Welfare Impacts of Single-Provider Residential-Electricity-Service Price Discrimination

Daniel M. Hamblin, Dan Hamblin & Associates, Inc.

I. Introduction: residential service deregulation that came and went

In California five electric service providers are registered to compete for (small) residential customers in the Utility Distribution Company service territories of Pacific Gas & Electric, San Diego Gas & Electric, and Southern California Edison.[1] This notwithstanding, California and Virginia suspended deregulation and retail choice after having approved and initiated it.[2] The State of New Jersey Board of Public Utilities lists four UDC electric service companies – Atlantic City Electric, Jersey Central Power and Light, Orange & Rockland Electric, and PSE&G.[3] Orange & Rockland cites seven energy choice alternative suppliers authorized to provide retail household service in New Jersey.[4] However, New Jersey has had no utility restructuring activity since February 2008.[5] Restructuring means that a monopoly system of electric utilities has been replaced with competing sellers.[6] California suspended restructuring activities in March of 2010.[7] The Maryland Public Service Commission cites residential energy choice alternatives separately for its four UDC's:[8] Three are cited for Allegheny Power with two described as brokers and one as broker and supplier. Eleven are cited for Baltimore Gas and Electric with five described as brokers, two described as brokers and suppliers, and four described as suppliers. Five are cited for Delmarva with three described as brokers, one as broker and supplier, and one as supplier. Six are cited for Pepco with four described as brokers, one as broker and supplier, and one as supplier. Maryland has had no utility restructuring since January 2010.

In all, seven states have suspended deregulation that had chosen it; twenty-eight states chose not to deregulate in the first place; fifteen states and the District of Columbia have deregulated and offer retail choice; however, no state is pursuing utility restructuring activity.[9]

U.S. investor-owned-UDC's operate as single providers to the vast majority of their customers, as spatial monopolies legally sanctioned to practice price discrimination. The paper examines how residential electricity service providers (ESP's) known for price discrimination through declining block rates can additionally discriminate by offering flat-rate service contracts to some customers and by offering bundled services and technologies paired with different base- and peak-load generation sources. It reports application of a discrete choice method for predicting the market potential of new residential technologies and energy services that provide mutual benefit to customer and ESP.[10] Included are helical fluorescent bulbs and two sizes of photovoltaic panels. The estimation informs creation of a demand schedule depicting options more diverse than a utility's standard offer but less diverse than a perfectly discriminating monopolist's. Estimated parameters enter Version 3.8 of a Nash game, **Shadowprice.com Autopilot**, where their influence grows or diminishes as market power dictates. The paper includes a welfare estimation of consumers and producers surplus caused by the single provider's discriminatory behaviors.

Technology and service portfolio selection in Version 3.8 replaces previous versions' home security system with an Energy Star-rated refrigerator/freezer and bonus-points customer retention program with an Energy Star-rated front-loading *clothes'* washing machine. The utility offers promotional incentives to encourage customer purchase of the new appliances. Additional energy-saving incentive is bundled in "Energy Conservation Assistance" as part of the ESP's Standard Offer, resulting in four times the conservation impact of previous versions.

The paper assesses the welfare impacts of additional price discrimination using an update to a Monte Carlo tool originally designed to look at competition between an incumbent utility (UDC) and eight new entrants into its residential market.[11] Discovering an Autopilot-series single-provider-price-discrimination-profit maximum converts the UDC’s competitors into Nash coalition partners offering prescribed menus of the Energy Star technologies and/or services, randomly selected to be “on offer” or else “available” for any game of a series. A **Shadowprice.com Autopilot** game simulates a year of service under rules of play that reward performance that equals or exceeds winning by lottery, except that preference is lexicographic because surviving the year (in the coalition) is more important than making money.[12] **Shadowprice.com Autopilot** finds solutions using topology set in motion by a “game-assignment-seed.” Its method permits a user to duplicate any game of a series through its game assignment seed and choices made on the bus-stop and Programmatic Activities’/Market-Power-Manifestation Strategies’ screens. Version 3.8 distinguishes between something it calls end-of-year incremental “monopoly” profit and producer’s surplus. Because Pareto efficiency requires that no service and technology portfolio allow the UDC's market power to (perversely) leave it worse off, “monopoly” profit must be non-negative. (An ESP's customers and society at large might like for this incremental boost in monopoly surplus to be modest.) Version 3.8 measures and reports producer’s surplus using shadow prices, computed as the difference between the price charged the customer and the so-called Hayek starting price that has been purged of the influence of factor prices and depends on customer preference alone.[13] This surplus will be negative if no Nash coalition linking the UDC and its wholesale power cost to alternative technology and service bundles individually paired with wholesale power costs leaves the UDC at least as well off. A negative surplus is a plausible outcome for a market of intransigent customers grown accustomed to a UDC’s Standard Offer, especially if it has recently been beefed up with electricity-saving conservation measures that are easy to implement.

Section II describes the paper’s Study Design, in which heuristic scenarios set boundary conditions that encompass the outcomes possible from extending price discrimination to encourage customer acceptance of Energy Star technology and service options. Section III reports the evidence **Shadowprice.com Autopilot** simulations yield for High and Low base load power cost regimes – single-provider profit-maximizing game solution and the market power strategy that produced it, the end-of-year incremental “monopoly” profit for this game and strategy, the producer’s surplus for this game and strategy, and the consumer surplus per customer accrued over the year for this game and strategy. Section IV appraises the evidence reported in Section III – in terms of what it says about Nash and Von Neumann-Morgenstern coalitions. Section V concludes the paper with speculation about whether our experimental analysis has revealed or predicted an efficient UDC market made possible by a robust customer offer that sustains the utility's monopoly position.

II. Heuristic scenarios set boundaries for producer and consumer surplus

In *Heuristics and Design*, Britton Harris described the importance of heuristics for resolving real-world city planning problems for which optimization tools such as dynamic programming were poorly equipped to produce realistic, usable answers.[14] Alternatively, a planner or energy economist might develop heuristic scenarios designed to bound all probable outcomes and use them to guide the analysis.[15] This paper's heuristics' based Study Design starts with a 4-quadrant or Cartesian approach stemming from the UDC's starting point and its household price-setting behavior:

- The UDC provides a Standard Offer that it may advertise with up to four television spots per month and that includes the beefed-up energy conservation assistance described above. The Study Design calls this IO1.
- Or else, the UDC advertises and implements two to four of twelve possible mutually exclusive technology and/or service programs (e.g., Energy Star helical fluorescent bulbs and an outage reduction program). The Study Design calls this IO2.

combined (or crossed) with

- a prohibition on offering retail prices below the wholesale cost of power plus bundled program costs. The Study Design calls this IP1.
- or else, the ability to offer retail prices below cost, at will.[16] The Study Design calls this IP2.

