Designing a Competitive Wholesale Electricity Market That Benefits Consumers

by

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1. Introduction

All wholesale electricity markets currently operating in the United States are unlikely to yield significant consumer benefits relative to the former vertically-integrated monopoly regime because of the divergent goals pursued by the regulators of the retail versus wholesale segments of the industry. The federal government, through the Federal Energy Regulatory Commission (FERC), oversees interstate wholesale electricity markets. State public utilities commissions (PUCs) have jurisdiction over the retail electricity markets within their boundaries. These differences in geographic scope imply that the same political or economic actor can have significantly more influence over one of the two regulatory processes that impact a single geographic market. For example, a former vertically-integrated investor-owned utility should be able to exert significantly more influence over its state PUC regulatory process than it does over the federal regulatory process. On the other hand, a merchant power producer with financial stakes in wholesale markets throughout the US should have relatively more influence over the federal regulatory process than it does over any single state PUC regulatory process. These differences in relative influence imply that the wholesale market policies pursued by federal regulators can be wildly at odds with the retail market policies pursued by state regulators.

These conflicting regulatory policies are the primary reason why all wholesale electricity markets in the US have yet to yield tangible economic benefits to final electricity consumers. FERC's desire to create wholesale electricity markets throughout the US has led them to give electricity suppliers enormous discretion over how they bid and operate their electricity generating facilities. In contrast, the attempts of state regulators to balance the competing pressures they face from consumer groups and the remnants of the former vertically-integrated monopolies in their state has resulted in retail market policies that limit the product choices available to final consumers and eliminate their ability to benefit from responding to movements in the hourly wholesale electricity price. The market conditions that result from this combination of regulatory policies creates significant opportunities for generation unit owners to earn enormous economic profits for sustained periods of time, as occurred in California from May 2000 to May 2001.

Other US markets are not immune to a "California Electricity Crisis." The probability of this event and the magnitude of consumer harm would result depends on factors such as the level of peak demand relative to the total generating capacity in the market, the share of this generating capacity owned by each market participant, water availability (in regions that receive a significant fraction of their energy from hydroelectric facilities), the fraction of within-market demand met by imports from outside of the region, weather conditions in the region, as well as the regulatory regime governing retail market. Warning signs that similar events could occur in other US markets appeared before the summer of 2000.

If state PUCs implement the physical and legal retail market infra-structure essential to support a competitive wholesale market, the events of May 2000 to May 2001 in California are extremely unlikely to repeat themselves in other wholesale markets. There are three essential components of this retail market infrastructure. First, all final customers must have real-time meters to record their consumption at the same level of time aggregation that wholesale prices are set. Second, retail competition must be implemented in a manner that does not favor the incumbent retailer or any of its unregulated affiliates. Finally, state-level regulation of the retail sector must continue to protect the interests of consumers, but in a manner that enhances rather hinders the ability of consumers to benefit from active participation in the wholesale electricity market.

Unless all customers have real-time meters and pay the real-time wholesale spot price as the default for all of their energy purchases, a wholesale market that ultimately benefits consumers relative to the former monopoly regime is very unlikely to develop. This requirement to pay the real-time price by default does not force any customer to pay the real-time price for all or even a portion of their electricity consumption in any hour. The crucial feature of this requirement is that a customer must sign a forward contract with a retailer to obtain a fixed-price supply commitment for pre-specified duration. Retailers are then free to sign fixed-price contracts with any electricity producer to hedge their wholesale price risk.

Competition to attract consumers will provide strong incentives for retailers to keep their wholesale energy purchase costs as low as possible. Only those retailers with the least cost blend of forward and spot wholesale electricity can offer the most attractive pricing plans to final consumers. Moreover, with the widespread deployment of real-time metering technology in the local distribution network, each retailer can compute precisely how much it is paying in wholesale energy costs to serve each customer and not have to rely on representative hourly consumption patterns approved by the state PUC to approximately these costs.

Because retail competition should impose downward pressure on retail prices, state PUCs no longer need to regulate retail electricity rates. However, they must still actively foster a competitive wholesale market. This requires managing the process of separating the supply or electricity retailing business from the local distribution network business of the incumbent investor-owned utility. The PUC must also set the regulated prices that all electricity retailers, including the newly unregulated incumbent electricity retailer, pay for use of the local distribution network. A new, but very important, role for State PUCs is to monitor the level of wholesale market price risk borne by all competitive electricity retailers to ensure that they are able to meet their current and future electricity supply obligations to final consumers. PUCs must ensure that every retailer serving customers in their state has procured sufficient forward market commitments for fixed-price wholesale electricity to cover these retail obligations. This oversight process is very similar to the cash or short-term reserve monitoring requirements in the retail banking sector.

To provide tangible evidence of the potential benefits of universal real-time meters and default real-time pricing (unless a customer elects to signed forward contract with a retailer) and the costs of failing to enact these policies, the paper presents an analysis of the experience with real-time pricing for large industrial and commercial customers in the England and Wales electricity markets. This analysis shows that benefits of real-time meters and real-time pricing and the cost of failing to implement these policies are highest in markets with volatile wholesale prices.

The following section argues that price volatility plays a crucial role in creating a wholesale market that provides tangible benefits to final consumers. This section argues that attempts to eliminate price volatility by regulatory interventions such as price caps or bid caps will most likely create a spot market with less spot price volatility but higher average prices than a market without these regulatory interventions. This section concludes that without some price volatility consumers have little incentives to make the investments necessary to realize significant benefits from a competitive wholesale electricity market.

The final section of the paper recommends a retail market infrastructure for the California electricity market. A plan for introducing real-time meters, default real-time pricing, retail competition and getting the state out of the business of buying power on behalf of California consumers is presented. This plan is designed to minimize the costs to California consumers of the events of May 2000 to May 2001 and the associated forward contracts that the state signed as a result of FERC's failure to enforce the just and reasonable rate provision of the Federal Power Act. This plan will also allow California consumers to realize the full benefits of retail competition as soon as possible.

The remainder of the paper proceeds as follows. First I characterize both the nature of the conflict between federal and state regulators that the exists in all US wholesale electricity markets and its impact on the performance of these markets. The paper then lays out the essential features of the state-level retail market policies necessary to support a competitive wholesale market that benefits final electricity consumers. This section provides a detailed discussion of each of the three features of the recommended retail market infrastructure described above and how they address the current market performance problems in all existing competitive wholesale electricity markets. The paper then summarizes the existing evidence on the actual performance these retail market policies in other markets from around the world. The paper then turns to a summary of the performance of real-time pricing for a sample of customers in the England and Wales electricity market. The following section discusses the important of role wholesale price volatility in providing the necessary incentives for wholesale market that benefits final customers. The last section applies the analysis of this paper to the California electricity market to devise plan for minimizing the costs of the events of May 2000 to May 2001 to California consumers and maximizing the likelihood that they will benefit from wholesale competition as soon as possible. The paper concludes with a brief discussion of the necessity of providing the proper the incentives to both the supply and demand sides of the market in order for wholesale competition benefit to final consumers.

2. Conflict Between Federal and State Regulatory Processes

This section first lays out the historical background for the conflict between federal and state regulators. I then discuss the incentives and constraints faced by FERC and contrast those with those faced by state PUCs. As should be clear from this discussion, the incentives faced by each regulatory body and the current legal framework for wholesale electricity industry regulation creates the potential for conflicts in the future similar to the one currently in progress between California and FERC. This section concludes with several suggested remedies for this conflict.

2.1. Origins of the Current Federal-State Regulatory Conflict

The former vertically integrated monopoly regime in the US electricity supply industry created limited opportunities for conflicts between state and federal regulators. This regime involved few interstate spot market transactions of wholesale electricity, because in exchange for its legal status as monopoly for a given geographic area, each vertically-integrated monopolist had an obligation to serve all retail demand a price set by the state PUC. States also played a major role transmission and generation capacity planning decisions of its investor-owned utilities. This model for the electricity supply led to an industry dominated by state-level oversight, with most interstate electricity transactions on a long-term contract basis. The vast majority of short-term interstate electricity transactions were for reliability reasons because the state-level obligation to serve all demand at the regulated retail price imposed the entire risk of expensive spot market electricity on the investor-owned utility. In response to this state-level regulatory dominance, transmission networks were designed to serve state-level markets and interstate electricity sales for reliability reasons only.

The Arab Oil Embargos in the early and late 1970s disturbed this equilibrium in the US electricity supply industry. After the first price shock, state regulators and investor-owned utilities continued with their capacity expansion plans at historical rates despite rapidly increasing oil and natural gas prices over this time period. These higher input fuel price significantly increased the price of retail electricity, which led to a significant reduction in the level and rate of growth of US electricity demand. This slower growth in demand rendered unnecessary a number of the large nuclear and coal facilities under construction at the time. As consequence, many state regulators began to disallow the recovery of these construction costs from retail electricity rates. In response, virtually all construction new generating capacity by investor-owned utilities ceased. However, the demand for electricity continued to grow, albeit at a lower rate than before the 1970s.

Concerns about having sufficient generating capacity to meet this growing demand led federal policymakers to pass legislation designed to foster the interstate wholesale electricity markets. This provided investor-owned utilities will another source of generating capacity that was not explicitly subject to the state-level regulatory process. Instead of having to gain state-level regulatory approval for a new generating facility, the investor-owned utility merely had to obtain the PUC's consent for the terms of a long-term supply contract with a wholesale electricity producer. The continued reluctance of investor-owned utilities to embark on large-scale new capacity construction programs for fear of future regulatory disallowances despite continuing growth in electricity demand led to an active competitive wholesale electricity sector in many parts of the US. As the amount of energy delivered to final customers produced by independent power producers grew, so did their political clout and their demands to be able to sell larger volumes of electricity over longer distances. In response, FERC enacted policies to provide to access the transmission grids of the investor-owned utilities to facilitate these sales. A variety of FERC orders during the 1990's, most notably, Order 888, attempted to provide non-discriminatory access to unused transmission capacity controlled by the investor-owned utilities to wholesale power producers. However, the investor-owned utilities had little incentive to operate generating and transmission facilities to leave much unused transmission capacity to wholesale power producers because this might allow wholesalers to sell to one of utility's large customers. The regime of voluntary access of unused transmission capacity was largely view by the independent power producers and FERC as unsuccessful at promoting competitive wholesale electricity markets.

In response, beginning with California in early 1998, competitive wholesale electricity markets were formed. These markets required the investor-owned utilities to turn over control of their transmission grids to an independent system operator (ISO) to provide open-access to those suppliers–both the former incumbent investor-owned utilities in the state and the independent power producers–willing to pay the highest price to access the transmission network. If the necessary retail infrastructure exists in the states with this form of wholesale competition, then only those competitive retailers able to supply to final customers at the lowest possible price will be able to survive. A competitive retail sector with minimal barriers to entry should therefore provide strong incentives for all suppliers of wholesale electricity to sell at the lowest possible price.

It is important to emphasize that if more flexibility is given to electricity wholesalers, more flexibility must be given to electricity retailers. If FERC gives wholesalers wide-ranging discretion to operate their facilities to maximize the profits, then state regulators must give retailers the same amount of discretion to buy wholesale and sell retail electricity to maximize their profits. Virtually all regulatory restrictions on the behavior of electricity retailer will hinder their ability to foil the attempts of electricity wholesalers to raise electricity prices and therefore impose significant potential harm on final consumers.

Unfortunately, there are very strong incentives for state PUCs to do just that. First, from the perspective of the state politician or PUC, the introduction of wholesale competition with an ISO means that the state loses its ability to control retail electricity prices. The FERC regulates wholesale electricity markets and to the extent that a single state, even one as large as California, is part of an even larger integrated multi-state wholesale market, the state PUC cannot control wholesale electricity prices within its boundaries.

The choice facing policymakers in states that have not yet re-structured is to retain the vertically integrated monopoly regime with its associated significant state-level control over retail electricity prices, or a transition to wholesale market regime with the potential of lower wholesale prices through competition but with significantly less control over retail electricity prices. Before the events of May 2000 to May 2001 few state policymakers believed there was a significant downside risk to electricity industry re-structuring. Because virtually all of the states that have yet to re-structure have average retail electricity prices lower than the US average, policymakers in these states are weighing the potential costs versus benefits of electricity restructuring and are electing delay, and in some case indefinitely, their industry re-structuring plans.

The California crisis has shown that downside risk of restructuring can be enormous. The lack of evidence that consumers in any US wholesale market have received tangible benefits from wholesale competition relative to the former vertically integrated monopoly regime suggest that the likely benefits to consumers are limited. However, as discussed above, there is alternative explanation: the lack of coordination between wholesale and retail regulatory policies has not allowed it to do so. I now discuss the reasons for this conflict between federal and state regulators.

