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THE NATURE OF SUPPLY BIDDING IN PENNSYLVANIA ELECTRICITY MARKETS

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Abstract

The nature of bidding for supply contracts in electricity markets is not well-understood. In particular, it is not clear what drives the number of bidders or the winning bid price. Though many jurisdictions worldwide have restructured their electricity markets, the only research on this topic is Hattori (Energy Economics, 2010), which only deals with the number of bidders for particular contracts in Japanese electricity markets. This paper analyzes competition in the scope of Pennsylvania's electricity market, which is among the most deregulated in the U.S., both at the wholesale and more recently retail levels.

Specifically, this paper examines what factors impact the number of bidders and the price of the winning bid in the Pennsylvania Power and Light territory, using data from the Penn State Facilities Engineering Institute (PSFEI), which acts as a technical advisor for a large number of state agencies and private entities. The data provides the base for an analysis of the effect that both wholesale and retail competition had on the contract bidding process within the state, and whether each type of competition had a significant impact on the number and level of bids. Using similar controls to those employed by Hattori on demand levels, contract length and regional characteristics, this analysis shows that electric suppliers value the level of consumer demand, the future cost of serving electricity, and the type of bid allowed when constructing their bid prices . There is, however, little to no competition between suppliers on most of the contracts, which may be a consequence of the deregulation process in Pennsylvania and/or simply due to the preliminary nature of PSFEI's hosting of the bidding events. Additional analysis should investigate the issue of competition as more suppliers become aware of and participate in the events in the future.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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Chapter 1

History of U.S. Electricity Markets

It is no secret that electricity is an integral element of modern society, and up until the era of deregulation of electricity markets, consumers did not seem to pay much mind to the industry. Arguably, that is still the case, but as deregulation of markets has unfolded, consumers are slowly being awakened to the issue and encouraged to consider switching electric providers.

Era of Regulated Electricity Markets

Basic economics says that the interaction of producers and consumers sets the equilibrium quantity and value of products, and ideally, competition between firms ensures that an efficient price reflecting the value of the product is achieved. That is the goal, but not always the case. In the 1880s, electricity in the U.S. began as a sort of free market, where a large number of suppliers competed to serve customers. But by the early 1900s, suppliers argued for regulation of the market, claiming to be confronting "ruinous" competition that only resulted in poor service for customers and no guarantee of protection from high prices (Lave et. al, 2004). Moreover, after 1896 the former direct current transmission line industry gave way to alternating current lines, which allowed suppliers to serve power over longer distances (VanDoren 2000), a both more costly but effective way of delivering and exercising market power. Suppliers who were able to build and buy up enough smaller transmission lines to serve power over expansive areas became, essentially, natural monopolies. Distribution lines exhibit similar characteristics in that the costs of connecting a distribution line network as a whole to the transmission line are less than those needed to connect each new customer directly to a transmission line; it would be difficult, for example, to install a step-down transformer for each new customer's connection point.

The resulting system after the 1890s essentially turned vertically integrated companies into regulated natural monopolies. Those companies owning electric generation, transmission and distribution capacity were granted exclusive service over certain territories—generally, state by state—if they agreed to serve power at low prices. In exchange, they were allowed guaranteed rates of return that were high enough to attract capital, which were based on the utility's cost of service and planned future investments (Slocum 2007).

While this system seemed to work until the 1970s, utilities abused their power through powerful influence over policymakers and increasing rates for consumers (Slocum 2007). Desiring to increase their rates of return, and in response to Alternative Energy Portfolio Standards (AEPS) mandated by the Public Utility Regulatory Policy Act (PURPA) in 1978, they made high-cost investments in nuclear power plants that were supposed to provide cheap, clean electricity. Ultimately, however, the cost overruns manifested themselves in higher overall rates for consumers (VanDoren 2000). Rates were generally based on average costs rather than marginal costs of the utility, so consumers were either over- or underpaying for their electricity, depending on the time of year; in either case, they did not know (Blumsack et. al, 2009). Utilities also enjoyed exclusive control over their region's transmission lines, so even if a buyer wanted to purchase electricity from another supplier, that supplier would have to use the lines of the incumbent utility, who could deny access and force the alternative supplier to buy its higher priced power (U.S. Department of Energy).

Further, regulators generally lacked either business or technological expertise. Lave et. al (2004) notes that half of regulators were generally lawyers and did not understand the technical details or the justifications for the utility's cost allocations to various customer classes. Utilities were charging residential and commercial customers inflated rates in order to offer industrial customers (the largest electric consumers and sources of revenue) more favorable prices (Blumsack et. al, 2009). This problem of cross-subsidization worsened as increased electric demand throughout the 1960s required larger power plants to be built. These plants, as a result of efficiency measures after the Arab Oil Embargo of the 1970s, were generally more expensive coal and nuclear plants (U.S. D.O.E.), and ultimately, end-users were completely unprotected from high rates.