IP1 and IP2 bound the choices allowed by **Shadowprice.com** single games, for which a player may let the incumbent UDC price below cost by up to 15% of a cap set on average price per kWh, by up to 25% of a cap set on average price per kWh, or else by up to 50% of a cap set on average price per kWh – each between the not-at-all and at-will boundaries designated IP1 and IP2. The Cartesian quadrants are IO1, IP1; IO2, IP1; IO2, IP2; and, IO1, IP2.

However, **Shadowprice.com Autopilot** engages a player to start things off with a program portfolio selected and implemented for every game of a 90-game season. This "live-player" problem extended the Study Design heuristics to include the nature of choices he or she made:

- P1: Strong player choices including flat-rate 2-year service contract;[17]
- Or else, P2: Weak player choices including flat rate;
- Or else, P3: Strong player choices without a flat rate.[18]

Adding what the live player does to the Study Design defines twelve scenarios of Autopilot game play, ordered as follows:

1. **P1, IO1, IP1**
2. **P1, IO1, IP2**
3. **P2, IO1, IP1**
4. **P2, IO1, IP2**
5. **P3, IO1, IP1**
6. **P3, IO1, IP2**
7. **P1, IO2, IP1**
8. **P1, IO2, IP2**
9. **P2, IO2, IP1**
10. **P2, IO2, IP2**
11. **P3, IO2, IP1**
12. **P3, IO2, IP2.**

The Study Design heuristic scenarios were implemented subject to several caveats:

1. **Basic Electricity Service.** In a 2001 working paper, Paul Joskow defined the acid test for the value of electricity technology/service bundles as how well they compete against no-frills direct access to wholesale power.[19] Several states offer some form of B.E.S., also called *default service*. At Massachusetts Electric, all customers who had either opened an account after March 1, 1998, and were not currently being served by a Competitive Power Supplier or were served by a CPS in the past received the no-frills default service.[20] This paper follows the Massachusetts Electric precedent by giving all new customers default service for the **Shadowprice.com Autopilot** year of simulation. New customers net of electricity service departures during the year sum to about 3.5% of the customer base. Additionally, however, existing customers may also switch to default service, even, for example, if they do so after paying a penalty for breaking a 2-year flat-rate service contract. The sequel reports the success of combined new- and existing-customer default service in the game play for this paper.

   In order to implement default service in Shadowprice.com, it must take the place of one of eight new entrant competitors against each other and the UDC, or for this paper's purpose, non-UDC coalition partners. Coalition (or competitor) slot 6 was chosen (see Fig. 1 below). Using slot 6 eliminates "Cash incentive to switch provider" as a utility program portfolio choice. This is no great loss, in view of the paper's objective to look at welfare impacts of additional price discrimination. Shadowprice.com topology follows Ruth Bolton's analysis of cash incentives offered to cellular telephone customers.[21] She found that switching incentives were poorly suited to retaining households.[22] When B.E.S. is turned off and cash incentives are available, they are rarely included in "winning" portfolios (and coalitions) because Shadowprice.com's solution algorithm identifies them as not closest-to-Nash-cooperative and optimal or best.
2. **Price Wars or Not.** In game play, the fundamental competitive behavior is to raise price if "you" can, but lower it if "you" must. Particular **Shadowprice.com Autopilot** strategies employed in this paper permit price wars on the toss of a fair coin (Strategy 1, episodic and always ending on the uptick) or for every game (Strategy 4, also always ending on the uptick). The topology space for a Strategy 1 price war differs from that for a Strategy 4 price war.

   Strategies 2 and 3 are price peace strategies. For Strategy 2, all coalition partners assume other partners will raise price. For Strategy 3, all coalition partners assume other partners will raise price but by not much more than the maximum fixed rate or by not much less than the minimum fixed rate – if fixed rates are offered by any coalition partner.

The topology space for a Strategy 2 price peace differs from that for a Strategy 3 price peace. Furthermore and fundamentally, Shadowprice.com topology simulates herd behavior that penalizes coalition partners who break from the herd.

A particular price war, ending on the uptick, may finish a game simulation year with coalition profit exceeding that for a particular price peace at the end of a game simulation year.

3. **Base Load Generation Cost Order of Series Play and Price Wars or Not.** The player confronts a bus-stop-screen decision to begin a heuristic scenario series play with low or else high base load power costs. These costs approximate the range of Midwestern U.S. delivered wholesale power costs from 2001 to the present – in which "low" pays for coal-fired and nuclear generation and "high" pays for natural gas and nuclear generation.

   Since its inception in the Year 2000, the most difficult Shadowprice.com solution path to attaining (the required) Pareto efficiency is with the UDC's Standard Offer and the "low" base load generation cost regime in the presence of price wars. What may happen under this setup for Autopilot simulations is that it may be unable to attain a Pareto Efficient solution in 163,200 trials (40,800 trials in one game simulation plus three reseeds of the random numbers generated). In this case, running Autopilot Strategy 1, Shadowprice.com uses its "GoBack" feature to draw another Game Assignment Seed that changes programmatic portfolio selection for non-UDC and non-player coalition partners, shuffles the assignment of wholesale price regimes to non-UDC partners, and tosses a fair coin to see if the replay will be a price war or price peace. As it does so repeatedly, Autopilot may find it necessary to switch most or all Strategy 1 price wars to price peace replays. This risks producing a non-uniform distribution of Game Assignments that fails the Chi-Square Test of the 90-game series.

   Under this dire situation implemented for the **IO1** heuristic scenario definitions above, if the player has run the high-base-load-price simulations first, he or she with high likelihood will have passed the Chi-Square uniform distribution test for the series, only to fail the test for the Autopilot Replay of the low-base-load-price series.

   A similar dire situation may occur under Strategy 4, in which price wars are waged in every series game – and the low-base-load-price regime and UDC Standard Offer prevail. In this case, the price-peace-switch-option is unavailable, and the only solution path changes the distribution of player assignments (through the GoBack option) to the eight base load wholesale price vectors until an assignment that is Pareto Efficient is found. This process is also highly likely to "solve" a non-uniform distribution of Game Assignments that fails the Chi-Square Test.

   In light of this redoubtable strength of the Standard Offer in a Monte Carlo game of price wars, the eight **IO1** heuristic scenarios engage the "Price peace is certain" switch on the Shadowprice.com bus-stop screen, run only the Single-Provider Market Strategies 1 – 3 (excluding Strategy 4's price wars all the time), and run the low-base-load-price simulations before the high.

The **IO2** heuristic scenarios execute (all) Single Provider Market Strategies 1 – 4 and also run the low-base-load-price simulations before the high. Under Strategy 1 a fair coin toss determines peace or war. Low first is the default setting on the bus-stop screen.