2.2. Incentives and Constraints Facing FERC

The Federal Power Act of 1935 established the regulatory framework for federal oversight of wholesale electricity markets. It formed the Federal Power Administration, the predecessor of the FERC and established for requirements for wholesale electricity prices that FERC has the authority to enforce. The Federal Power Act requires that FERC set "just and reasonable" wholesale electricity prices. The following passage from the Federal Power Act clarifies the wide ranging authority FERC has to fulfill its mandate.

> Whenever the Commission, after a hearing had up its own motion or upon complaint, shall find that any rate, charge, or classification, demand, observed,

> charged or collected by any public utility for transmission or sale subject to the jurisdiction of the Commission, or that any rule, regulation, practice, or contract affected such rate, charge, or classification is unjust, unreasonable, unduly discriminatory or preferential, the Commission shall determine the just and reasonable rate, charge, classification rule, rule, regulation, practice or contract to be thereafter observed and in force, and shall fix the same by order (Federal Power Act of 1935).

Historically, just and reasonable prices are those that recover all prudently incurred production costs, including a return on capital invested. The Federal Power Act also mandates that if FERC finds that electricity has been purchased at unjust and unreasonable prices it must order refunds of any payments in excess of just and reasonable rates.

For sixty years FERC implemented its obligations to set just and reasonable rates under the Federal Power Act by regulating wholesale market prices. During the 1990s, based on the belief that if appropriate criteria were met, "market-based rates" could produce lower prices and a more efficient electric power system, FERC changed its policy. It began to allow suppliers to sell wholesale electricity at market-based rates but, consistent with FERC's continuing responsibilities under the Federal Power Act, only if the suppliers could demonstrate that the resulting prices would be just and reasonable. Generally, FERC allowed suppliers to sell at market-based rates if they met a set of specific criteria, including a demonstration that the relevant markets would be characterized by effective competition. FERC retains this responsibility when a state decides to introduce a competitive wholesale electricity market. In particular, once FERC has granted suppliers market-based pricing authority it has an ongoing statutory responsibility to ensure that these market prices are just and reasonable.

FERC's ability to determine both whether a rate is just and reasonable and what actions are appropriate to fulfill its statutory mandate to set just and reasonable rates, creates significant opportunities for conflicts between federal and state regulators. Specifically, FERC's recognition that only a market characterized by effective competition yields just and reasonable rates can lead to disagreements between state and federal regulators over what constitutes a market with effective competition. Clearly, a market without effective competition, the most extreme case being monopoly, can set prices far above the historical just and reasonable rate standard for sustained periods of time.

The history of federal oversight of the industry described above illustrates that FERC has a very different perspective on the role of competitive wholesale markets than state PUCs or state policymakers. This difference is due in large part to the pressures put on FERC by the entities that it regulates versus the pressures put on state PUCs and policymakers by these same entities. The merchant power producers have been very supportive of FERC's goal of promoting competitive wholesale markets. These companies have taken part in a number of lawsuits and legislative efforts to expand the scope of federal jurisdiction over the electricity supply industry.

The more FERC expands it authority over access to the US transmission network, the greater will be the opportunities for merchant power producers such as Enron, Dynegy, Reliant, Mirant, Duke, and Williams to compete will the incumbent investor-owned utilities to sell electricity to final customers. When the merchant power sector applies it considerable political and economic clout to expand the extent of federal oversight over the industry, it is furthering the stated policy of the FERC to promote competitive wholesale markets. In this sense, there is a clear commonality of goals between FERC and the merchant power sector.

2.3. Incentives and Constraints Facing State PUCs and Policymakers

State PUCs and policymakers face a very different set of incentives and constraints from the FERC. First, for more than 50 years, state PUCs have set the retail price of electricity and managed the process of determining the magnitude and fuel mix of new generation investments by the investor-owned utilities within their boundaries. This paternal relationship between the PUC and the firms that it regulates makes it extremely difficult to implement the necessary physical and regulatory infrastructure necessary for a competitive wholesale market.

Neither the state PUC nor the incumbent investor-owned utility benefits from the introduction wholesale competition. The state PUC loses the ability to set retail electricity rates and the investor-owned utility faces the prospect of losing customers to competitive retailers. It is difficult to imagine a state regulator or policymaker voluntarily giving up the authority to set rates which can benefit certain customer classes and harm other customer classes. Because every citizen of a state consumes some electricity, the rate-making process is an irresistibly tempting opportunity for regulators and state policymakers to pursue social goals in the name of industry regulation. In addition, the introduction of wholesale competition also limits the scope for the state PUC and policymakers to determine the magnitude and fuel mix of new generating capacity investments. Finally, different from the former regulated regime where the PUC and state played a major role in determining both the magnitude of new capacity investments and the input fuel for this new investment, in the competitive regime, these decision will be made by the merchant power producers. For these reasons, the expansion of wholesale competition and the creation of the retail infrastructure necessary to support it directly conflict with many of the goals of the state PUCs and incumbent investor-owned utilities. The state PUCs and policymakers lose the ability to order economic transfers from certain groups of electricity producers and consumers and award them to more politically powerful or favored groups of consumers and producers of electricity. Because it is a former monopolist, the incumbent investor-owned utility only stands to lose retail customers as a result of the implementation of effective retail competition. It is usually among the top-5 employers in the state, so it is able to exert influence over the state-level regulatory process to protect its financial interests. Because the state PUC loses much of its ability control the destiny of the electricity supply industry within its boundaries when wholesale and retail competition is introduced, the incumbent investor-owned utility finds a very sympathetic ear to arguments against adopting the retail market infrastructure necessary to support a competitive wholesale market.

FERC's statutory responsibility to take actions to set just and reasonable wholesale rates, provides state PUCs with the opportunity to appear to fulfill their statutory mandate to protect consumers from unjust prices, yet at the same time serve the interests of their incumbent investor-owned utilities. The state can appease the incumbent investor-owned utility's desire to delay or prohibit retail competition and by relying on FERC to protect consumers from unjust and unreasonable wholesale prices though regulatory interventions such as price caps or bid caps on the wholesale market. However, the events of May 2000 to May 2001 have emphasized, markets do not always set just and reasonable rates, and FERC's conception of policies that protect consumers may be very different from those the state PUC and other state policymakers would like FERC to implement.

Because FERC also decides whether wholesale rates are just and reasonable and determines what actions are appropriate to ensure that rates are just and reasonable, state PUCs and policymakers that rely only on FERC to protect consumers from the exercise of market power may be taking an unacceptably large risk. As California learned over the past year, a long time can elapse before the necessary legal and political pressure can be brought to bear on FERC to fulfill its statutory mandate to protect consumers in a manner that state policymakers find acceptable. In the meantime, an enormous amount money can be extracted from consumers, taxpayers and the shareholders of the incumbent electricity retailers as result of the unilateral exercise of market power made possible by poorly designed state-level retail market policies.

2.4. Solutions to Federal Versus State Regulatory Conflict

There are a number of approaches to resolving this federal versus state regulatory conflict. All of them involve the explicit recognition that markets do not always set just and reasonable prices, and are only unlikely to do so unless consumers are given strong incentives to take the appropriate pre-cautions in advance to avoid paying high spot prices. This section first describes the incentives faced by final customers as a result of this reliance on federal oversight to protect retail consumers from the exercise of market power in the wholesale market. This is followed by several recommended changes in the FERC oversight process that will provide strong incentives for final demand to become the active participant in the wholesale market.

2.4.1. The Market Outcomes with Only Federal Oversight

The physical characteristics of electricity make it extremely susceptible to the unilateral exercise of market power. Supply must equal demand at every instant in time and at every location in the transmission grid. Electricity cannot be stored without incurring significant cost. All electricity must be delivered to final consumers through a single transmission grid subject to periodic congestion. It takes approximately 24 months to build a new state-of-the-art generating facility, not including the time to obtain the necessary regulatory and environment approvals for the new plant. All of these factors imply that unless consumers purchase a substantial fraction of their expected demand on the forward market, they face the risk of high spot prices for sustained periods of time. However, consumers have the incentive to make the necessary forward market purchases only if the appropriate state-level retail market infrastructure is in place.

FERC has chosen to mitigate consumer harm in wholesale markets with inadequate forward hedging by implementing price caps or bid caps on the spot wholesale market. However, price and bid caps on the spot market dull the incentives that consumers have to enter into forward contracts, because they limit the consumer's exposure to high spot prices from failing to hedge in the forward market. Moreover, price caps on the spot market reduce the incentives that consumers have to install the technologies that allow them to alter their demand in respond to hourly wholesale prices. The maximum saving from reducing demand in a given hour is much less in a wholesale market with price cap of a $100/MWh versus to a spot market without a price cap. Lower price or bid caps on the spot market imply less market efficiency-enhancing investments by consumers. A price cap on the wholesale spot market only masks the symptoms of poorly designed wholesale and retail market policies. It provides no incentive to enhance the long-term efficiency of the market.

2.4.2. FERC Policy Changes to Resolve Federal-State Conflict

FERC's desire to promote wholesale competition and its responsibility to set just and reasonable wholesales price presents the following dilemma. FERC can intervene in the market to protect consumers and impose a price cap on the spot market. This action would provide concrete proof to state policymakers that there is little need implement the appropriate retail market infrastructure to protect consumers from the exercise of market power by electricity producers. Alternatively, FERC can refuse to intervene and therefore provide strong incentives for state PUCs to adopt the appropriate retail market policies that will allow wholesale competition to benefit consumers. The first choice results in wholesale market price caps with the shortcoming listed above. The second choice can cause a sustained political conflict between state officials and FERC over the need to intervene to protect consumers from unjust and unreasonable wholesale prices. This process can lead to the transfer of enormous amounts of wealth from electricity consumers to electricity producers similar to what occurred during the period May 2000 to May 2001 in California. Neither choice is particularly attractive.

One solution is to eliminate of the just and reasonable rate standard of Federal Power Act when a geographic market that makes the transition to the ISO model of wholesale competition. If FERC has a legal requirement to maintain just and reasonable rates in a competitive wholesale market, states have limited incentives to enact retail policies that allow consumers to realize the full benefits of wholesale competition. Ideally, such a policy change would involve federal legislation. With this policy change in place, any state considering re-structuring would recognize that citizens must bear the full costs of any failure to implement policies that foster effective retail competition.

An alternative solution would require FERC to issue an order stating that at some pre-specified date in the future all market transactions are *per se* just and reasonable because they involve voluntary trades between a willing buyer and a willing seller. Although it is very likely that FERC's authority to issue such an order would be challenged on legal grounds as not enforcing the Federal Power Act and for being inconsistent with 50 years of legal precedent, if it stands, this policy would provide strong incentives for states to implement retail market polices that allow consumers to benefit from wholesale competition.

To reduce the likelihood of a legal challenge to this order, FERC could pick a date of two or three years in the future to make this policy change effective. A time horizon of more than two years in the future is necessary because no firm is likely to be able to exercise significant market power at this time lag between signing an agreement and delivering the electricity. Competition to supply electricity at this time horizon takes place both among all firms currently owning generating facilities and all firms with ability to construct new generating facilities. FERC argue that by giving this amount of advance notice of its policy change, all geographic regions have the opportunity purchase their electricity needs at forward market prices that reflect effective competition. Any load serving entity that does not engage in the appropriate amount of forward market purchases does so at its own risk.

In closing this section, it is important to emphasize that unless final consumers face the risk of high hourly spot prices and are able to capture the full benefits of altering their demand in response to spot price movements, there is unlikely to be a sufficient amount of hedging activity to prevent sustained periods of very high spot prices. Unless the transition from a regime which shields final consumers from the hourly spot price is made with a sufficiently long time lag, final consumers may be forced to purchase electricity at extremely high prices for as long as two years.

3. Retail Market Infrastructure Essential to Support Workable Wholesale Competition

This section describes the three essential features of the state-level retail market infrastructure necessary to support a wholesale market that benefits final consumers. I first discuss the necessity of universal real-time metering. Because this overhaul of the metering infrastructure will take time, I suggest a scheme for its implementation. The next subsection focuses on the role of retail competition in creating a wholesale market that benefits final electricity consumers. It describes why sustainable retail competition is impossible without the widespread implementation of real-time meters. The final subsection outlines the role for state PUCs in a fully competitive retail market. PUCs must monitor the portfolio positions of all electricity retailers to ensure that they are not taking imprudent gambles in forward electricity markets that may prevent them from fulfilling their contractual obligations their retail customers.

