, customer x does not face the indivisibility in consuming an additional 300 kwh. If it is society's goal to increase customer x's consumption of electricity by a set amount at the least cost in subsidization, then the fixed fee fuel stamp program is the better of the two programs. Essentially, the purchase requirement sets up a budget constraint causing him to consume more while still spending the same amount of money. This particular fuel stamp program is also lower in aggregage cost since only specific consumers, the low income families, are

subsidized. For customer x, the advantage of the lifeline rates is that if his indifference curve is tangent further up along b'c'd', his choice can be to consume less than 300 additional kwh, at lower total cost to him. For a person with a preference map like x to x", the fuel stamp results in a corner solution: he spends $30 and has lower utility than at x".

Prior to the social pricing policies, customer y consumed approximately 1050 kwh with an expenditure of $50. If customer y has a zero income effect and thus wished to maintain his 1050 kwh both the lifeline rates and the fuel stamp program would provide a subsidy of $10 so that customer y's new expenditure for electricity would be only $40 at y'. However, if customer y's preference map was such that he wished to maximize the electricity consumed for his initial $50 expenditure, then the lifeline rates would provide him with only approximately 1350 kwh while the fuel stamp program would provide him with approximately 1600 kwh. In such a case, the fuel stamp program offers a higher utility at y"' than the lifeline rates at y". Both social programs offer customer y the same utility level if his perference map is y to y'.

The subsidy cost to achieve y' for customer y is the same for both the fuel stamp program and the lifeline rates. Aggregate cost, though, could be substantially higher under the lifeline rate structure since all consumers along the b'd' portion of the budget line, including the nonpoor, receive a $10 subsidy. Under the fuel stamp program, the low income customer y would receive an additional subsidy of $2 if his preference map yielded y"' (with an additional 250 kwh) compared with y" under the lifeline rate structure. From a social point of view, the fuel stamp program again encourages greatest use of electricity at the consumer's previous expenditure level for consumers with a high income elasticity.

The third case also yields some interesting observations. Prior to the introduction of any social programs, customer z was consuming 1800 kwh of electricity at an expenditure of $65. Under the fuel stamp program, if customer z is

a low income consumer, he may maintain his present consumption at an expenditure of only $55 with a government subsidy of $10, assuming his preference map is z to z'. If customer z had preferences which caused him to continue the $65 outlay, (z to z"'), the fuel stamp program would subsidize his consumption to 2400 kwh at a cost to taxpayers of $10.

Under the lifeline rate structure, customer z would be "taxed" by charges above marginal cost to recoup the subsidization provided consumers along abcd of the budget line. Customer z will "pay" for the benefits of customers x and y through reduced consumption of electricity, a lower level of utility and probably through increased expenditures for electricity. If customer z preferences are such as to maintain his 1800 kwh consumption of electricity, he will be at point z" and will be spending $90. Point z" represents a "tax" payment of $25 toward the recoupment of subsidization costs and also a lower level of utility. If customer z has a substantial income and substitution effect then he might move to point z"" where he maintains his $65 level of expenditure but consumes only 1500 kwh, a decrease of 300 kwh. Customers z's utility is less than under the original pricing structure in either case. Customer z is worse off under the lifeline rate structure than with either the original pricing schedule or the fuel stamp program since even not qualifying for the latter program leaves him at z. If the social goal was to provide price relief to low income families, the lifeline rate structure could act to further deteriorate the financial position of low income consumers with high electricity consumption, thus conflicting with the stated goal.

Therefore, for customer z, the fuel stamp programs allows him to move along d'e', resting at point z' or z"', while the lifeline rate structure leaves customer z at a lower level of utility. The fuel stamp program continues to require government expenditure for subsidy of customer z's consumption while the lifeline

rate structure begins to recoup past subsidies through pricing above marginal cost. By pricing above marginal cost, lifeline rates adds a social cost to the program.

4. Conclusions

The purpose of the above example was to illustrate the type of analysis needed to make comparisons of suggested social programs involving electricity pricing. Consideration must be given to the impact of price changes on individual consumer behavior. Aggregate data on residential customers will not be adequate for analysis. As evident from the above example, the divergent impacts on individual consumers and the multiple social goals involved makes identification of the superior social program difficult. Given the complexities of trying to construct pricing schedules to reflect individual needs and social goals rather than cost of service, direct cash subsidies may be the more viable alternative.

As a second best solution, the fuel stamp program is preferred. The fuel stamp program is more accurate in achieving its social goal of providing price relief to low income families. In addition, the fixed fee fuel stamp program does not present social problems of inefficiency, resulting from pricing above marginal cost. Its aggregate cost to the taxpayer will be lower due to income restrictions in qualifying for price relief and it does achieve the social goal of increasing electricity use among low income families (a "merit good").

Furthermore, closer attention should be given to seasonal and daily peak consumption. Experiments with daylight differentials are now being carried out in Vermont. A study by one of the authors (9) indicates that most of the seasonal peak in Gainesville Florida is due to middle and high income homes (mean incomes in 1970 of $11,000 and $20,000), presumably due to air conditioning. About half of their annual consumption occurs in three summer months, compared

with one-third for the low income homes. Thus, both efficiency and equity require some price differentials based on costs. A social program like life-line rates is unlikely to result in improvements in both these dimensions. Furthermore, the analytical frameworks presented here indicate that conflicting social goals are complicated by the variety of preference maps among the poor. Careful quantitative studies of individual consumption patterns are necessary for the evaluation of social rate making.

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