4. **Discarded series.** This paper's intent was to discard 90-game series that fail the Chi-Square Test and record the number of discards**.** If the failure occurred with the Autopilot Replay base-load-price regime, then 180 games played would be discarded. Under the order of and conditions for Heuristic Scenario game play established by Caveat 3, Scenario P1,IO1,IP2 under the low base load price regime failed the Chi-Square Null Hypothesis Test of statistical uniformity twice and Scenario P3,IO1,IP2 under the high base load price regime failed the Chi-Square Test once. Hence, two 90-game series were discarded and one (Autopilot Replay) 180-game series was discarded prior to (respective) scenario executions that passed the Chi-Square Test.
5. **Market Shares.** Market shares of coalition partners are determined using attractiveness frontiers.[23] The Shadowprice.com frontier engages in competition between the UDC and the partner that multinomial logit coefficients reveal to be most attractive. The default-service provider is included in the competition. Subsequently the frontier competes this best non-UDC coalition partner (possibly the default-service provider) against all remaining coalition partners, again choosing the partner that multinomial logit coefficients reveal to be most attractive. The exercise is repeated until the coalition partners are exhausted. Shares for switching from the UDC and new customer choice are computed recursively as fractions of what remains to the right along the frontier. The *retention* frontier uses different multinomial logit values and combines with switching in determining market share. By making paired comparisons, attractiveness frontiers purge the multinomial logit of irrelevant alternatives.[24]
6. **Consumer Surplus.** Shadowprice.com is a Monte Carlo game about utility behavior. As such, benefit to household customers derives from decisions about programmatic portfolio selection and market power strategy made by the UDC, and by extension, its seven coalition partners (not including the default-service provider). Programmatic decisions for non-player and the UDC IO2 offer are random choices made in accordance with Fig. 1.

	Price/Product Design Attributes	Choices available to non-player coalition partners										Player Choices		
		UDC Standard Offer (IO1)	UDC IO2 Offer	1	2	3	4	5	6	7	8	P1	P2	P3
1	Advertising with brand name TV spots	X	X	X	X	X	X	X	X	X	X	X	X	X
2	Renewables in supply mix		Random selection of price/product design attribute portfolio from those available to non-player coalition partners 1 through 5, 7 and 8 -- and 2 to 4 options from it	X		X				X				
3	Conservation assistance	X		X		X	X				X	X		X
4	Helical fluorescent bulb promotion				X				X					
5	Improved customer service			X		X					X			
6	Performance-based fixed rate				X				X					
7	Whole house surge protection				X						X			
8	Landscape lighting							X						
9	Energy efficient refrigerator/freezer							X			X			
10	2-way customer/utility datacom for appliance management					X				X				X
11	Bundled electricity, water, natural gas				X		X					X	X	X
12	Bundled electricity, H2O, nat. gas, PV panels w/net metering							X		X				
13	Reduced outages			X			X		X			X	X	X
14	Cash incentive to switch								X					
15	Energy efficient washing machine						X							
16	2-year service contracts with penalty for breaking							X		X		X	X	

Figure 1. Price/Product Design Attribute Tableau for UDC and Coalition Partners

Rules govern the **Shadowprice.com Autopilot** game play in this paper.

a) At least four non-UDC coalition partners do television spot advertising with the number of spots randomly and individually selected, never exceeding ten per month, and redrawn quarterly over the year of simulation.
b) A coalition partner offering renewable energy in supply is not required to advertise. It does so at random.
c) A coalition partner offering the performance-based fixed rate (option 6 above) must advertise.

Otherwise, choices are made for non-player coalition partners at random. For example, coalition partner 3's random decision might be to offer renewable energy in supply and nothing else. The game requirement and objective is to generate a Pareto efficient tableau of portfolio choices in the ever present shadow of the UDC's market power. Hayek starting prices reflect the value of price/product design attributes, including those held in inventory but not randomly selected for a particular game simulation. Also, the selection of base load and peak wholesale power costs is a paired random assignment to coalition partner slot that changes from game to game.

The random choice of what to do concords with Gary Becker's demonstration that downward sloping demand curves do not require the assumption of utility maximization, nor does the consumer surplus that accrues because customers were willing to pay more for less at prices above the margin.[25]

Shadowprice.com Autopilot computes the value of a consumer surplus triangle but follows Mark Blaug in making a Hicksian income compensation[26] adjustment that cuts it in half.[27] The surplus measure of interest is that for all coalition-partner customers (including the UDC) but excluding the default-service customers.[28]

Consumer surplus is calculated for every game of a series, in each month for each non-B.E.S. coalition partner, for all randomly selected Price/Product Design Attributes (subject to the rules governing game play), for the number of customers selected for the coalition partner under consideration.

After consumer surplus each month is summed over programmatic portfolio selections X adopters, it is then divided by the service territory customer base each month less the default service customers for the month, and finally summed for the prediction-year total. This step is taken to fulfill the paper's desire to know the market's consumer surplus on a per customer basis to compare and contrast with producer's surplus.

7. **Market Shares' Sum.** "New" default service customers cannot be added to coalition-partner competition before the number of new customers is determined from month to month by the accounting module. This system of eighteen equations and identities was adapted by Ratchford[29] from a study describing financial service providers by Rust, Zahorik, and Keiningham.[30] New customers are added to the default service competition in the coalition partner balance sheets' module of **Shadowprice.com Autopilot**. Subsequently, as Shadowprice.com optimizes, it makes utilization adjustments based on price elasticities and take-back effects. Each time it completes an optimization round along its (40,800 pass) solution path it re-computes the market shares' sum. However, the

bell rings on the last utilization adjustment. No attempt is made to normalize the resulting market shares' sum. Rather the average performance across the twelve heuristic scenario single provider maxima is reported below.

III.The evidence supports the robust nature of the ESP Standard Offer with energy conservation assistance beefed up with Energy Star technology and service promotion

The paper graphically summarizes heuristic scenario results by UDC starting point, base load generation cost regime, and "winning" Market Strategy number (in parenthesis following the scenario label):