3.1. The Necessity of Real-Time Metering Technology

To understand the need for real-time metering technology, I first review the determinants of firm profitability in the former vertically-integrated monopoly regime versus the competitive wholesale market regime. I then describe why sustainable retail competition is unlikely to develop unless in any market unless there is widespread implementation of real-time meters. This subsection concludes with a discussion of the economics of implementing universal real-time metering for a representative local distribution company.

3.1.1. Firm Financial Viability Under Competition Versus Regulation

Both the regulated monopoly regime and the wholesale competition regime require that firms obtain sufficient revenues to cover total production costs over the year from all customers. The difference between these two regimes is how firms recover these production costs.

The monopolist can serve many customers at a loss for long periods of time as long as it earns significant revenues in exceed of production costs from other customers. This is possible because it has a legal monopoly on the supply of electricity for a given geographic area and other firms are prohibited by law from entering profitable segments of the monopolist's business. Consequently, the regulated regime can tolerate huge cross-subsidies from between classes of customers as distinguished by their geographic location in the transmission network, their load shape, or other observable characteristics.

The previous regime, the monopolist received the same regulated price for each KWh of energy it supplied to a final customer on a fixed retail rate. This is true regardless of the cost of supplying a KWh to the final customer. Consequently, the monopolist has a strong incentive to make investments which eliminate the number of hours when its wholesale energy costs are higher either because it must operate expensive peaking generation units or pay to have load curtailed by its interruptible customers.

Under a wholesale market regime, firms have must attempt to make profits on every KWh of energy they sell. Because there are a number of suppliers of wholesale electricity, competition among them will eventually erode any excess profit opportunities. Therefore, it is very unlikely that cross-subsidies across customer classes will persist in a competitive wholesale market.

The price a seller receives for each KWh it supplies depends on conditions in the wholesale market. Differences in competitive conditions can lead to huge variations across hours of the day, week, month or year in the price that a supplier receives for electricity sold in an hour. Different from the regulated regime, the firm may be able to take actions which impact these market conditions, and therefore the price it receives for electricity. If firm is able to this raise price more than it raises average production costs, then it is profit-maximizing for the firm to engage in activities that raise its costs of producing power, something the regulated monopoly has no incentive to do.

Because firms in a wholesale market earn their profits one hour at a time, it is crucial that consumers pay for their electricity at these hourly prices. Schemes such as load-profile billing and other methods which attempt to compute proxies for a customers hourly consumption using that customer's monthly electricity consumption are largely ineffective at providing the necessary hourly price signals. The following example of load profile-billing illustrates this point.

Virtually all meters for small commercial and residential customers only can only capture usage over the time interval between meter readings. In all markets in the US, meters for residential and small business customers are read on a monthly basis. This means that the only information available to an electricity retailer about these customers is their total monthly consumption of electricity. Under a load-profile billing scheme this monthly consumption is distributed across hours of the month according to a representative load shape proposed by the retailer and approved by the PUC. For example, let q(i,d), denote the consumption of the representative consumer in hour i of day d. A customer with monthly consumption equal to Q(tot) is assumed to have consumption in hour i of day equal to:

$$qp(i,d) = \frac{q(i,d)Q(tot)}{\sum_{d=1}^{D}\sum_{i=1}^{24} q(i,d)}$$

This consumer's monthly wholesale energy bill is computed as

$$Monthy\ Wholesale\ Energy\ Bill = \sum_{d=1}^{D}\sum_{i=1}^{24} qp(i,d)p(i,d),$$

where p(i,d) is the wholesale price in hour i of day d. This expression can be simplified to P(avg)Q(tot), by defining P(avg) as:

$$P(avg) = \frac{\sum_{d=1}^{D}\sum_{i=1}^{24} p(i,d)qp(i,d)}{\sum_{d=1}^{D}\sum_{i=1}^{24} q(i,d)}$$

Despite this attempt to allocate monthly consumption across the hours of the month, in the end the consumer faces the same wholesale energy price for each KWh consumed during the month. If P(avg) increases because the wholesale prices are extremely high in several hours of the month, this customer's monthly bill will increase if his monthly consumption does not change. For example, if this customer maintained the same monthly consumption but shifted its consumption during the month from hours with very high wholesale prices to those with low wholesale prices, the customer's bill would be the same as if he didn't change his pattern of consumption during the month.

Without the ability to record a customer's consumption on an hourly basis it is impossible to implement a pricing scheme that allows the customer to realize the full benefits of shifting his consumption from high-priced hours to low-priced hours. In a competitive wholesale market the divergence between P(avg) and the actual hourly price can be enormous. For example, during the year 2000 in California, P(avg) was equal to approximately 10 cents/KWh despite the fact that the price paid for electricity often exceeded 75 cents/KWh and was as high as $3.50/KWh for a few transactions. In contrast, under the vertically-integrated monopoly regime, the utility received the same price for supplying electricity that the final customer paid for every KWh sold to every customer served.

The implementation of real-time meters for all classes of customers would allow prices that reflect hourly wholesale market conditions to be charged to all customers for their electricity consumption during each hour. A customer facing an hourly wholesale price of $3.50/KWh for any consumption in that hour in excess of his forward market purchases would have a very strong incentive to cut back during that hour. This incentive extends to reductions in consumption below this customer's forward market purchases, because any energy not consumed below this forward contract quantity is sold at the spot market price of $3.50/KWh.

The importance of recording consumption on an hourly basis for all customers can be best understood by recognizing that a 1 MWh reduction in electricity consumption is equivalent to a 1 MWh increase in electricity production assuming that both the 1 MWh demand decrease and 1 MWh supply increase are provided with the same response time and at the same location in the transmission grid. Because these two products are identical, in a world with no regulatory barriers to active demand side participation, the major barrier being the lack of real-time meters, arbitrage should force the prices paid for both products to be equal.

One would never think of charging a generating unit anything but the real-time spot price for all energy supplied over the period that the price was valid. These prices signal the generator to when to supply more or less energy. The same logic applies to the demand side of market. But these price signals cannot operate without the ability to record the hourly consumption at the customer level.

To underscore the equivalence of demand reductions and supply increases, consider the following hourly demand curve for a customer, D(p). Let D(0) be the customer's demand at a price of zero. Define SN(p) = D(0) - D(p). If we add D(0) to the market demand, then SN(p) is this customer's hourly supply curve for electricity. It is no different from the marginal cost curve of a generation unit owner, which gives the true willingness to supply function for the generation unit owner. SN(p) is the true willingness supply function for this electricity consumer. Any attempts by this consumer to influence the market price by exercising its power as a buyer would use SN(p) as the basis for constructing its profit-maximizing bidding strategy. Similarly, any attempts by a firm to influence the market price by exercising its power as a seller would use the firm's marginal cost curve as the basis for constructing its profit-maximizing bidding strategy.

3.1.2. Sustainable Retail Competition Requires Real-Time Meters

Real-time metering technology is crucial to the development of sustainable retail competition. The logic for this view follows. Competition among firms occurs because one firm believes that it can better serve the needs of consumers than firms currently in the industry. These firms succeed either by offering an existing product at a lower cost or by offering new product that serves a previously unmet consumer need.

Consider the case of electricity retailing without real-time meters. The only information each retailer has is the customer's monthly consumption of electricity and some demographic characteristics that might be useful for predicting its monthly load shape, the q(i,d) described in

Section 3.1.1. The dominant methodology for introducing retail competition is load-profile billing to the retailer for the hourly wholesale energy purchases necessary to serve each customer's monthly demand. This scheme implies that all competitive retailers receive the same monthly wholesale energy payment (for the wholesale electricity it allows the incumbent retailer to avoid purchasing on this customer's behalf) for each customer of a given type that they serve. Customer types are distinguished by a representative load shape and monthly consumption level.

Under this mechanism, competitors attract customers from the incumbent retailer by offering an average price for energy each month, P(avg) as defined above, that it below that value offered by other retailers. The inability to measure this customer's consumption on an hourly basis implies that competition between electricity retailers takes place on a single dimension, the monthly average price they offer to the consumer. The opportunities for retailers to exploit competitive advantages relative to other retailers under this mechanism are severely limited. Moreover, this mechanism for retail competition also always requires asymmetric treatment of the incumbent retailer relative to other competitive retailers. Finally, the state PUC must also continue to have an active role in this process because it must approve the representative load shapes used to compute P(avg) for each customer class.

The telecommunications industry provides an excellent example of the potential perils of introducing retail competition without the ability to measure a customer's consumption at the same level of granularity that the good is purchased in the wholesale market. Imagine running a competitive market in long-distance services with only the ability to measure the total number of minutes of phone calls a customer makes in a month. Each competitive long-distance provider would then apply a representative calling pattern set by the regulator to this monthly total number of minutes of phone calls to the customer's monthly bill.

The opportunities for customers to exploit these representative calling patterns for their own gain are enormous. A customer could claim a calling pattern with many local calls, all of short duration. However, once a representative calling pattern for monthly billing purposes was set, the customer could make long-distance calls of long duration to far away places. As long as the total number of minutes of phone calls was the same as it was under his claimed calling pattern, his monthly bill would be unchanged. However, the cost to the provider of network services in the second case is dramatically higher than it would be in the first. Clearly, no state or federal regulator would ever consider running competition in long-distance services without the ability to measure the origin and destination pair of each call, the exact time it was made and the duration of the call, all factors which determine the cost of providing this call.

What is being attempted in retail electricity competition throughout the US fits this representative calling pattern pricing model for long-distance competition. Customers are charged an average price for all of their monthly electricity consumption, regardless of when this electricity is consumed during the month. Because of the large variation in the price of wholesale power across hours of the day, week, month or year under the wholesale market regime, similar opportunities to exploit these representative load shapes exists for electricity customers. As noted above, once a customer has been assigned a representative load shape, it has achieves the same monthly bill decrease from reducing its consumption by 1 KWh in any hour of the month. In the former vertically integrated monopoly regime, the variation in production costs across hours of the year was significantly less than the variation in market prices in wholesale market regime. In the vertically-integrated monopoly regime variable production costs in the highest cost day of the year where no more than three times variable production costs in the lowest cost day of the year. In the wholesale market regime in California during 2000, prices paid for wholesale electricity ranged from −$330/MWh to $3,500/MWH. Consequently, the efficiency loss from using representative load shapes to compute a customer's monthly bill was significantly less under the vertically integrated monopoly regime relative to the wholesale market regime.

With ubiquitous real-time metering, retail competition can allow this economic efficiency loss to be captured by the consumers and competitive retailers. Competition to attract customers can now take place along as many as 744 dimensions, the maximum number of hours possible in a one month. A retailer can offer a customer as many at 744 different prices for a monthly period. Producers can offer a enormous variety of nonlinear pricing plans that depend on functions of their consumption in these 744 hours. Retailers can now specialize in serving certain load shapes or offering certain pricing plans as their way to achieve a competitive advantage over other retailers.

Real-time meters allows retailers to use retail pricing plans to match their retail load obligations to with the hourly pattern of electricity purchases. Rather than having to buy pre-determined load shape in the wholesale market, retailers can instead buy a less expensive load shape and use their retail pricing plan to offer significantly lower prices in some hours and significantly higher prices in other hours to cause their retail customers to match this load shape yet achieve a lower average monthly retail electricity bill. This is possible because the retailer is able to pass on the lower cost of its wholesale energy purchases in the average hourly retail prices it charges the consumer.

Universal real-time metering has the additional advantage of eliminating the need for asymmetric treatment of the incumbent retailer versus competitive retailers. Because every consumer's consumption is available at the level of time aggregation that wholesale electricity is bought and sold, there is no need for the regulator to set representative load shapes for any customer.

Conventional real-time metering technology uses mobile radio communications technology to broadcast each customer's hourly or half-hour consumption levels to a central data collection agency. This automated meter reading technology will significantly reduce the cost and time delay in the settlement process, which is the process of determining how much to charge each customer for the electricity they consume and pay each producer for electricity they provide. To those unfamiliar with the electricity supply industry, this may seem to be a relatively straightforward task. However, because of line losses throughout the transmission network generators provide more electricity to the transmission network than consumers ultimately receive from the transmission network. In addition, for a variety of reasons, meter reading errors, theft, or inefficient system operation, energy is injected into the transmission network that is never recorded as being withdrawn from the system. In the conventional monthly meter reading system, many meters are not read even on a monthly basis, which further complicates the problem of assigning the appropriate obligation to pay to each customer. As a consequence of these problems, the process of producing final settlement data against which a customer's bill is determined using conventional metering technology can take more than one year. This is the case in the England and Wales electricity market. The settlement process is not finalized until 14 months after the date the electricity was delivered.

