The Customer Bill as an Index of Performance

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October 20, 1993

Some policy-makers have proposed using the customer bill to measure a utility's success at implementing a least cost plan, including its demand side management program. Use of a bill index results in imperfect incentives and unfair comparisons: thus, customer bills should be rejected as a device for performance evaluation.

One proposal to improve incentives for aggressive demand side management (DSM) programs involves the use of customer bills to measure the impact of least cost planning (Moskovitz, 1988; Moskovitz and Rosen, 1992).[1] Cavanagh also articulates this position: "...it is energy bills, not rates, that ultimately determine both consumer satisfaction and utilities' competitive success."[2] If least cost planning is equated with the minimization of revenue requirements, then the bill (revenue per customer) would appear to be a good proxy for performance. Thus, if the per customer bill for a target utility fell relative to the average customer bill for a group of comparison utilities, we might be tempted to conclude that the target utility's performance was better than that of the peer group--and could reward the target firm accordingly.

However, customers care about more than their bills--they also care about the quantity and quality of energy services received. Thus, a low per customer bill is not necessarily a good indicator of utility performance. Basing regulatory rewards on relative bills sends inappropriate signals to utilities--rewarding uneconomical activity, such as the discouragement of efficient electricity consumption. Not only are there perverse incentives associated with the use of bills as indicators of performance, but the creation of comparable indices for a target firm and peer utilities is an administrative (and analytical) nightmare.

Consider an investment which lowers unit costs and price. If demand were elastic, the price decrease leads to an increase in customer expenditures on electricity. Customer bills go up! Total production costs could well increase. Yet it can be shown that customers are better off after the price decrease. Thus, a test that focused on total cost minimization would give an incorrect ranking of the initial versus the new situation. If instead, per unit costs (instead of revenues per customer) were used--the before and after comparison would at least have the right ranking. However, the

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[1]Moskovitz, David. "Profits & Progress Through Least-Cost Planning," National Association of Regulatory Utility Commissioners, November 1989. Moskovitz, David and Richard Rosen. "Bill Indexing," in *Regulatory Incentives for Demand-Side Management*, eds. Steven M. Nadel, Michael W. Reid, and David R. Wolcott, American Council for an Energy-Efficient Economy, 1992.

[2]Cavanagh, Ralph, "The Future Of America's Electric Utilities: Reconciling Deregulation and Least-Cost Planning," *The Electricity Journal*, May 1991, p. 22.

appropriate calculation of the change in welfare would take changes of consumer surplus into account. This observation is crucial to understanding why the minimization of customer bills has limitations as a proxy for the achievement of production or consumption efficiency.

Production and Consumption Efficiency

Electricity is not a "bad"; it is a "good". Its production can generate "bads" such as pollution, so this market failure needs to be taken into account when evaluating the net benefits from electricity consumption. Similarly, there are substitutes for electricity which are also "goods". Information on the availability and efficacy of energy efficiency substitutes may not be widely available. Thus, the potential existence of information inadequacies (a market imperfection) also needs to be taken into account in a comprehensive evaluation of electricity sector performance.

In the past two decades, utilities have had to incorporate both these concerns into the planning process, often due to substantial pressure from "outsiders": regulators, environmentalists, and conservationists. These groups have helped focus attention on how the cost-effectiveness of supply-side options depends on externalities and customer awareness of electricity substitutes.

The purpose of this article is to determine whether a bill-based incentive mechanism promotes production and consumption efficiency. Some features appear to promote aggressive DSM activities by utilities. In addition, a bill index can provide an incentive for utility cost control (although potential intertemporal cost shifting needs to be addressed). Under an incentive scheme, operating costs will be attended to by managers of the target firm, since cost increases that are reflected in price increases will tend to raise average customer bills (for inelastic demanders). Another positive impact is that DSM costs will be kept in line; however, the selection of cost-effective projects is still problematic since only utility costs are counted. DSM participant costs incurred because of programs are not reflected in electricity prices or bills. Running counter to this is the fact that participation rates depend on incentives, but unnecessarily high incentives raise program costs. So utilities will tend to take both these concerns into account. Nevertheless, the exclusion of participant costs raises questions regarding project selection.