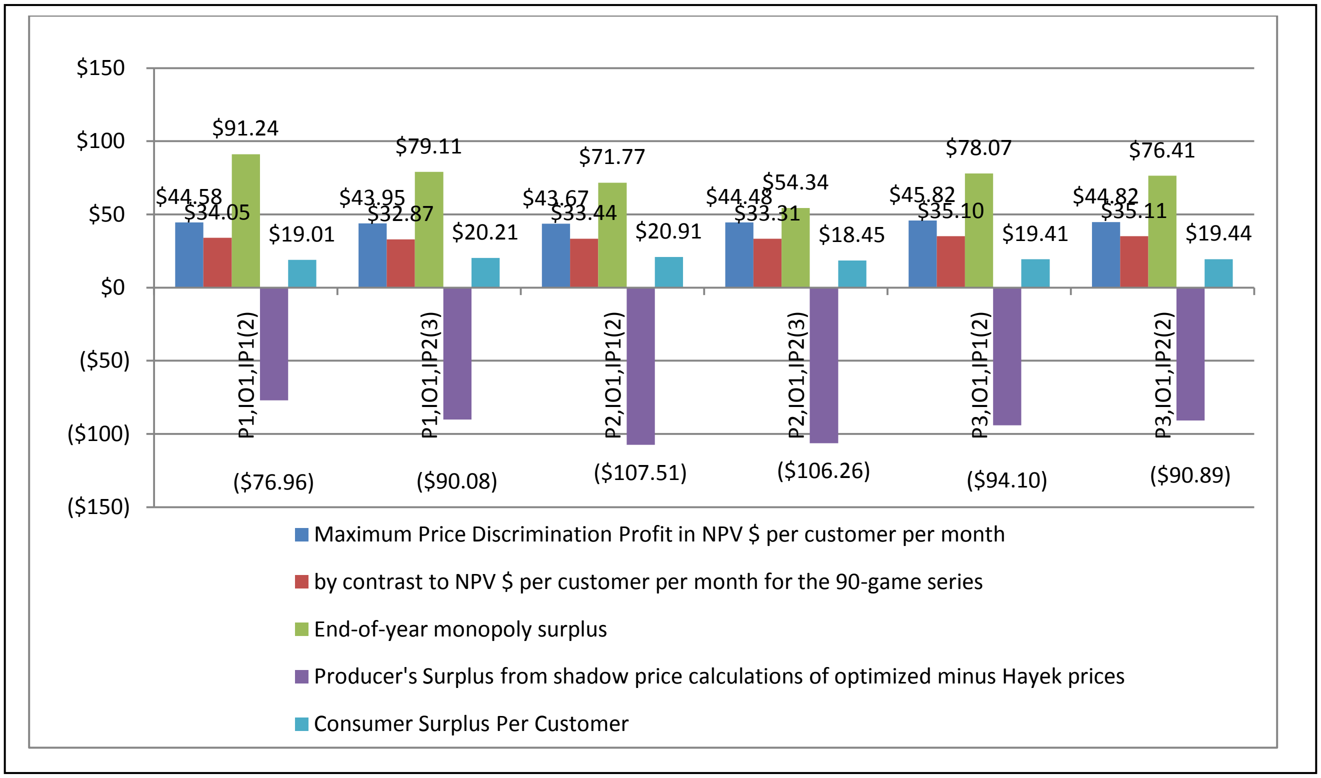

Figure 2. UDC Standard Offer – High Base Load Generation Cost

Note that the profits are measured per customer per month, consumer surplus is measured per customer over the entire year, and producer's surplus is measured over the entire year.

Why is producer's surplus negative for the UDC Standard Offer, when the six **IO1** heuristic scenarios engage the "Price peace is certain" switch on the Shadowprice.com bus-stop screen? It is negative because the optimized prices had to be less than the Hayek prices in order to achieve Pareto efficiency. This implies that the market was efficient to begin with, and the producer had to sacrifice in order to engage coalition partners promoting Energy Star technologies.