In the former vertically integrated monopoly regime, the costs of these time lags and administrative processes was primarily borne by consumers. The monopolist received all the customer payments and the primary point of debate was whether the customer over or underpaid in a given month. However, in a competitive wholesale market where many wholesale suppliers and competitive retailers are injecting and withdrawing energy from a large number of locations in the transmission grid the magnitude of energy unaccounted for because of metering errors, load profiling errors, theft and inefficient system operation can be even greater. Moreover, unaccounted-for-energy costs impact the bottom line all competitive wholesalers and retailers, so all them can be expected to attempt to shift these costs on to other market participants. The installation of real-time metering for all customers would significantly reduce the magnitude of unaccounted for energy and costs of dealing with it.

3.1.3. Incremental Cost Universal Real-Time Metering Technology

Several investor-owned and municipal utilities have implemented an automated real-time metering (AMR) system for all of their customers. However, no geographic wholesale market has adopted universal real-time metering, although there have been some feasibility studies performed for specific regions. This section describes the results of such a feasibility study for the state of New York were it was contemplated to install an AMR system for the approximately 7 million customers in the state of New York. Because of the economics of installing and operating an AMR system the lowest average costs per meter installed and operated are achieved under a universal real-time metering scheme. Using data from this New York study an average monthly bill increase across all customer classes over the next 20 years of approximately $2/month would be sufficient to pay for the additional costs of universal real-time metering technology.

It is important to emphasize that in exchange for this additional cost of real-time metering the customer receives a service that is vastly superior to conventional monthly meter reading. Providing a comparable level of service to that provided by an AMR system using the conventional manual metering technology would require hiring a single person to read at each of the 7 million meters in the state. The meter reader would have to record the value of the meter each hour or half-hour of the day for all days of the year. Consequently, despite the fact that conventional manual meter reading on a monthly basis is cheaper on a going forward cost basis than AMR, these two technologies must be compared providing the same quality of service. On this basis, the cost of AMR technology is far below the cost of conventional meter-reading technology for the service quality provided by AMR.

Given the current state of computing and other information technology, the monthly expense associated with processing real-time data on a customer's hourly consumption is significantly less than the costs of processing the customer calling patterns in a telecommunications network. Significantly less information must be collected and processed. There are a maximum of 774 pieces of information that must be collected and analyzed each month. In the telecommunications industry there is no limit on the amount of calling information that must be collected an analyzed each month. Consequently, the technical challenges to universal AMR and automated hourly billing and settlement are relatively minor. In fact, many of the investor-owned and municipal utilities have already set up web-sites where customers can access real-time meter reads of their consumption.

According to an Arthur Anderson Consulting (1998) study performed for the New York Public Service Commission the major costs drivers associated with an AMR system are: (1) a radio module to retrofit existing meters used to broadcast hourly meter reads, (2) the capital infrastructure of the radio network, (3) monthly meter reading and validation systems, and (4) operation and maintenance costs of the radio network. The majority of existing meters can be retrofitted with a radio module and thus do not require a new meter purchase and installation. The Anderson Consulting analysis assumed that 30% of residential and small commercial customers, 40% of intermediate industrial and commercial customers and 100% of large industrial and commercial customers would need their meter replaced. For residential and small business customers the fixed cost of the radio module and retrofit was assumed to be $40 with an installation charge of $16. Installing a new meter would add $25 to this total. For intermediate and industrial and commercial customers the fixed cost of the radio module was assumed to be $70 with an installation charge of $25. A new meter for these customers was assumed to cost $125. Finally, the large industrial and commercial customers were assumed to have the same charge for the radio module and the installation cost, but a new meter was assumed to cost them $200. Based on these assumptions, Anderson Consulting computed at 20-year net present value of the incremental customer cost of universal real-time meters for approximately 7 million customers of roughly $2 billion.

Universal real-time metering using AMR technology allows the utility to eliminate virtually all meter reading jobs and many meter data-processing jobs. Anderson Consulting computed the 20-year present value of these net avoided labor costs of $750 million. This led to roughly $1.25 billion net incremental costs for 7 million meters, or slightly less than $200 per meter on a 20-year net present value basis. Assuming a 10% discount rate, this implies about a $2.00/month incremental cost increase across all customer classes.

Given the significant volatility in wholesale electricity prices, by giving customers the opportunity benefit from responding to real-time price signals, which is not possible with conventional manual meter reading, they should be able to realize reductions in their monthly electricity bill over the course of the year that average more than $2/month. It is also important to emphasize that this $2/month is an average over approximately 7 million meters. For many customers the potential from being able to respond to real-time prices will substantially in excess of $2/month. Those customers could be identified and charged higher monthly prices for metering services, so that the price metering services to customers not likely to realize small monthly bill reductions would have metering charges less than $2/month.

Economies to scale in the installation and operation and the positive externality that one customer being responsive to real-time prices provides to other customers also favors universal real-time meters rather than installation on a piecemeal basis. Much the same radio network is needed to read one meter as is necessary to read all meters in a given geographic area. In addition, installing meters on a house-by-house basis in a given geographic area saves on a number costs relative to the case of installing the meters at a small number of locations scattered throughout the same geographic area. Finally, the knowledge that are a number customers with the ability to respond to hourly wholesale prices will cause generation owners bidding to supply electricity to recognize that higher-priced bids make it more likely that their units will not be called upon to produce electricity.

4. The Role of Retail Competition in Creating a Workably Competitive Wholesale Market

This section describes the role of a properly designed competitive retail sector in guaranteeing that a wholesale electricity markets benefit final consumers. First I discuss the problem of determining the regulatory reasonableness of wholesale prices and how retail competition can solve this problem. Next I describe how the combination of real-time metering and retail competition can improve the competitiveness of the wholesale market by allowing retailers to exercise their market power as buyers and promote efficient investments in distributed generation and renewable technologies. This section concludes with a description of the proper design of the default provider obligation in a competitive retail market. It argues that the conventional fixed-price default provider obligation is an unhedged risk of an unknown magnitude. For this reason I argue that the default provider rate for all final customers must be the real-time price, just as it is for all generating units.

4.1. The Regulatory Reasonableness Problem of Wholesale Energy Procurement

Consider the case of a regulated monopoly retailer purchasing wholesale electricity to deliver to final consumers. There are a number of forward markets of different horizons that the retailer can use to procure its retail energy delivery obligations for a given hour. Which procurement policy will yield the lowest possible cost to deliver power to final consumers is unknown to both the regulator and the retailer, despite the fact that both of these entities must jointly decide the optimal forward market procurement strategy for the monopoly retailer.

What are the incentives faced by the retailer and regulator in this joint decision-making process? As long as the regulator guarantees recovery of wholesale energy procurement costs in retail rates, the monopoly retailer is indifferent to the combination of forward market purchases used to meet its retail market obligations. Under these circumstances, the regulator must impose downward pressure on wholesale energy procurement costs through it purchasing behavior. However, the pressures that regulators face from politicians and consumer groups biases this procurement choice in favor of short-term or spot market purchases.

When considering whether give approval to a forward contract offered to the retailers, the regulator must consider the implications of allowing the retailer to pass through this forward contract price in its retail rates. Specifically, once the retailer signs a significant amount of forward contracts, this will pre-commit wholesalers to be more aggressive competitors in the spot market, which could result in spot electricity prices that are lower than the average forward contract price. If such an event occurs the regulator will come under attack by both consumer groups and politicians for these "ex post" imprudent forward contract purchases, despite the fact that this level of spot prices would not have occurred if the regulator not permitted the retailer to sign in these "high-priced" forward contracts. Conversely if the spot price turns out to be higher than the forward contract price, the regulator also faces the risk of complaints from consumer groups that it failed to engage in a sufficient amount forward contracting for low cost power.

The regulator recognizes that virtually any choice it might make on the forward market will be second-guessed by consumer groups and politicians. For this reason the regulator is extremely reluctant to guarantee the pass-through in retail rates of any forward contract purchases. By delaying all purchases to the short-term spot market, the regulator can avoid being second-guessed for the simple reason that they are no forward contract prices to compare against the spot price. This logic highlights the difficulty of having the regulator purchases spot price insurance on behalf of consumers. Regardless of what choice is made, it will be wrong ex post.

A market with retail competition is able to solve this problem by allowing consumers to choose their desired level of spot price insurance. Each consumer can make their selection about how much to hedge spot price risk through the retail pricing contract they purchase from electricity retailers. Rather than the one-size-fits-all approach to spot price risk management under the monopoly retailer regime, with retail competition consumers can choose their desired level of risk. Each consumer bears the full cost of these hedging decisions.

The other benefit of retail competition is that the least cost mix of forward and spot market purchases is unknown. The best way to learn to the least cost way to perform a task is to run a competitive market with low barriers to entry. Only those firms that can produce at least cost will survive in the industry and consumers will benefit from the lower prices that result from intense competition among firms. Because the barriers to entry into the retail sector are extremely low, retail competition is the best way to learn the optimal wholesale electricity procurement strategy. The primary role of retailers in a wholesale market structure is similar to that of mutual fund managers. Retailers will compete to attract retail customers in the same way that mutual fund managers compete to attract investors. Investors desire the highest return for a given level of market risk. Electricity consumers demand the lowest average price for given level of wholesale price risk.

4.2. The Market Efficiency Enhancing Role of Retail Competition

Combining retail competition with real-time pricing can allow a large retailer to exercise its unilateral market power. Fortunately for consumers, competitive retailers have a different objective function from large generators. Their actions to maximize profits can reduce the average wholesale prices that consumers pay. However, this requires the retailers to charge real-time pricing customers a different real-time price in a given hour than the retailer is actually paying for power in that hour. Specifically, during hours when the aggregate bid supply curve is very steep, a retailer exercising market power charges a price in excess of the price is pays for wholesale power and in hours when the aggregate bid supply curve is flat, a retailer exercising market power charges a price below the wholesale price.

Consider the following two-period example of a single retailer exercising its unilateral market power as a buyer. Suppose this retailer is serving customers on a fixed price retail rate and customers paying a real-time pricing rate. An equivalent assumption is that each customer pays for some quantity of consumption at a fixed price and any remaining consumption at the real-time price.

Let PW_i equal the wholesale price in period i and PR_i the price charged to retail customers on the real-time pricing program in period i. Let $D_i(p)$ equal the demand of real-time pricing customers at price p in period i. Suppose that the retailer commits to guaranteeing that demand served on the real-time pricing contract will provide no marginal contribution to retailer's profits. This imposes the following constraints on the expected profit-maximizing values of PR_i for i=1,2:

$$PR_1 (D_1(PR_1) + PR_2 (D_2(PR_2) = PW_1(D_1(PR_1) + PW_2 (D_2(PR_2), \qquad (1)$$

The total payments by customers facing real-time prices, PR, equals the total payments the retailer makes to the wholesale market to purchase this energy, because PW is wholesale price in that hour that the retailer pays for all its wholesale market purchases.

Suppose the retailer maximize the profits associated with serving customers on fixed retail rates. Let PF equal the fixed retail rate and QF_i the demand for customers facing price the PF in period i. Let $S_i(p)$ equal the aggregative bid supply curve in period i. The profit function for the firm assuming the constraint (1) is:

$$\Pi(PR_1,PR_2) = PF(QF_1 + QF_2) - PW_1 QF_1 - PW_2 QF_2$$

The wholesale price for each period, PW is the solution to $S_i(PW_i) = D_i(PR_i) + QF_i$. This equation implies that PW_i can be expressed as:

$$PW_i = S_i^{-1}(D_i(PR_i) + QF_i),$$

which implies that PW_i is a function of PR_i.

The simple two-period model of choosing PR_i to maximize the retailers expected profits can be illustrated graphically. Figure 1 makes the simplifying assumption that D(p) and S(p) are the same for periods 1 and 2. The only difference is the amount fixed price load the retailer must serve in each period. I assume that $Q_1 < Q_2$. I define P_i as the value of wholesale price in period i if the retailer passively bids in the real-time demand function D(p) in each period. In this figure, PW_i is the wholesale price in period i assuming that the retailer chooses PR_i, the price charged to real-time pricing customers, to maximize daily profits. The large difference in PR_2 and PW_2 shows the tremendous benefit in high demand periods from the retailer exercising its market power. In order to satisfy the constraint that the retailer makes less than or equal to a zero profit from serving real-time pricing load, the retailer must set PR_1 below PW_1. The two lighter shaded areas in the Period 1 and 2 diagrams are equal, illustrating that the constraint (1) given above is satisfied. The large difference between P_2 and PW_2 versus the relatively small difference PW_1 and P_1 illustrates the large reduction in daily average wholesale prices from the retailer using its real-time pricing customers to exercise market power versus simply using their demand curves non-strategically. The darker shaded rectangles in the Period 1 and Period 2 figures, shows profit increase achieved by the retailer as a result of exercising its buying power. Some of the difference between the large dark rectangle in Period 2 and the small dark rectangle in period 1 can be given to the real-time consumers as payment for their price response efforts.