Two aspects of consumption efficiency warrant attention when considering a bill index. First, the average bill for the firm goes up as additional electricity uses are identified. Thus, performance-based incentives based on a bill index would not motivate managers to experiment with rate designs which encourage valued consumption. The impact on DSM incentives is less ambiguous. Cut-backs in consumption reduce the target utility's average bill, so utilities will certainly take DSM seriously. The key question is whether relatively good performance will actually be captured in a bill index.

Characteristics of an External Bill Index

Two possible approaches to a bill index have been suggested: performance relative to other utilities (external) and relative to its own least cost planning forecasts (internal). The first approach compares a target utility's average bill with that from "comparable" utilities: the utility would be rewarded or punished, depending on the behavior of its average bill relative to the average bill of peer utilities. Alternatively, econometric methods could be used to forecast the target utility's bills, with lower actual bills being rewarded. Under either index, the incentive mechanism would presumably put pressure on the target utility to keep bills down. Moskovitz and Rosen (M-R) argue that both cost-minimization and DSM would be encouraged through the use of such a mechanism.

Because of the possibilities of corporate gaming with an internal index, we consider comparisons with the performance of other firms. The fundamental function of an External Bill Index (EBI) incentive mechanism is to reward the target utility if its average bill ($Bill_t$) declines in comparison with the average bill for a "comparable" set of utilities ($XBill_t$). The resulting EBI (= XBill/Bill) could be based on a single year or over a longer time period. Here, a higher EBI implies better target utility performance relative to its peers.

Clearly, a bill can be a powerful signal to customers. It arrives monthly and can involve significant outlays. Thus, it is regular and visible, and may entail negative images for consumers. By definition, when demand is completely inelastic, consumption is totally unresponsive to price. In such a situation, a price reduction leads to a reduction in consumer expenditures on the item in question: the average bill decreases. From the standpoint of price changes, so long as demand is inelastic, lower bills and improvements in consumer welfare go hand-in-hand. Since they move together, bill reductions indicate that consumers are better off. However, if price declines, and demand is elastic, then outlays on the item increase. The customer is better off, but the bill is higher.

Customer Coverage: Comprehensive vs. Residential

This observation about elasticities suggests that the size of the bill is not a good indicator of consumer welfare if consumption is responsive to price. Discussion of the EBI has tended to focus on residential bills, in recognition of the greater price responsiveness of industrial consumption (including opportunities for time-of-use pricing which would encourage off-peak consumption). Classification changes and shifts within the customer mix for the commercial sector also limits the use of an EBI for this sector.[3]

Of course, by splitting off nonresidential customers from the index, differential state regulatory policies towards customer-class cost allocations would also influence EBI changes. The determination of revenue requirements across customer groups will depend on the energy options available in the different regulatory jurisdictions. Where industrial self-generation (or relocation) is a viable option, costs will tend to be re-allocated to residential customers to avoid losing contributions to net revenue from such firms. Thus, the index (as a ratio of residential bills) can be driven by factors beyond the firm's control.

If the problem of cost allocations can be ignored, residential demand elasticities imply that changes in the bill can be an indicator of performance by a single firm. Since empirical studies of demand elasticities for residential consumers indicate that short run demand is inelastic (from -.2 to -.3), residential customer bills and welfare move together in response to a utility's price changes. DSM programs will also tend to lower bills for participants, but how program costs affect the price of electricity determines the bill impact on nonparticipants. If average bill falls, then welfare

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[3]For example, a building could be refurbished: what once was a warehouse becomes an office building (or vice-versa). Such shifts may not alter the standard industrial classification for a billing unit, yet the size of the bill could change dramatically. Such shifts would be reinforced by relocations out of and start-ups within the utility's service territory. Furthermore, the billing unit itself is subject to change. The owner of several apartment buildings might centralize payments, leading to higher average bills (as the number of customers falls). Higher demand elasticities and customer classification problems tend to make the EBI infeasible for industrial and commercial customer classes.

unambiguously increases if (a) demands are inelastic, and (b) the DSM program causes no reduction in energy services received by customers.