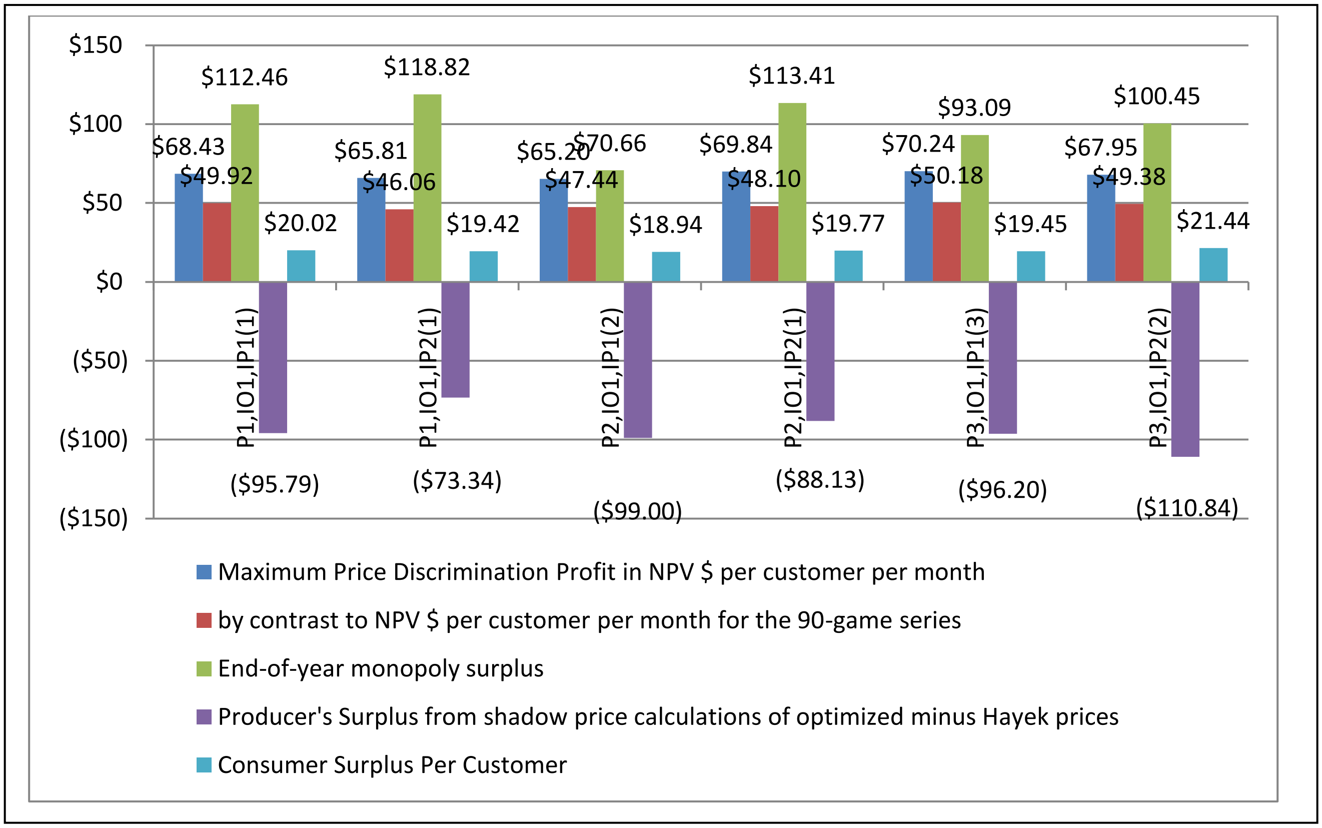

Figure 3. UDC Standard Offer – Low Base Load Generation Cost

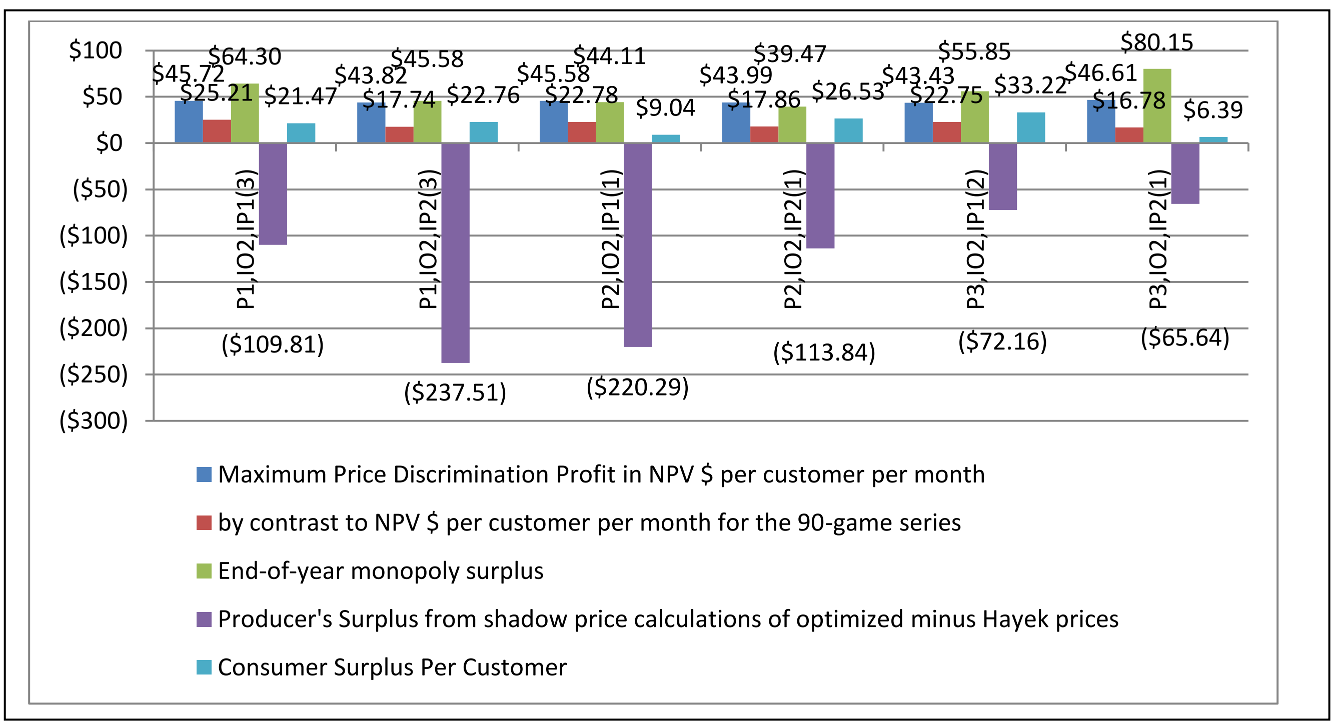

Figure 4. UDC More Than a Standard Offer – High Base Load Generation Cost

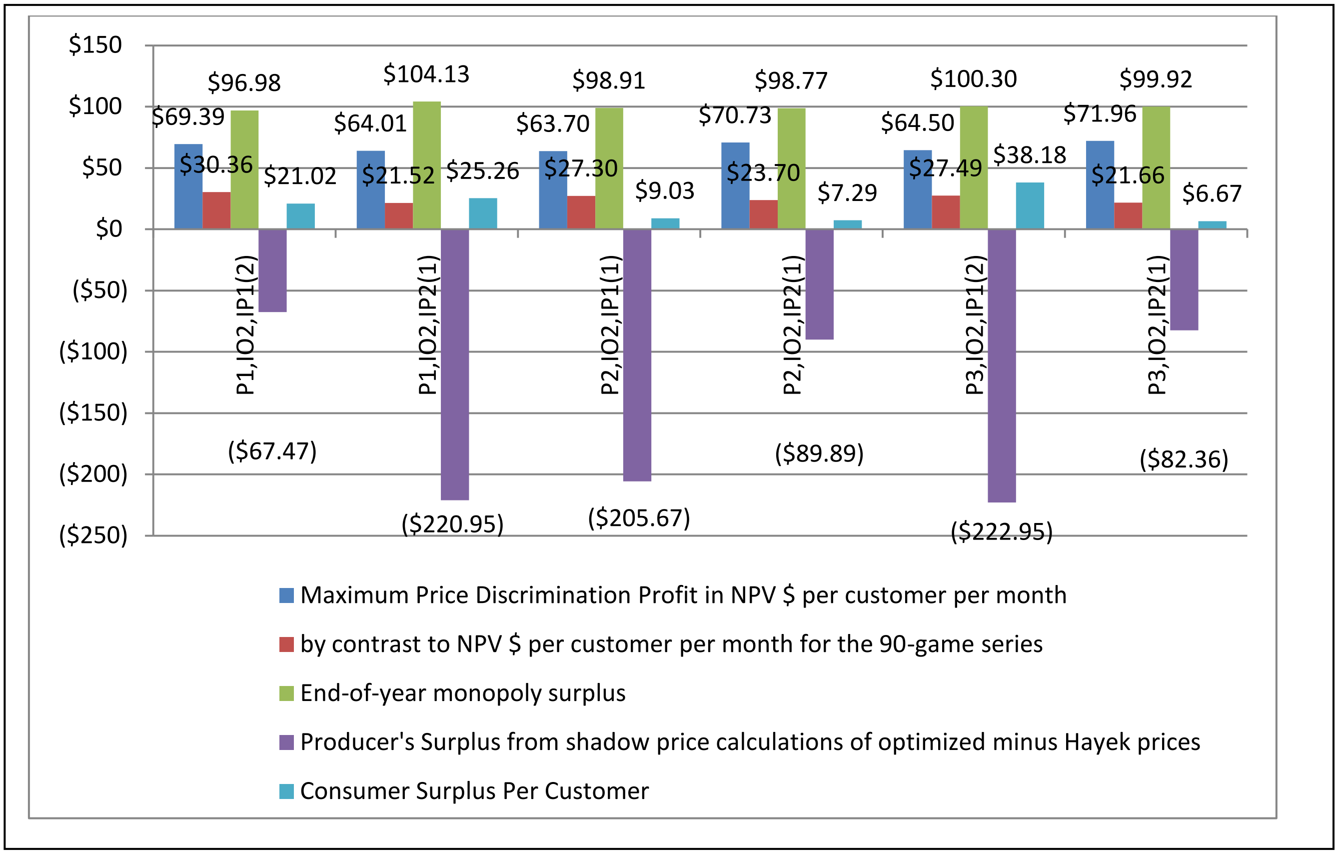

Figure 5. UDC More Than a Standard Offer – Low Base Load Generation Cost

The existence of price wars makes the results appear more erratic, but the story line does not change. Maximum and 90-game-series-average price discrimination profit per customer per month is large. By contrast, the surplus values measured over the entire year are a pittance. Notwithstanding caveat 2 in Section II above, price wars in every game do not yield a maximum-price-discrimination-profit "winner." Price wars do however depict a UDC coalition partner setting in which one branch manager (partner) lowers his Energy-Star-technology-laden portfolio prices in order to grab market share from another branch manager (partner) with a different Energy-Star-technology-laden portfolio.