This strategy for retailers to exercise market power extends in a straightforward manner to multiple time periods within the day, week or month. It represents a major source of potential benefits from a competitive retail sector

4.3. Retail Competition for Efficient New Capacity Investments

An additional benefit of the combination of real-time meters with real-time pricing is expansion in the range of economically viable new generating technologies. Specifically, distributed generation technologies that may be low cost to install, but high cost to operate are now much more likely to be financially viable. Finally, by allowing retail competition new generating investment decisions can be driven by consumers preferences. Retail competition allows advocates of renewable or other non-standard or more costly technologies to provide direct financial support to in these technologies.

Roof-top solar panels are an excellent example of a technology that becomes more attractive in a real-time pricing regime. Suppose that the relevant fixed retail price in a region is $0.10/KWh. Unless the average cost of the solar panels or other distributed generation technology is less than $0.10/KWh it makes little economic sense to invest in this technology. With real-time meters and real-time pricing, even though the average real-time price may be less $0.10/KWh, there can be periods when the price is $1.0/KWh or $0.30/KWh. It doesn't take too many hours when the solar panel or distributed generation technology is replacing power that can be sold at these prices before this investment pays for itself. Consequently, a solar panel or other durable but high cost generating technology is a hedge against having to pay very high spot prices. The risk of high spot prices during the hottest hours of the summer when the solar panel is most efficient provides strong incentives for a rational consumer to invest.

Real-time metering and retail competition gives final customers more control over what types of new generating facilities will be built. Specifically, a customer wanting more solar facilities or some other sort renewable technology facility can sign a long-term supply agreement with a competitive retailer that specializes in buying or building the desired renewable energy resource. For example, if a customer want to encourage wind capacity, it can sign long-term a deal that commits a retailer to build a certain amount new wind generation capacity. By allowing consumers the freedom to engage in forward commitments to supply electricity with any retailer the consumer would like, renewable power producers can obtain the promised revenue stream necessary to undertake new this new construction.

4.4. The Economically Efficient Default Provider Rate

A major impediment to sustainable retail competition is that all state PUCs have implemented the default provider obligation as a huge unhedged risk against movements in the spot price of wholesale electricity. The only satisfactory way to solve this problem is to make the default wholesale rate the hourly spot price of electricity and require all retailers to offer this service. Any attempt to set a fixed default retail price that a consumer can switch to at their own discretion is an invitation to create a "California Problem," in the sense that there is a risk the default provider rate is less that the wholesale price of electricity.

Many competitive retailers are likely to go bankrupt when the spot wholesale price of electricity rises and unexpectedly and they are forced to continue to buy on the spot market to meet their fixed-price retail load obligations. If these firms have not sufficiently hedged their fixed-price retail obligations, many will go bankrupt and this will lead to a greater demand for electricity at the default provider rate at precisely that time when the default provider rate is likely to be unprofitable. Any fixed default provider retail rate creates a moral hazard problem for competitive retailers. Their incentive is to take on more wholesale price risk than would be optimal in the absence of this fixed default provider retail rate. The firm that takes on this default provider rate obligation has a potentially huge unhedged risk. If the wholesale electricity prices rises above the fixed wholesale price implicit in the fixed default provider retail rate, there is not much the default provider can do meet its obligation without going bankrupt or having the regulator raise the default provider rate.

The only solution to this problem is to set the default provider rate equal to the hourly spot price of electricity. This is the same default rate faced by all electricity generation units. Unless owners of units enter into forward market agreements, they will receive the hourly spot price for all electricity they deliver in real-time. Similarly, all final customers, including residential and small business customers should have to purchase all of their consumption in each hour at a retail price that reflects the hourly real-time wholesale price plus the relevant transmission and distribution charges. However, all customers should also be able to enter into forward contracts and other forward market hedging agreements with competitive retailers, if they desire, just as generators are permitted to do. No final consumer must purchase any of its energy at the real-time if its is willing to pay to a market-determined price for the spot price risk management services.

Consequently, rather than attempt to create a default provider obligation and have a single firm that must manage the risk of potentially supplying all customers at a previously agreed upon fixed price at any point in the future, the default provider obligation should be a condition imposed on all competitive retailers to offer a real-time pricing plan. This default provider scheme will reduce the incentive for competitive retailers to take on unacceptably high levels of wholesale spot price risk. However, it will not eliminate it. The next section describes a regulatory scheme for state PUCs monitoring of the risk-taking activities of retailers.

5. Role of State Level Regulation Retail Sector

The new wholesale market landscape has created an entirely new sector of the electricity industry–energy trading. Energy trading is a way for market participants to manage the risk of meeting their final demand for electricity from forward, future and spot market purchasing decisions. In a wholesale market, the competitive electricity retailer plays the role of risk manager.

The ability to trade risk among market participants is a large source of potential benefits from electricity re-structuring. In the former vertically integrated monopoly regime all of this risk was assigned to the vertically integrated utility. It managed the risk of delivering electricity to final customers in real-time and then sent the bill for doing this to consumers. In this wholesale market regime risks can be bought and sold. For that reason, we would expects risks to be borne by those entities able to manage this risk at least cost.

As discussed in the previous section, there is still a moral hazard problem in electricity retailing similar to the one that exists in retail banking. The fear in retail banking is that the bank will take customer deposits and invest them in extremely risk assets in an effort to deliver a very favorable return to the investor and the bank's shareholders. However, engaging in this risk-taking behavior may lead to outcomes that render the bank unable to meet certain future obligations to its depositors. An analogous chain of events happens in the electricity retailing industry. The retailer has a strong incentive to under-invest in forward contracts to cover their future load obligations when it sells a fixed-price commitment to a customer for one or two-year period. It maybe able to earn a higher expected return by taking risks that increase the probability of bankruptcy but also have the prospect of very high positive profit levels due to low wholesale prices.

Consequently, similar to the retail banking sector regulation, state PUCs must monitor forward contract coverage requirements of all retailers relative to their forward retail market commitments. If firms are always required to hold a certain amount of fixed-price wholesale market commitments for given amount of fixed-price retail market commitments, then these firms will find it profit-maximizing to honor their retail market commitments.

This market monitoring process should require all retailers to submit to their state PUC on a monthly basis a list their retail market commitments by duration and price and their wholesale market coverage by quantity and price. The role of the PUC would be to verify that the retailer met these risk management prudency standards and assess penalties and sanctions for violations.

Consider the following example of how this might work. The second and third column of Table 1 contains a list of the quantity-weighted average wholesale price implicit in the fixed retail price retail and quantity obligations that the retailer has agreed to supply for various delivery months in the future. The fourth and fifth columns of Table 1 contain the quantity-weighted average fixed wholesale price and quantity commitments the retailer has signed with wholesale energy suppliers. The sixth columns contain the desired percentage of the total monthly quantity of fixed-price wholesale quantity commitments that the state PUC deems that it prudent for the retailer to hold as a hedge against its fixed price retail commitments for each future delivery date. The last column contains the product the percentage in the sixth column and the fixed price retail obligation quantity given in the second column.

In this example there are several horizon where the desired hedge quantity is greater than the amount given in the fourth column. In these instances there are several actions that the state could take. First, it could assess a penalty per MWH on the positive part of difference between desired quantity in the seventh column and the actual quantity in the fourth column. The PUC could also prohibit this retailer from selling more fixed-price retail obligations at this time horizon or shorter until the retailer submits a monthly report that is not out of violation for all months longer than this delivery horizon.

For the case given in Table 1, the first month the retailer is out of compliance is month 4. This means that retailer is prohibited from signing fixed price commitments for deliveries longer than 3 months in the future during the next month unless it submits proof of compliance in the next month for all delivery horizons up to 3 months. There are other prudency standards that state PUCs could impose on hedging behavior of retailers that uses risk measures based on the prices of retail obligation versus the price of wholesale commitments that cover them. Fortunately, these hedging standards do not need to be set using very sophisticated methods in order provide a reasonable level of assurance that all retailers will be able to meet their fixed price retail obligations with a high degree of certainty.

These prudency standards will also provide strong incentives for retailers to attract customers to accept some real-time price risk for some or all of their monthly consumption. Any load that faces the real-time price will reduce the need for the retailer to obtain additional fixed-price forward market commitments energy deliveries as it takes on more customers.

The other role of the state PUC in a competitive retail market is to ensure that all retailers have equal access to the billing and metering services provided by the regulated monopoly local distribution company. The PUC must establish rules that prevent the local distribution company from favoring its competitive retailing affiliate.

The technologies of real-time meter installation, operation, and maintenance imply that the most cost effective strategy for quickly creating a market with ubiquitous real-time meters is to make the provision of metering and data collection services part of the local distribution company's regulated services. The regulated distribution company would formulate jointly with the state PUC an aggressive plan for installation of real-time metering for all customers in the most cost-effective manner possible. At the same time the local distribution company can manage the elimination of meter reading and other jobs associated with manual meter reading and data processing.

6. Real-Time Pricing in the England and Wales Electricity Market

This section summarizes the experience of large industrial and commercial customers in the England and Wales with a real-time pricing. This summary is based on the dataset and analysis in

Patrick and Wolak (1997) which also discusses the specifics of the real-time pricing program studied and econometric estimates of the half-hourly demands of customers on this pricing plan. The focus of this section is to provide empirical evidence on the magnitude of the economic efficiency gains that could be obtained from implementing real-time pricing. With this goal in mind, I show that the level of wholesale price volatility is directly related to and the magnitude of potential consumer benefits from implementing real-time meters and real-time pricing.

The during the England and Wales Pool regime that ended in early 2001, wholesale prices were set on a half-hourly basis by the National Grid Company, the system and market operator. In addition, customers on real-time pricing plans were also charged a demand charge for their usage of energy during the three highest demand half-hours of the fiscal year which runs from April 1 to March 31 of the following year. Therefore the expected price paid each half-hour by customers on the real-time pricing plan is equal to the wholesale price of energy in that hour plus the product of the probability of the demand charge in that hour and the value of the demand charge. Patrick and Wolak (1997) discusses the process used to construct this expected half-hourly purchase price faced by all real-time pricing customers.

There are two ways that a customer can benefit from participating in a real-time pricing program versus a fixed retail price program. Under a fixed price program, all customers, regardless of what their load shape, pay exactly the same average price for all of their consumption. However, a customer with a load shape that is relatively high when the real-time price is low and relatively low when the real-time price is high can achieve a significantly lower electricity bill than it would achieve by paying according a fixed price set equal to the total system demand-weighted average wholesale price. This logic implies that certain fixed load shapes that are different from the average for the entire system would benefit from real-time pricing with no real-time price response effort.

The other way for a customer to benefit from participating in a real-time pricing program is through its ability to adjust its electricity demand throughout the day in response to half-hourly prices. One example of flexibility is a customer that only needs to consume a certain amount energy during the day, and is largely indifferent which period in the day it consumes this energy. This sort of customer can obtain extremely large benefits from real-time pricing by consuming electricity during the half-hours when the market price is the lowest.

Let p_{id} be the real-time price in hour i of day d and q_{kid} the consumption of customer k in hour i of day d. All real-time pricing customers face the same values of p_{id}, however they are free to vary the values of q_{kid} on a half-hourly basis to minimize their annual expenditures on electricity. Let

$$p(time\ ave) = \frac{1}{(24)(365)} \sum_{i=1}^{365} p_{id}$$

denote the unweighted average annual wholesale price for given fiscal year. Let

$$p_k(quantity\ ave) = \frac{\sum_{i=1}^{365} \sum_{d=1}^{24} p_{id} q_{kid}}{\sum_{i=1}^{365} \sum_{d=1}^{24} q_{kid}}$$

be the quantity weighted average price for customer k. Note that p(time ave) does depend on the consumption level of any given market participant. Note that if a customer consumed the same amount of energy in all hours of the year, $q_{kid} = q_{kje}$, for all hours i and j of the day and all days d and e, p_k(quantity ave) would equal the p(time ave). The greater the fraction of annual consumption a customer purchases during low priced hours the lower will be p_k(quantity ave). Note that if most of a customer's consumption takes place in the high priced hours of the year, p_k(quantity ave) will exceed p(time ave).

One measure of the extent to which real-time pricing can benefit final retail customers is the divergence between quantity-weighted average prices across real-time pricing customers. To the extent that customers on real-time pricing plans are indicative of the price-responsiveness that exists in the set of customers currently on fixed-price retail rates, the divergence between quantity-weighted average prices across real-time pricing customers also provides a market of the loss in market efficiency that results from setting fixed retail prices to final consumers.