Because the EBI would only reflect residential bills, its implementation as an incentive mechanism would be in the form of a bonus to the utility. The purpose of the bonus would be to promote managerial efforts toward improved performance. The actual level of managerial effort is unobserved--regulators only observe performance outcomes, such as costs actually incurred and kWh supplied. As shall be seen, adjustments would still be necessary to ensure comparability between the target firm and the reference group.

Selective Adjustments to Bill Indices: Administrative Complexity

Selective adjustments are needed to reflect different DSM opportunities or exogenous cost changes faced by the target utility that are not faced by peer firms. Such adjustments would be agreed upon up-front--reflecting the recognition that a completely "comparable" external index might be impossible to obtain. Thus, to some degree, such adjustments are likely to be necessary for any incentive mechanism which depends on external indexing. Advance agreements on procedures for adapting to foreseen and unforeseen contingencies are very important.

In this case, the simplicity of using the bill as an indicator of performance is negated by administrative costs associated with obtaining comparability among situations. Total residential revenues divided by total residential customers is easy to calculate. However, utilities that are in different situations will experience very different bill outcomes--say, when price falls. For example, let price decline for the target firm and the peer group. If the target firm's residential demand is less inelastic (i.e., relatively more elastic) than the comparison group's demand, the bill will be relatively higher for the target firm (assuming identical initial bills).

A simple example illustrates the crucial role of total comparability between the target and reference utilities. Let us consider two inelastic demands (-.2 and -.3) and identical price changes.

We normalize initial price and quantity at one.[4] Price falls to .67 in both cases.

P_0	Q_0	E	P_1	Q_1	ΔP	ΔQ	$Bill_1$
1	1	-.2	.67	1.08	.33	.08	.72
1	1	-.3	.67	1.12	.33	.12	.75

Note that we adopt the convention of using the average price and quantity as bases for calculating the percentage changes. Basic conclusions are unaffected by this convention.

[4]Elasticity (E) is defined using average price and quantity as the base for calculating percentage changes in price and quantity demanded. $E = \Delta Q/\overline{Q} \div \Delta P/\overline{P}$ so $\Delta Q = (\Delta P/\overline{P}) \cdot E \cdot (Q_0 + Q_0 + \Delta Q)/2$. Here, $\overline{P} = .84$ so $\Delta P/\overline{P} = .39$. $\Delta Q = (.39E)/(1 - .26E)$.

If the target utility has -.3 as the price elasticity and the reference utility has a price elasticity of -.2, the ratio of bills (XBill/Bill) goes from 1 to .96, which (without adjusting for demand elasticities) would suggest relatively *weak* performance by the target utility. However, consumer surplus has actually increased *more* for the target utility than for the reference utility. Thus, relative performance rankings based on an EBI are arbitrary unless some adjustment is made.

Highly complex calculations are required to ensure appropriate performance comparisons. An understaffed and overworked regulatory commission will have to incur additional costs to cover administrative and technical personnel needed for elasticity, weather, and other adjustments. In addition, with an EBI mechanism, technical studies will still be needed to ensure that DSM programs are promoting cost-effective electricity consumption reductions. Thus, the EBI's simplicity is superficial in nature, and associated administrative costs may be considerable.

Different Regulatory Accounting Treatments of DSM

Moskovitz and Rosen (1992) recommend cumulative indices due to variability in year-to-year indices.[5] M-R illustrate this point by taking a stylized example of a DSM program under different regulatory accounting treatments. Assuming completely inelastic demands (so the price impacts on consumption can be ignored), they show that expensing the DSM program increases the bill in the first year--with annual bill reductions thereafter. Such "front-loading" of the electricity conservation investment gives a very different pattern of bill changes than when the outlays are capitalized. Annual fixed charges under traditional capitalization and straight line depreciation also lead to some front-loading of cost recovery since the undepreciated rate base is larger in the initial years. Revenue requirements to cover these capital costs are correspondingly higher in the early years. If the total of fixed charges (returns on investment plus depreciation) is levelized in real dollars, a different pattern of bill reductions occurs. Thus, the accounting treatment of DSM outlays has implications for bills.[6]

Concluding Observations

In their study, Moskovitz and Rosen conclude that the potential gains from an EBI are worth the cost--that regulators can overcome the problems noted here. They argue that incentive plans cannot substitute for effective Least Cost Planning--just as price signals in markets do not substitute

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[5]M-R (p. 36) find that bill indexing is most appropriate for long term incentives for three reasons: "First, the efficacy of bill indexing depends upon the ability to detect relatively small differences in average customer bills. Second, annual bill changes will be more difficult to detect statistically than cumulative changes over many years. Third, gaming opportunities related to differences in the timing of cost recovery are also diminished if bill indexing is viewed as a long-run incentive plan." Each of these points supports the use of a cumulative index.