As was the case with the UDC Standard Offer, optimized prices less than the Hayek prices in order to achieve Pareto efficiency appears to be necessary as well for a UDC starting with “More Than a Standard Offer.” This again implies that the market was efficient to begin with, and the producer had to sacrifice in order to engage coalition partners promoting Energy Star technologies.

The heuristic scenario simulations told some other stories as well:

1. **Player influence on price discrimination profit.** Batting average is a Survival Risk metric for player performance over a **Shadowprice.com Autopilot** series.[31] Was player

batting average good or bad for the average price-discrimination profit for all coalition partners over the 90-game series? The correlation coefficient between the two series was -0.08829, inferring that a relatively lower player survival risk signaled relatively higher average price-discrimination profit for all coalition partners over the 90-game series.

2. **Default service maximum market shares** (see Fig. 6 below).

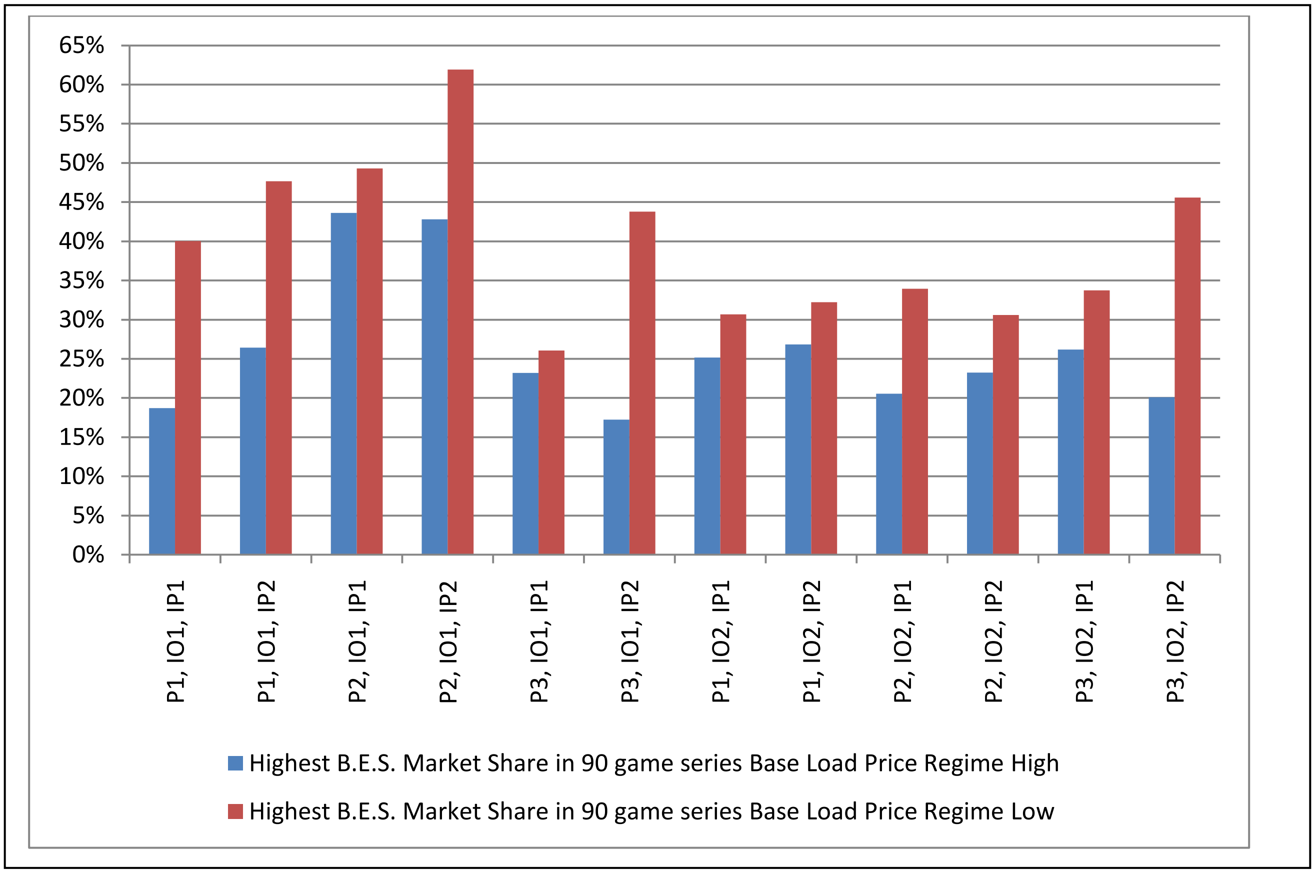

Figure 6. Basic Electricity Service Market Share Maxima by Heuristic Scenario and Base Load Price Regime

2. **Distribution of Player Landings.** As noted above, the player is assigned at random to one of eight base load price series within the base load price regime in effect for the 90-game series under consideration. Each base load price series is paired with a peak load price series reflecting the cost of wholesale power to the player at this landing. On average, over many 90-game-series simulated, there should be a 45/45 split between the high-priced and low-priced landings. For the high-base-load-price-regime 90-game series simulated, player landings ranged from 55 low, 35 high to 41 low, 49 high. For the low-base-load-price-regime 90-game series simulated, player landings ranged from 55 low, 35 high to 40 low, 50 high. For the twenty-four 90-game series comprising the twelve heuristic scenarios, on average there were 46.417 low-priced landings drawn and 43.583 high-priced landings drawn.
3. **Market Shares' Sum in game of maximum price discrimination profit.** The twenty-four maximum-price-discrimination-games' average Hayek market shares' sum was

100.45%. The twenty-four maximum-price-discrimination-games' average optimized market shares' sum was 101.15%.