Table 2 lists the means and standard deviations of the half-hourly prices in £/MWH faced by the customers on the real-time pricing program in the England and Wales electricity market described in Patrick and Wolak (1997) for each fiscal year from April 1, 1991 to March 31, 1995. Figures 2 to 5 plot the half-hourly values of the pool-selling price for each fiscal year. These figures provide a graphical illustration of the tremendous volatility in the wholesale prices across hours in the day.

For each fiscal year and each real-time pricing customer, I computed the value of p_k(quantity ave). Figures 6 to 9 plot a histograms of these customer-level quantity weighted average prices for each fiscal year. There are 370 customers in 1991, 370 in 1992, 603 in 1993 and 431 in 1994. To illustrate the relationship between wholesale price volatility and the benefits of real-time pricing consider the histograms for the 1992 fiscal year and the 1994 fiscal year. Price volatility for the 1992 fiscal year is the lowest of the four fiscal years. Price volatility for the 1994 fiscal year is by far the highest. Range of quantity-weighted average prices for the 1992 fiscal year was 22.32 £/MWH to 28.23 £/MWH. The range of quantity weighted average prices for the 1994 fiscal year was 18.43 £/MWH to 43.20 £/MWH. The other two years had ranges closer to 1994, than 1992.

The fiscal year with significantly higher price volatility shows a much greater range of benefits from real-time pricing, and costs of fixed retail prices.

These quantity weighted average prices are also the annual average wholesale energy costs tp serve each real-time pricing customers. If the price-responsiveness of the real-time pricing customers is representative of the price responsiveness of customers currently on fixed price retail rates, then the average annual cost of providing fixed-price retail energy could differ by almost a two to one ratio for the 1994 fiscal year. This implies very large cross-subsidies currently exist across fixed price retail customers. If we assume that the fixed retail rate is set to cover the total costs of supplying all fixed rate customers, some customers are paying substantially more than the average cost of serving them and others are paying substantially less. As a consequence, many customers are consuming substantially more electricity than they would consume if they faced the true cost their consumption pattern imposed on the system and other would consume much less than they would if they faced the true cost their consumption imposed on the system.

These results also demonstrate that if all customers faced the real-time price as the default pricing plan, many of them would choose to remain on this sort of pricing plan and significantly reduce their monthly bill as a result. This would be particularly true in a market with a substantial amount of wholesale price volatility.

7. Price Volatility in a Competitive Retail Market

The results of previous section show that price volatility is a major source of potential benefits from competitive wholesale markets. Nevertheless, many politicians and policymakers have complained about the tremendous price volatility that exists in wholesale electricity markets. Price caps and bid caps have been proposed to control this price volatility. These concerns about price volatility are misplaced in market with ubiquitous real-time meters and retail competition with the real-time pricing as the default pricing plan. Occasional price spikes are necessary to cause consumers to shift their demand away from high-priced hours of the day and market the necessary investments in price responsive technologies. This section makes this point.

A regime with virtually all customers facing a fixed retail price yields an hourly demand for electricity that is inelastic with respect to changes in the hourly wholesale price of electricity. Generators bidding into the market account for this inelastic hourly demand when they formulate their bids to supply electricity. As a consequence, they bid substantially steeper bid curves than they would if they faced an elastic hourly aggregate demand. These bid curves result in a substantially higher average price and more volatile prices. Figure 10 provides graphical illustration of this point. For the same change in demand from Q_L to Q_H, the resulting market price is higher on average for the steeper supply curve, $S_1(p)$, relative to the flatter supply curve $S_2(p)$. Moreover, the range of prices for the steeper curve is must greater than for the flatter curve.

If all generators know that they face a price-responsive hourly demand for electricity, each firm will find it expected profit-maximizing to bid flatter supply schedules, which will result in a flatter aggregate supply schedule and lower average prices and a less volatile prices for given range of aggregate demand. Conversely, a less price responsive aggregate demand curve will result in a steeper aggregate supply schedule and higher average prices and a more volatile prices.

In a competitive retail market with universal real-time meters and a default of the real-time pricing, consumers are forced to account for this relationship between the half-hourly aggregate demand elasticity and average prices and price volatility. If they wish to avoid this price volatility then they can sign up for a fixed-price retail contract offered by a retailer. However, this fixed-price retail contract will contain a risk premium relative to the average expected spot price. This risk premium will greater in more volatile markets because a generator gives up significantly more up-side profit potential from high prices in a market with a significant amount of price volatility versus one with less price volatility, and should be unwilling to sell a retailer a fixed-price forward contract unless he is compensated for these forgone opportunities in the agreed upon fixed price.

Consequently, this level of wholesale price volatility is endogenously determined by three factors: (1) the amount of forward contracts to supply electricity that generators have sold, (2) the amount of final demand that purchases electricity according to the hourly spot price, and (3) the amount of excess capacity that exists in the market. Although holding a significant amount of excess generating capacity can reduce spot price volatility, this is not without a cost. For excess this capacity to remain in the market, its owners must be paid a return on their investment. A far cheaper way to reduce wholesale price volatility is simply to treat final consumers in the same manner as generators. They must have hourly meters installed to record their hourly consumption. They must face the hourly wholesale price as the default for all of their hourly consumption unless they take actions on the forward market to hedge this spot price risk.

Under these conditions in the retail market, price volatility will serve the dual role of encouraging forward market hedging of wholesale price risk by competitive retailers and encouraging customers facing on the real-time price risk for some or all of their consumption to reduce their demand during high priced periods. This demand responsiveness allows the market to serve the same number of customers, but with less capacity because price can be used to reduce demand and therefore render unnecessary a new peaking generating facility. Both more forward market hedging of spot price risk and more customers facing the real-time price for some or all their consumption will also cause generators to bid flatter supply curves into the wholesale market and therefore result in lower and less volatile wholesale prices. The resulting more efficient utilization of existing generating capacity implies lower capital costs for the market at large, which implies lower average wholesale prices. Note that a key determinant of these lower average prices is extremely high wholesale prices during certain time periods so that price-responsive demand will decide to consume less and thus eliminate the need to invest in a peaking facility.

To provide a quantitative assessment of the potential benefits of using hourly wholesale prices to smooth load throughout the year, consider the California electricity market. Take the total amount of energy consumed in the California ISO control area during 2000 of 238,723,261 MWh and divide by 8784, the total number of hours in that year. This yields an average number of MWs of capacity used each hour of the year of 27,177. This calculation implies that a steady use of 27,177 MW of capacity every hour of the year would yield amount of electricity produced in 2000. The total amount of instate capacity in California is approximately 45,000 MW and the peak demand during 2000 was nearly 44,000 MW. To the extent that hourly prices could be used to reduce peak demands, this would allow California to serve the same number of consumers without having to construct new capacity and keep average electricity prices over the year as low as possible.

8. A Solution for California

This section adapts the retail infrastructure in this paper to deal with California's current problems. California faces two problems that are not present in other markets considering re-structuring. First, the state has a large accumulated debt due to the enormous run-up in wholesale prices during a period with fixed retail rates. Second, the California Department of Water Resources (CDWR) entered into a number of fixed-price contracts of ten or more years of duration at prices that are vastly in excess of expected spot prices for the foreseeable future.

The state found it necessary to sign these forward contracts during the winter of 2001 in order to guarantee sufficient supply of electricity during the summer of 2001. FERC steadfastly refused to enforce the just and reasonable rate provision of the Federal Power Act of 1935 throughout the entire period May 2000 to May 2001, so the only way the state could procure a reliable supply of electricity for the summer of 2001 was to sign long-duration forward contracts that trade off cheap energy in the future for very expensive energy during the summer of 2001 due to the exercise of market power by generators serving the California electricity market. Borenstein, Bushnell and Wolak (2001) provides a detailed analysis of the extent of market power exercised in the California electricity market over this time period.

Despite these financial obligations, the state should not delay the introduction of retail competition and vertical separation of the three investor-owned utilities. The state should first order the vertical separation of each of the three investor-owned utilities into a regulated local distribution company and a unregulated competitive retailer. Any generation assets owned by one of the three utilities should be retained in a separate company regulated by the California PUC or sold at auction. Unless the unregulated affiliate of the investor-owned utility pays California ratepayers a market determined price for the assets owned by its regulated affiliate, the parent company should not be allowed to retain ownership of any generation assets in an unregulated affiliate. These assets were purchased by California ratepayers under the regulated market structure and operated by the investor-owned utilities. As the owners of these assets, California consumers are therefore entitled to the market value of these assets. Therefore any revenues earned from the sales of these assets should be used to pay down the accumulated debts of California ratepayers. Alternatively the assets could be retained in a separate affiliate regulated by the California PUC for the benefit of California consumers.

Once this vertical separation has taken place, the California PUC should order the immediate installation of real-time metering technology for all customers served by these local distribution companies. The installation of these meters should be done through a competitive bidding process and the installation cost should be included in the rate base of the newly formed regulated local distribution company.

Once the program for the installation of real-time metering technology has been initiated, retail competition should be introduced for any customer with a real-time meter in place. Only those customers with interval meters would be eligible for retail competition. A real-time meter must be a pre-condition for eligibility for retail choice.

In order to pay off the accumulated debts associated with past and future unjust and unreasonable wholesale prices paid or to be paid by California consumers due to FERC's failure to enforce the Federal Power Act, the California PUC should introduce a per unit surcharge to the bill of all customers with a real-time meter. This surcharge should be set high enough to recover the California's accumulated debt in a finite time period, but not too high as to punish customers for installing a real-time meter. Given that the average retail price in California is close to 13 cents/kWh and the current average spot wholesale price of electricity is less than half this value, a 2 to 3 cents/kWh charge would accomplish both goals.

As real-time metering technology spread throughout California, and more customers were eligible for retail choice, the state of California would no longer need to buy as much power on behalf of California consumers. The competitive retail sector, regulated as described in Section 5, could take over this task. To facilitate this process, CDWR could hold periodic auctions for its stock of forward contract holdings to be sold to competitive retailers and other wholesale market participants. Any difference between the purchase price of the forward contract by the state and sales price to a third party would then go to pay off the accumulated debt. The state could decide how much of these contracts to put up for sale in consultation with the PUC and the competitive retail sector. Through this process the state could eventually sell off all its forward contracts to the competitive retail sector.

Because of the extremely high prices paid by the state for these contracts necessitated by FERC's inaction during the winter of 2000-2001, I would expect that for some contracts competitive retailers would instead have to be paid to take on these obligations. In these instances, firms would bid negative prices rather than positive prices, meaning they are bidding for how much the state must pay them to take on this contractual obligation. Any payments by the state would then be added to the accumulated debt to be paid off with the 2 to 3 cents/KWh charge on the bill of all customers.

Once all of the contracts have been sold to competitive retailers, the 2 to 3 cents/KWh charge would remain on the bill of all customers until California's accumulated debt has been paid off. This scheme would allow the state to pay off its accumulated debt as rapidly as possible, keep the costs of May 2000 to May 2001 and the high-priced forward contracts signed by the state to a minimum, and provide California consumers with the full benefits of retail competition as soon as possible.

9. Concluding Comments on the Necessity Retail Competition

Wholesale competition in electricity supply can benefit consumers. I have argued that this is unlikely to occur unless there is open-access retail competition with ubiquitous real-time metering and symmetric treatment of producers and final consumers electricity. That is because competition can only benefit consumers if it provides superior incentives to the former vertically integrated monopoly regime for efficient production, investment, consumption and risk management.

All existing electricity markets in the US have failed to introduce the necessary demand-side incentives for setting the lowest possible prices for wholesale electricity consistent with the long-term financial viability of the industry. In the name of protecting financial consumers, state PUCs have denied consumers the ability to benefit from being active participants in the spot market. By handicapping the demand side of the market the PUCs are only increasing the likelihood that wholesale suppliers will be able to raise prices through their own unilateral bidding and scheduling behavior.

Final consumers must bear the full cost of high wholesale prices and have the ability to realize the full benefits from taking actions in the forward and spot markets to respond to these high prices. Investments in hedging instruments and demand-responsiveness technology will then lead to a more competitive wholesale market that will, in turn, lead to lower average prices than the former vertically integrated monopoly regime when final demand was a passive participant in the wholesale market.

The well-known dictum of "there's no such thing as a free lunch" applies to the case of introducing competition into a formerly regulated industry. Unless competition changes the behavior of some market participants, it cannot benefit consumers relative to the former monopoly regime. For example, if generation unit owners continue to produce the same amount of electricity in the same manner as they did under the former monopoly regime and all input costs for all companies remain the same, then total production costs will not change. Similarly if consumers continue to demand the same amount of electricity in each hour of the year their annual electricity bills cannot decrease.