Transition to Deregulated Markets

Responding to customer complaints about high rates and pressure from those looking to make huge gains in the electric industry, the Federal Energy Reliability Commission (FERC) began to take a more aggressive approach to deregulation of the electric market. Relying on its experience in previously deregulating the natural gas market in the 1980s, it issued Order 888 in 1996 to promote competition, opening the door to independent power producers (Slocum 2007). Some industrial customers had already started to contract a limited number of independent power producers to avoid high utility rates (Blumsack, et. al, 2009), but not to the scale that was allowed by Order 888.

Deregulation was intended to create a competitive market with real choice of suppliers, which would result in lower prices and encourage new products and services ("National Energy Marketers Association"). These new regulations aimed to foster competition specifically at the generation level, as utilities were forced to unbundle their generation from transmission and distribution assets to allow supply generators to compete and offer electricity based on marginal costs. Generators with the lowest costs were to be dispatched first, and then electricity was to be delivered over transmission lines that were allowed to remain partial monopolies due to the nature of the assets. In the three years following FERC Order 888, 24 states forced unbundling of utilities' generation assets and in response to grid reliability concerns (problems in California) FERC passed order 2000 to create Regional Transmission Organizers (RTOs) to ensure safe, reliable, and nondiscriminatory operation of transmission networks (Slocum 2007).

Today in the U.S. there are seven RTOs that cover multiple states, some of which have deregulated their electricity markets. After the energy crisis in California, many states in the

West and Southeast repealed or postponed their deregulation. One of the first states to deregulate is Pennsylvania, the focus of this research paper.

Deregulation in Pennsylvania

After the passing of various FERC orders, states adopted their own regulatory regimes and further extended deregulation into the retail electric markets. Pennsylvania was one of the first, and responded with the Pennsylvania Electricity Generation Choice and Competition Act of 1996, which made incumbent utilities the owners of regional distribution networks; they were charged with delivering electricity to consumers, who were now able to choose their electric supply company. A region's "electric distribution company" (EDC) was also responsible for maintaining the distribution system and to serve as the "default" supplier for end users who did not actively switch to an alternative supplier ("Philadelphia Business Journal"). So, for example, PPL would be the default provider and be responsible for distributing electricity in the light blue shaded areas on the map below, which outlines active utilities in Pennsylvania.

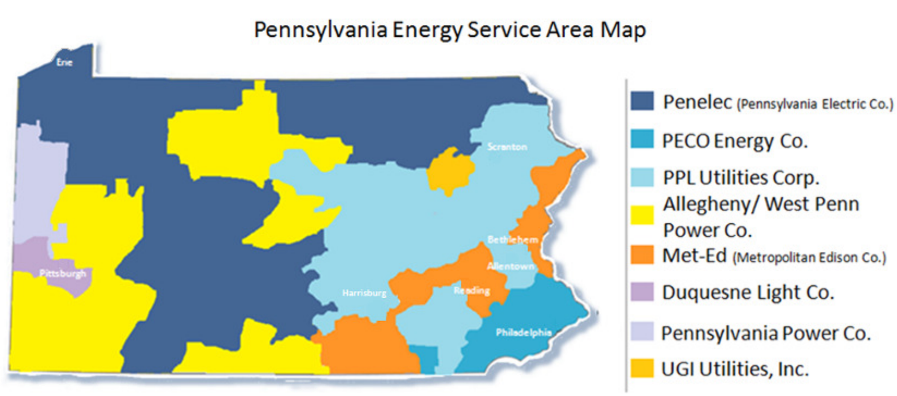

Figure 1: Utility territories in Pennsylvania

Customers that do not choose an alternative supplier or customers in places where third-party suppliers have not entered the market are dealt the default rates set by the Pennsylvania

Utility Commission (PUC). These rate caps were based on the incumbent utility's generation or expected power purchase costs and are calculated in much the same way that rate bases were under regulation (Blumsack et. al, 2009). The reasons for these rate caps were to allow EDCs to recover their stranded costs over a specified period of time, and to prevent the incumbent utility from exploiting its established market position and resources (Blumsack et. al, 2009). The goal was to make the rate cap high enough so that other suppliers would enter the market to compete against this "price to beat." Some states, notably Texas, set very high default rates to get competitors to enter the market, and saw a lot of success in retail competition and cost savings for customers (Kiesling 2009).