4. **Advertising excluded, most popular non-player coalition partner selections in game of maximum price discrimination profit.** Highest average selection rates by non-player coalition partners were for improved customer service (offered by coalition partners 1, 3, and 8) at an average selection rate of 129.2%; and for bundled electricity, water, and natural gas with consolidated billing (offered by coalition partners 2 and 4) at an average "non-player" selection rate of 125%. In third place, **Shadowprice.com Autopilot**, coalition partner slots 5 and 7 inventory photovoltaic panels, randomly sized at 1.575 kW DC or 3.15 kW DC, were selected in 21 of 24 games of maximum price discrimination profit – at an average selection rate of 120.8%. The overnight costs predicted for systems sized for the climate in Kansas City, Mo,[32] sold by Ameresco Solar, were $16,537.50 for the small-panel system and $33,075 for the large-panel system. The utility promotion cost was more expensive than any other technology or service option. The panels were predicted to reward the utility with renewable energy coupons (reks) valued at $20/MWH displaced per year. No federal or state conservation tax credit was included. Finally, household electricity was net-metered as allowed by Missouri statute and on the basis of Kansas City Power & Light electricity rates. The Pareto-efficient-solutions' attractiveness to the two coalition partners of the PV panels concords with a Lyon and Yin finding that, while private interests were drivers behind Renewable Portfolio Standards' legislation, renewable energy potential and partisan politics are more important, and "economic costs and benefits are not entirely absent from RPS politics."[33]

IV. No Nash coalition beats the single-provider's beefed up Standard Offer but the Cartel coalition with side payments is the Von Neumann – Morgenstern solution

The paper uses heuristic scenario P2, IO1, IP1 to examine a Nash coalition with the minimum side payments required to make coalition partners at least as profitable as they were at their Hayek starting prices. **Shadowprice.com Autopilot** used the Game Assignment Seed for this Standard Offer Single Provider Maximum Profit Solution to find the Market Power Strategy 9 Cartel Solution with the low-base-load-price regime, and then made the minimum side payments required for Pareto efficiency in the market (see Table 1 below).

The cartel solution gives the UDC and default service provider 98.46% of the customers by the end of the year. The table discloses that the side payments just necessary to achieve Pareto efficiency for the coalition reduce UDC profit by a pittance – 0.10%, surely within the error bounds of the data used in computation, including Kansas City weather and price information.

Side payments	UDC Profit (NPV)	in $/customer per month	(-) Side payment to Coalition partner 1	(-) Side payment to Coalition partner 3	(-) Side payment to Coalition partner 7	Pareto Efficient Profit - Coalition Partner 1	Pareto Efficient Profit - Coalition Partner 3	Pareto Efficient Profit - Coalition Partner 7
None	$17,100,459.08	$74.01	-$5,584.96	-$58.98	-$10,888.89	$5,586.29	$92.73	$11,427.21
to partner 1	$17,094,874.12	$73.98						
to partner 1 & 3	$17,094,815.14	$73.98						
to partner 1, 3, & 7	$17,083,985.23	$73.93						
		99.71%	UDC profit as a percentage of market profit					
		99.61%	UDC profit as a percentage of market profit after side payments					

Table 1. Nash Cartel With Minimum Side Payments Required for Pareto Efficiency (Heuristic Scenario P2, IO1, IP1)

The insignificance of it all describes a Nash game with little incentive for the UDC to play. Put in other words, why should it bother with side payments to three coalition partners, none of whom is currently offering Energy Star technology?

Alternatively, we may consider the coalition partners in the Market Power Strategy 2 solution (in which all coalition partners assume other coalition partners will raise price) as an *imputation* vector summarizing the payoff to each partner in the game.[34] The paper claims that the imputation will satisfy the weak criterion of dominance that makes it the Von Neumann-Morgenstern solution if the net change in profitability between the Cartel coalition with side payments depicted in Table 1 and the Strategy 2 solution is positive (see Table 2).

Coalition Partner	$/customer per month
UDC	-$113.16
1	$0.00
2	$36.42
3	$0.98
4	$79.23
5	$0.00
6	-$5.98
7	$145.92
8	$0.00
Total	$143.41

Table 2. Profitability Benefit From Abandoning Imputation Payoffs and Joining a Cartel Coalition (Heuristic Scenario P2, IO1, IP1)

The Cartel coalition is the Von Neumann-Morgenstern solution owing to the side payments to coalition partner slots 3 and 7. Without these side payments, Table 2's total would be -$8.30.[35]

V. This market with four possible manifestations of monopoly power and profit is efficient

This paper has conducted a Monte Carlo experiment designed to discern impacts from broadening its technology and service promotion to include Energy Star options in coalition partner portfolios – of a single-provider UDC, serving a Midwestern U.S. market. The paper also asked and answered other questions in the experiment, including

- how well a no-frills Basic Electricity Service "benchmark" would perform in this market,
- how close to one non-normalized market share summation would be in the presence of B.E.S. introduced after Ratchford's energy use accounting, and
- whether equally probable Monte Carlo choices were as random as the toss of a fair coin.

Our inquiry was guided by a heuristic scenario design framework inspired by Britton Harris. One dimension of the scenario design was portfolio selection by the player – characterized as strong with a flat rate, weak with a flat rate, and strong without a flat rate. The technology and service mix was not accidental. The player portfolios conform to ones whose "batting average" performance was reported in Hamblin and Ratchford.[36]

Single-provider-maximum-price-discrimination-profit games viewed across heuristic scenarios disclosed a common theme: high spatial-monopoly profits uniformly accompanied by negative producer's surplus. This yields the unfashionable conclusion that the market was efficient to begin with, and in the case of the IO1 scenarios, that the UDC's Standard Offer is robust against tinkering. An alternative interpretation of the results recognizes the difference in magnitude and term of numbers that contrast profit per customer per month with a year's worth of consumer's and producer's surplus. The surplus numbers are small enough to suggest that Energy Star technology promotion is relatively painless, while gaining customer attractiveness.[37]

Along the heuristic-scenario-simulation path, we additionally found that Basic Electricity Service could attract a large share of the market in particular competitive settings – above 60% once (See Fig. 6) and with average-market-share-maximums of 26.17% under the high-base-load-price regime and 39.62% under the low-base-load-price regime. A stronger proof of concept resides in B.E.S. performance "out of" or "in" the presence of price wars. For the UDC Standard Offer scenarios, the average-market-share-maximum under the high-base-load-price regime was 28.67% in contrast to 23.68% under the UDC More-Than-a-Standard-Offer scenarios (with price wars allowed). For the UDC Standard Offer scenarios, the average-market-share-maximum under the low-base-load-price regime was 44.78% in contrast to 34.46% under the UDC More-Than-a-Standard-Offer scenarios (with price wars allowed). Our "uninhibited" market-share-sums fell within 1.15% of 100%. And over all 2,190 games simulated, we fell within 1.417 games (+ or -) of the equally probable 45/45 landings' split.

We subjected our Monte Carlo game results from heuristic scenario P2, IO1, IP1 to cooperative game tests in Section IV. First, we recast the scenario as a Nash Cartel coalition with side payments. In this setting, it appears that there is little incentive for the UDC to form the coalition, since its share of market profit is little changed by doing so, while at the same time no Energy Star technology is being promoted by the coalition partners. Second, we took the imputation vector of Market Power Strategy 2's P2, IO1, IP1 payoffs and subtracted them from the Strategy 9 P2, IO1, IP1 Cartel-coalition-with-side-payments' payoffs – seeking a positive net payoff signaling that the Cartel coalition was the Von Neumann-Morgenstern solution. It was owing to side payments to coalition partner slots 3 and 7.