Only by providing incentives for more efficient operation of generating facilities and more efficient consumption signals can a market result in lower annual average prices than under the former monopoly regime. The retail market infrastructure presented in this paper providers the strong possible incentives for both consumers and producers to alter their behavior reduce the cost of producing wholesale electricity and making most efficient use of the generating capacity that currently exists.

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Table 1: Sample Monthly Forward Contract Filing						
	Retail Obligations		Wholesale Purchases		Compliance Levels	
Future Delivery Date for Energy (months)	Total Quantity (MWH)	Average Implicit Wholesale Price ($/MWH)	Total Quantity (MWH)	Average Purchase Price ($/MWH)	Hedge Factor (%)	Desired Hedge Quantity (MWH)
1	10000	44.56	9400	40.12	90	9000
2	10000	45.60	9400	45.00	90	9000
3	10000	42.00	9600	40.21	90	9000
4	12000	50.00	9800	49.00	85	10200
5	13000	54.00	8600	52.00	85	11050
6	11000	51.00	8000	50.12	80	8800
12	10000	48.00	8000	45.29	80	8000
18	10000	44.23	8000	39.56	75	7500
24	12000	44.00	8000	42.03	70	8400

Table 2: Sample Means, Standard Deviation, Maximum and Minimum By Fiscal Year of Expected Real Time Prices for England and Wales Market				
Fiscal Year	Mean (£/MWh)	Standard Deviation	Maximum (£/MWh)	Minimum (£/MWh)
1991/92	23.07	22.13	857.12	0
1992/93	24.78	11.33	363.64	0
1993/94	27.94	27.89	927.15	0
1994/95	28.02	50.00	1389.06	0

Figure 1

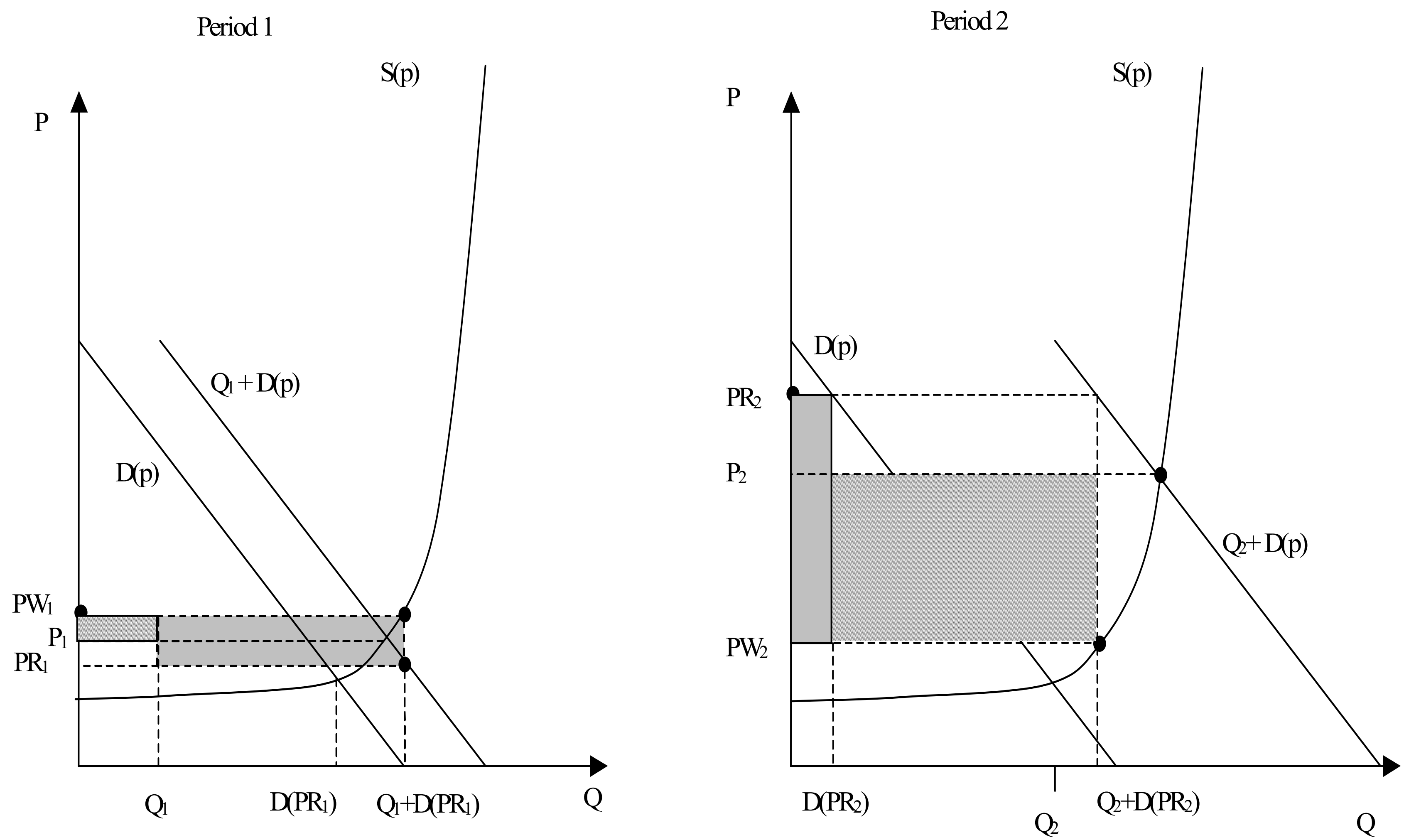
Period 1
S(p)
P
$Q_1 + D(p)$
D(p)
PW_1
P_1
PR_1
Q_1
$D(PR_1)$
$Q_1+D(PR_1)$
Q
Period 2
S(p)
P
D(p)
PR_2
P_2
$Q_2+ D(p)$
PW_2
$D(PR_2)$
Q_2
$Q_2+D(PR_2)$
Q