[6]Another aspect of the potentially perverse incentives associated with the EBI is the impact such a performance index has on utility efforts to meet new demands. For example, if storage batteries continue to improve, the electric automobile could become a viable alternative to gasoline-powered automobiles in some situations. An EBI would encourage the utility to minimize the penetration of electric vehicles in its service territory. Innovative rate designs (such as peak and off-peak prices) would not be explored by a utility uninterested in expanding off-peak sales. The result would be continued negative environmental impacts from gasoline-powered engines.

for antitrust enforcement. Thus, a market imperfection, like monopoly power, is a justification for government intervention. Similarly, other market imperfections (information inadequacies and capital market limitations) justify regulatory policies to "correct" problems in the electricity and energy service markets. M-R see the EBI as overcoming the insufficient incentives for DSM under present incentive mechanisms. Since M-R believe these market imperfections are significant, they find that a bias towards stimulating utility conservation initiatives is appropriate. Even when new utility actions are not cost-effective, policies can be reversed when quantitative results are available. They state: "Experience suggests that imprudent action is always more likely to be detected and deterred than imprudent inaction."

Of course, the alternative to an EBI is not necessarily "benign neglect." DSM can be encouraged via other mechanisms and justified on the basis of careful program studies. Here, the simplicity of the EBI has been shown to be superficial. Demand side and cost-side adjustments would need to be made to achieve comparability for the indices of the target utility and the reference group. Both these adjustments would be further complicated by the demand elasticity problem noted earlier. This lack of accuracy implies that as a relative performance indicator, EBI has little to offer. It provides a precise, but incorrect, calculation of relative performance.

It is likely that direct incentives for DSM or alternative measures of relative performance offer greater promise for encouraging cost-effective conservation investments. Furthermore, a comparison with outcomes in competitive markets is instructive. Do firms in unregulated markets tend to minimize customer bills (holding quality constant)? The answer is no. Price tends to equal incremental cost under competition--but price times per customer consumption is not minimized. Individual customer demand elasticities combine with price to determine customer outlays. In addition, changes in income and in the prices of substitutes and complements affect the quantity demanded at a given price (and thus affect customer bills on outlays for particular goods and services). Low outlays (or bills) do not imply that customers are obtaining a bargain from the supplier.

The EBI has severe limitations relative to alternative incentive mechanisms. Since it is most feasible for application to residential bills, it is a limited incentive. Also, the residential bill for a firm reflects cost allocations among customer groups that can differ across utilities. The need for a cumulative bill index means that the duration of the incentive plan must be quite long. As with other indices, adjustments for cost and demand differences have to be made to assure comparability; in addition, even with inelastic residential demands, the ratio of residential bills does not serve as a good relative performance index unless demand elasticities are the same. Finally, the incentives for economic efficiency are greatly attenuated since a premium is placed on consumption cutbacks--regardless of the customer costs associated with utilizing alternative energy services.

As outlined here, the cumulative EBI for residential customers resembles a lottery more than an incentive mechanism. If all sorts of "corrections" need to be made to the target firm's and peer group's bill indices (improving the fairness of the performance measure), the administrative costs associated with making appropriate adjustments would be substantial. Thus, the combination of imperfect incentives and unfairness of the EBI mechanism lead us to reject this approach to performance evaluation.[7]

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[7]This analysis is based on Chapter 4 of a much more comprehensive study prepared for the New York Public Service Commission, *The Potential for Using Performance Indices to Provide Regulatory Incentives* (December 30, 1992), prepared by the author, W. Erwin Diewert, Edward P. Kahn, Tracy R. Lewis, and David E.M. Sappington. Helpful comments from the other project analysts and from Keith O'Neal and from Mark Reeder (both of the New York Department of Public Service) are gratefully acknowledged.