---

[1] California Public Utilities Commission, June 18, 2010, "Registered Electric Service Providers," State of California, http://docs.cpuc.ca.gov.
[2] U.S. Energy Information Administration Independent Statistics and Analysis, June 2010, "Status of Electricity Restructuring by State," http://www.eia.doe.gov/cneaf/electricity/page/restructuring/restructure_elect.html.
[3] State of New Jersey Board of Public Utilities, June 2010, "Company Information: Electric," http://www.state.nj.us/bpu/assistance/utility/index.html.
[4] Orange and Rockland, June 2010, "List of Energy Suppliers (NJ)," http://www.oru.com/energyandsafety/energychoice/newjersey/njenergysuppliers.html.
[5] U.S. Energy Information Administration Independent Statistics and Analysis, Op. Cit.
[6] Ibid.
[7] Ibid.
[8] Maryland Public Service Commission, June 23, 2010, "Electricity Suppliers," http://webapp.psc.state.md.us/intranet/supplierinfo/electricsupplier_new.cfm.
[9] Ibid. At the two extremes, Wyoming and Georgia suspended restructuring in June 1998, while Connecticut did so in May 2010.
[10] Roberts, G.F. and D.L. Greene. 1983. "A Method for Assessing the Market Potential of New Energy-Saving Technologies," *IEEE Transactions on Systems, Man, and Cybernetics*, Vol. SMC-13, No. 1.
[11] Hamblin, D.M. and B.T. Ratchford, 2003. "Batting Average: A Composite Measure of Risk for Assessing Product Differentiation in a Simulation Model," *Proceedings of the 2002 Winter Simulation Conference, E. Yucesan, C.-H. Chen, J.L. Snowden, and J.M. Charnes, eds.,* San Diego: INFORMS.
[12] Ibid., Section 2.1 Survival Risk, pp. 1578-1579.
[13] Hayek, F.A. 1945. "The Use of Knowledge in Society," *American Economic Review*, Vol. XXXV, No. 4.
[14] Britton Harris, 1973, "Heuristics and Design," *Twelfth European Conference of the Regional Science Association*, Papers of the Regional Science Association, Vol. 31, 1973, p. 10.
[15] Ibid., pp. 7-13.
[16] Without getting caught and penalized for monopolistic practices.
[17] Thaler, R. Summer 1985. "Mental Accounting and Consumer Choice," *Marketing Science*. Vol. 4, No. 3. Thaler's seminal article suggests that "rational" consumers are willing to pay a little more for a technology-and-electricity service bundle offered at a flat rate than they would for the same bundle offered for real-time or time-of-day prices. This owes to the way the mind processes information. Subsequently, Shadowprice.com optimizes profit for these (*Cournot*) providers through number of customers served, not through price adjustments.
[18] Continuously provided services, in the absence of a flat rate, are *Bertrand* because it is difficult, if not impossible, to ration quantity produced as a means to optimize profitability.
[19] Joskow, P.L. 2001. *Why do we need electricity retailers? or Can you get it cheaper wholesale?* Unpublished Massachusetts Institute of Technology Department of Economics Discussion Paper. Joskow said that Basic Electricity Service is "the benchmark against which the social benefits and costs of retail competition and the best mechanisms to realize these benefits should be judged."
[20] Massachusetts Electric Co. 2002. *Default Service Pricing.* www.masselectric.com/res/default/index.htm.
[21] Bolton, Ruth N. May 20, 1998. Interview with Daniel M. Hamblin, College Park, MD: University of Maryland.
[22] Hamblin, D.M. and B.T. Ratchford. 1998. *Impact of Customer Churn on Profitability*. TR-111855. Palo Alto, California: EPRI.
[23] Keynes, J.M., 1936. *The General Theory of Employment, Interest, and Money*, New York: First Harbinger Edition, 1964, Chapter 11: The Marginal Efficiency of Capital.
[24] Arrow, K.J. 1950. "A Difficulty in the Concept of Social Welfare," in *Microeconomics: Selected Readings*, 3rd ed., Edwin Mansfield, ed., New York: W. W. Norton & Company, Inc., 1971, pp. 462-464.
[25] Schenk, R., 2010, "Consumers' Surplus," http://ingrimayne.com/econ/MaximizingBeha/ConSurplus.html.
[26] Hicks, J.R. 1946. *Value and Capital*. 2nd ed., London: Oxford University Press, Ely House. pp. 38-41.
[27] Blaug, M.. 1976. Economic *Theory in Retrospect*. 3rd ed. London: Cambridge University Press. pp. 381-383.
[28] No doubt this understates the consumer surplus total for any particular series game. Following Joskow, the paper's Basic Electricity Service has a built-in insurance hedge against market price volatility and against weather more

extreme than the average, or typical, seasonal degree-day fluctuations embedded in the simulator's wholesale price series for peak load. This suggests it is highly likely that customers would be willing to pay a higher default-service price for quantities less than that purchased at the margin. However, the paper excludes this computation and notes that, at the heuristic-scenario-specific games of maximum-price-discrimination profit, the percentage of default-service customers rarely exceeds the 3.5% new-customer-base for the simple reason that existing customers opting for default service contribute nothing to profit.

[29] Hamblin, D.M. and B.T. Ratchford, 2003. Op. Cit. Section 2.4 ESP Accounting: p. 1580.

[30] Rust, R.T., A.J. Zahorik, and T.L. Keiningham. 1995. "Return on Quality (ROQ): Making Service Quality Financially Accountable," *Journal of Marketing*, Volume 59.

[31] Hamblin, D.M. and B.T. Ratchford, 2003. Op. Cit. pp. 1578-1579.

[32] Climate for Kansas City, Mo., 11/27/2009, http://www.rssweather.com/climate/Missouri/Kansas%20City/.

[33] Lyon, T.P. and H. Yin, 2010, "Why Do States Adopt Renewable Portfolio Standards?: An Empirical Investigation," *The Energy Journal*, Vol. 31, No. 3. Cleveland: The International Association for Energy Economics. pp. 154 -155.

[34] The payoff to coalition partner 8 is zero because for this Game Assignment Seed, coalition partner 8 receives no-frills default service.

[35] Section IV derivations were inspired by Intriligator, M.D. 1971. *Mathematical Optimization and Economic Theory*. Englewood Cliffs: Prentice-Hall, Inc. Chapter 6, Section 4 Cooperative Games, pp. 123-130. Any errors in application are entirely the fault of Dan Hamblin.

[36] Hamblin, D.M. and B.T. Ratchford, 2003. Op. Cit. Tables 4 & 5, p. 1585.

[37] See, for example, the slide show that appears on Consolidated Edison's opening web page: http://www.coned.com/.