Figure 2

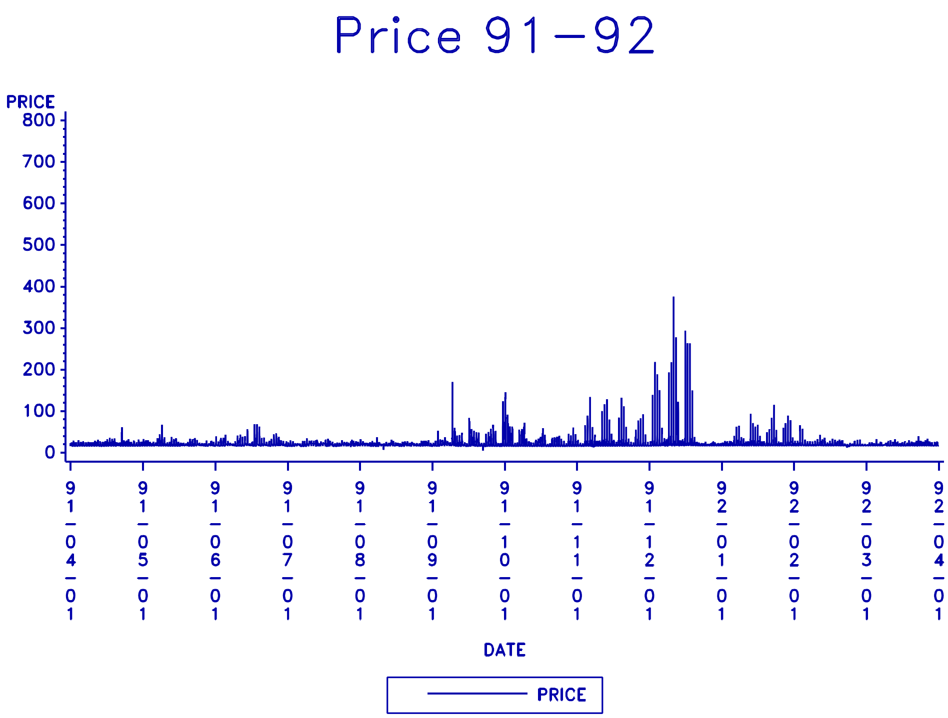

Figure 3

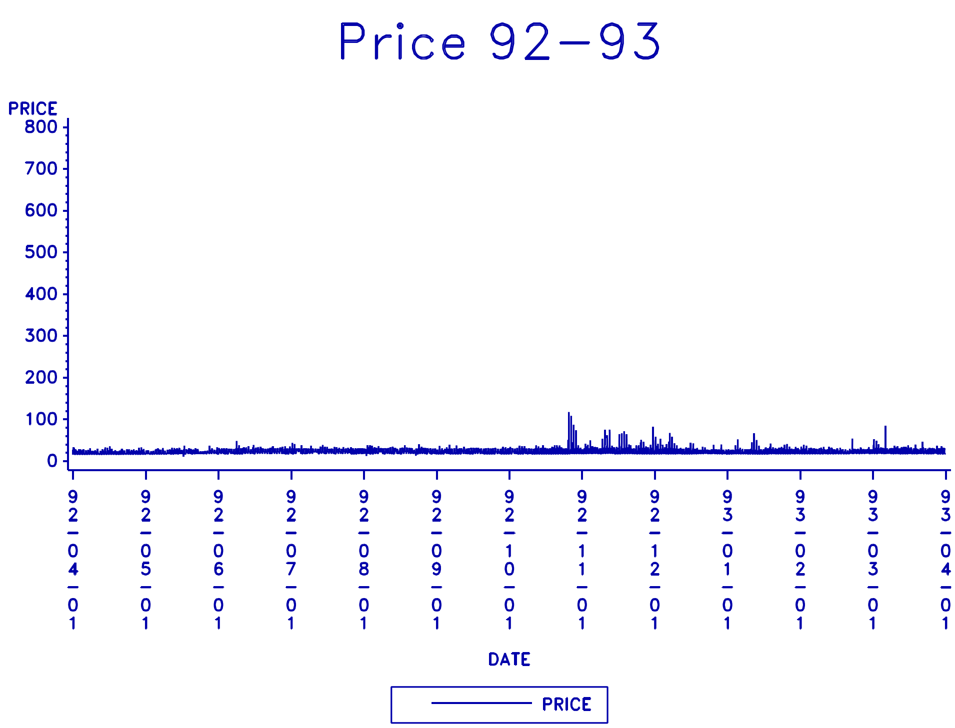

Figure 4

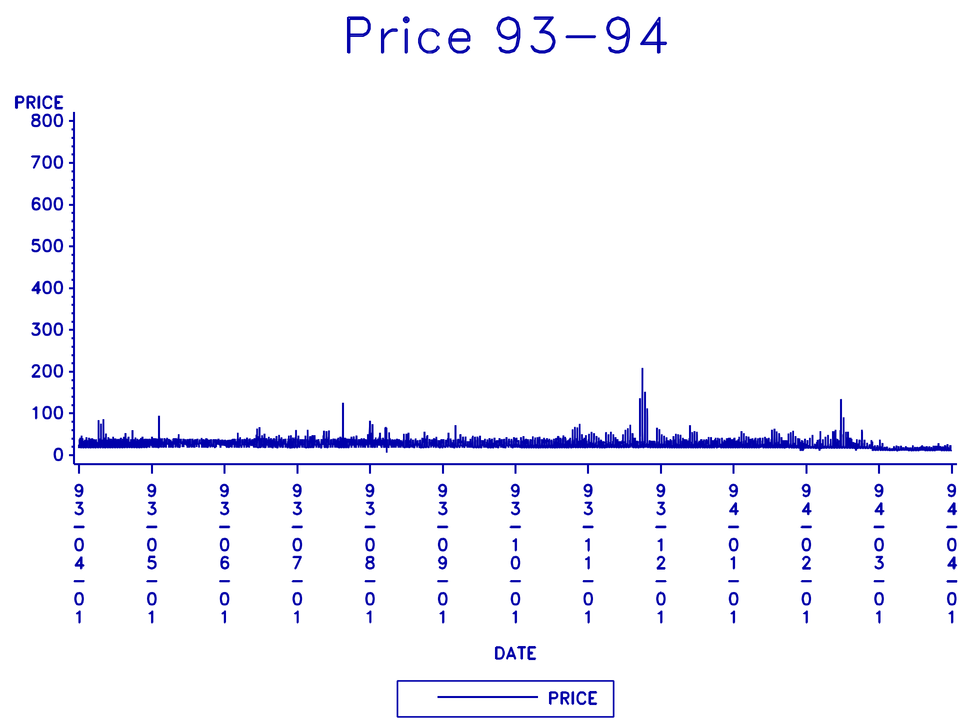

Figure 5

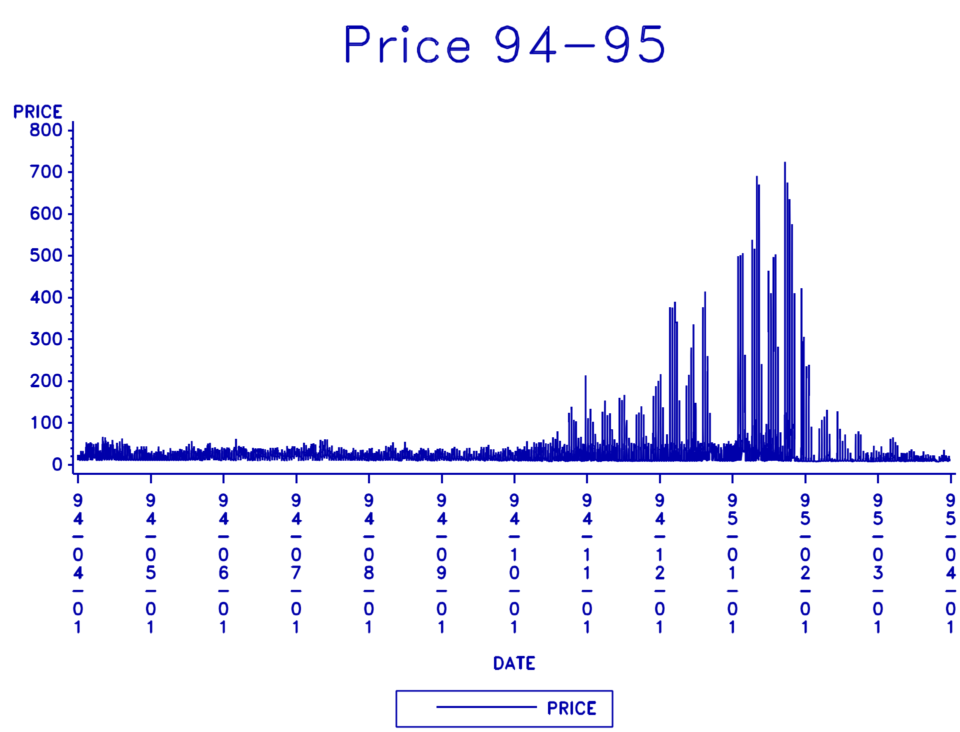

Figure 6

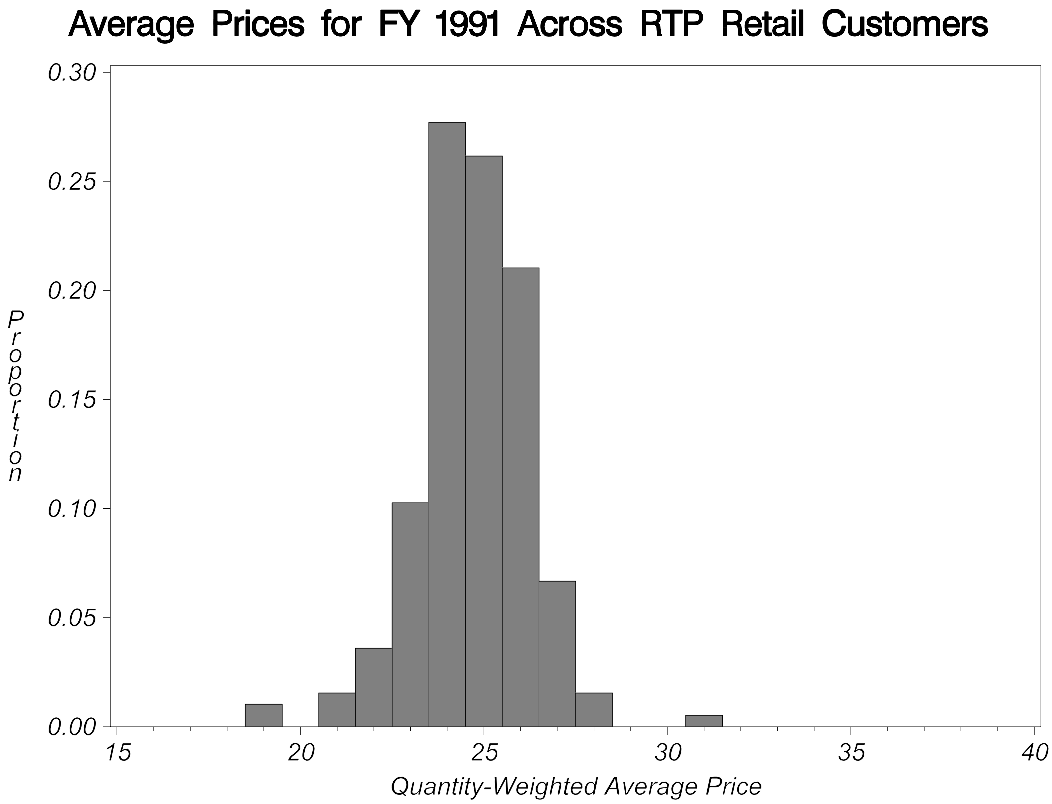

Figure 7

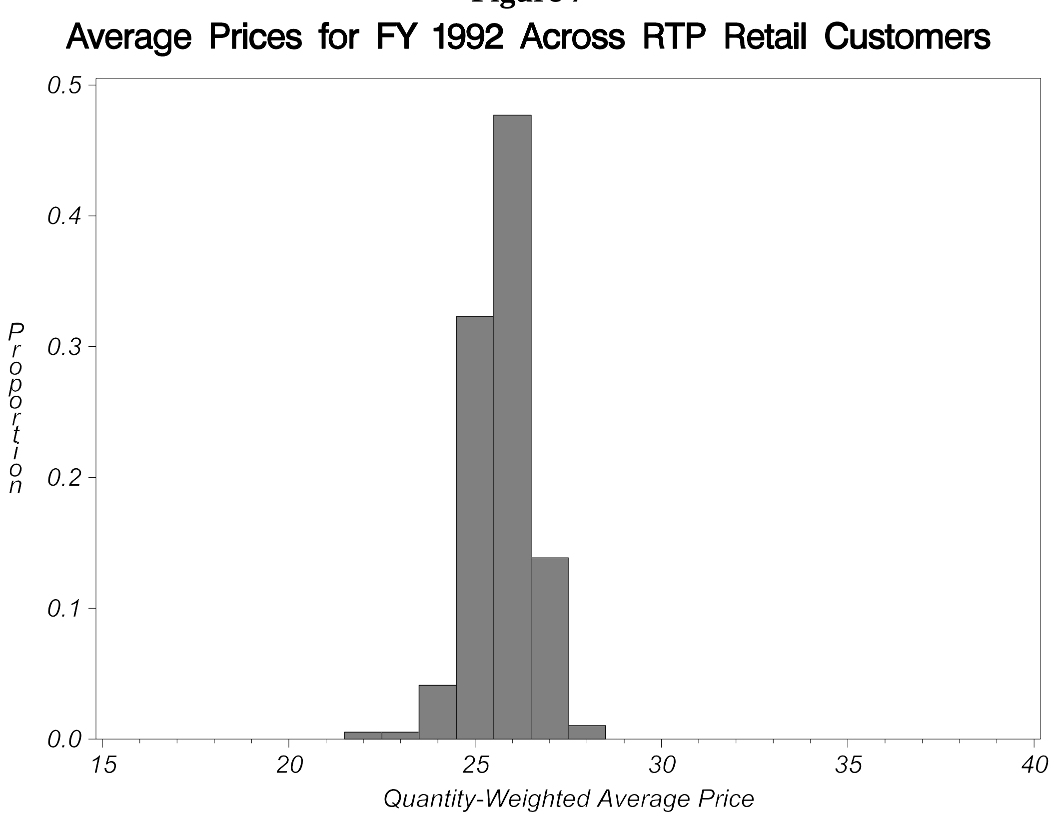

Figure 8

Average Prices for FY 1993 Across RTP Retail Customers

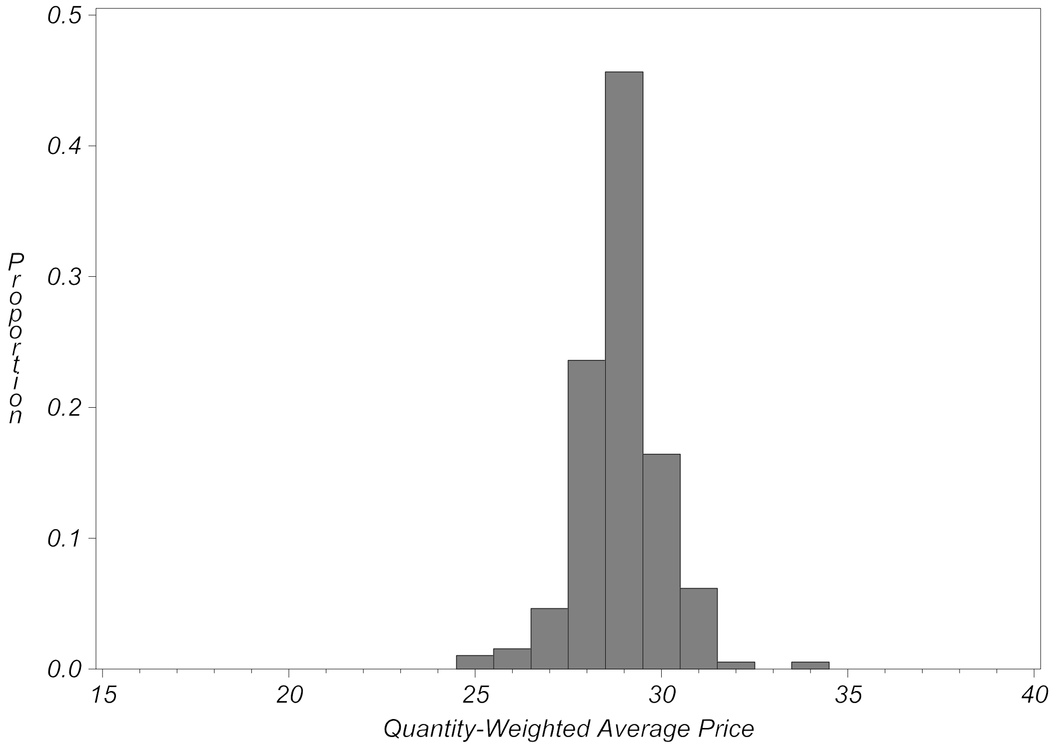

Figure 9

Average Prices for FY 1994 Across RTP Retail Customers

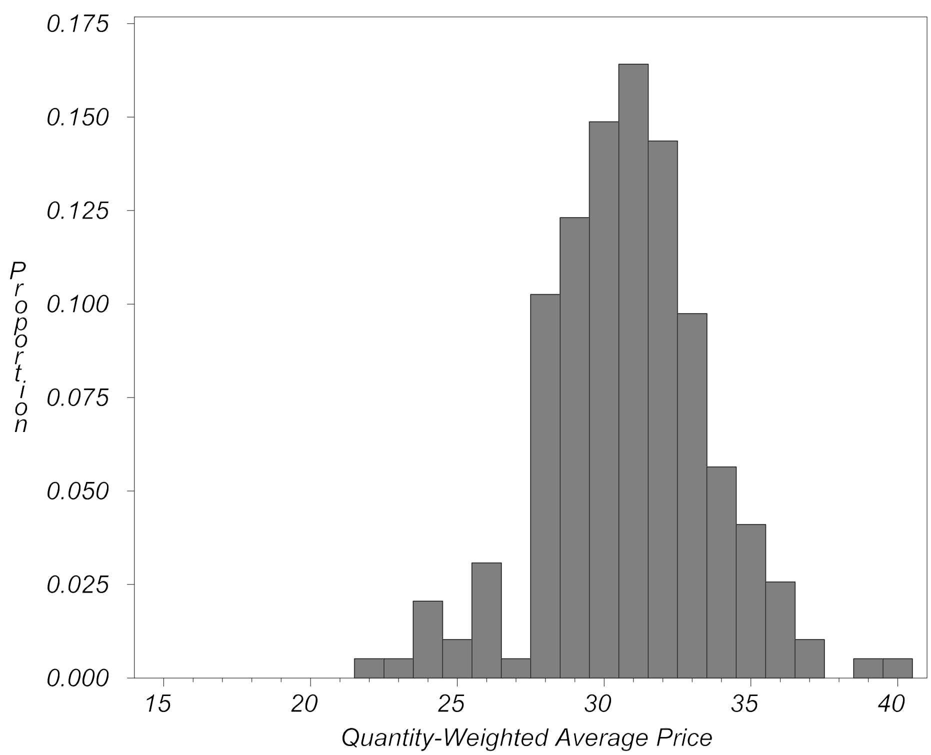

Figure 10