Pennsylvania, however, set its rate caps in the late 1990s when prices were low so that customers would benefit if prices rose. Since prices *did* rise, many competitive suppliers were forced out of the market before the rate caps expired. Moreover, regulators allowed the caps to last for a long period of time (12 years), so customers had the potential to face abrupt price increases once the rate caps were lifted, and the prices then reflected the new market environment, different from that when the rate caps were implemented (Blumsack et. al, 2009). Chen (2005) writes that this transition period was made to be so long because it was thought that a longer transition time would result in higher rates of customer switching to competitive suppliers, which the PUC requires as an indicator of adequate competition. Price should rather be used as a better indictor of competition, but it was thought that, overall, switching would be more prevalent if customers had more time to become aware of their opportunities to switch.

Table 1: Electric retail rates in cents/kilowatt hour as of Sept 15, 2010

	Residential	Commercial	Industrial
U.S.	11.32	10.03	6.65
Pennsylvania	12.58	10.11	7.59
Mid-Atlantic States	15.42	13.61	8.34

Source: U.S. Energy Information Administration

Since deregulation, overall electric prices across Pennsylvania have not necessarily decreased, but they have decreased relative to national averages. Before the Pennsylvania Electricity Generation Choice and Competition Act, Pennsylvania prices were 15 percent above the national average; and as of September 2010, prices were still above the national average but substantially lower than those of other Mid-Atlantic states.

However, the positive effects of deregulation are still in question. A study done by Rose (2006) conducted for the Virginia Corporation Commission notes:

> "The evidence suggests that, at least so far, no discernable benefit can be seen for customers in restructured states once the rate caps have expired. Increasingly the evidence is beginning to now suggest that prices for customers in restructured states may actually be increasing faster than for customers in states that did not restructure."

Either way, it has been presumed that Pennsylvania is heading down a favorable deregulatory track, and not like that of California. At the beginning of 2009, Pennsylvania had 45 electric generation suppliers statewide, and by early 2010, 85 suppliers existed, with more applications pending (Benedetto). One might argue, though, that despite the increase in the number of competitors in the market, the actual competition among them could have been better: looking at the table below, most utility rates for residential customers *increased* after the expiration of rate caps, despite more competitors. However, since almost all competitors increased their prices, there may indeed have been competition during the rate-capped period, because most suppliers behaved similarly in the new market conditions and adjusted their prices accordingly. Without competition during the rate-capped period (and after), prices very well may have been much higher once the caps expired.

Table 2: Generation Rate Caps in Pennsylvania by Utility

Utility	Rate Cap expiration	Residential rate under rate cap	Residential rate after expiration	% Change	Rates as of Oct 2010	% Change
Wellsboro Electric Co.	1/1/99	$45	$57	26.6%	$60	5.3%
Citizens' Electric Co.	1/1/99	$38	$52	36.80%	$56	7.7%
Duquesne Light Co.	12/31/01	$63	$54	-14.30%	$72	33.3%
Pike County Light & Power Co.	12/31/05	$56	$97	73%	$73	-24.7%
UGI Utilities Inc.	12/31/06	$42	$56	33.30%	$71	26.8%
Pennsylvania Power Co.	12/31/06	$60	$81	35%	$73	-9.9%
PPL Electric Utilities Inc.	12/31/09	$48	$73	52%	$71 (est. for 2011)	-2.7%
PECO	12/31/10	$70	$68	-2.80%	$72	5.9%
Pennsylvania Electric Co.	12/31/10	$43	$56	30.20%	$67	19.6%
Metropolitan Edison Co.	12/31/10	$47	$64	36.10%	$70	9.4%
Allegheny Power Co.	12/31/10	$36	$49	36.10%	$51	4.1%

Source: Pennsylvania PUC presentation, "National Energy Marketers Association: Fall Leadership Roundtable"

But the customer fear of uncertainty and of higher prices did lead to a degree of switching in Pennsylvania. As of October 2010, generation rate caps had expired for 40 percent of customers, and over 650,000 people had switched electric providers—the bulk of which took place in the Pennsylvania Power and Light (PPL) territory ("National Energy Marketers Association"). Blumsack et. al (2009) provides further reasons why switching rates among residential customers were not quite as high: residential customers have homogeneous demand for electricity in that they do not require differing, specific voltage or reliability standards like industrial customers, so generally, suppliers cannot differentiate themselves on more than just price. Also, customers spend less than 2 percent of their income on electricity, which does not represent a large enough portion to provide an incentive to explore other supplier options. Surprisingly, though, large commercial customers also demonstrated low switching levels, perhaps also because they do not require different voltage levels, etc. like industrial customers.

Pennsylvania has some of the lowest load served by competitive suppliers, especially when we compare industrial load from state to state. Looking at the figure based on Rose (2006) below, Pennsylvania industrial load has the lowest competition at 10 percent for industrial customers, while Texas has over 80 percent. Most states other than Texas seem to still struggle with competitive retail suppliers, as Pennsylvania has an about average percentage of load served by competitive suppliers, relative to other deregulated states.

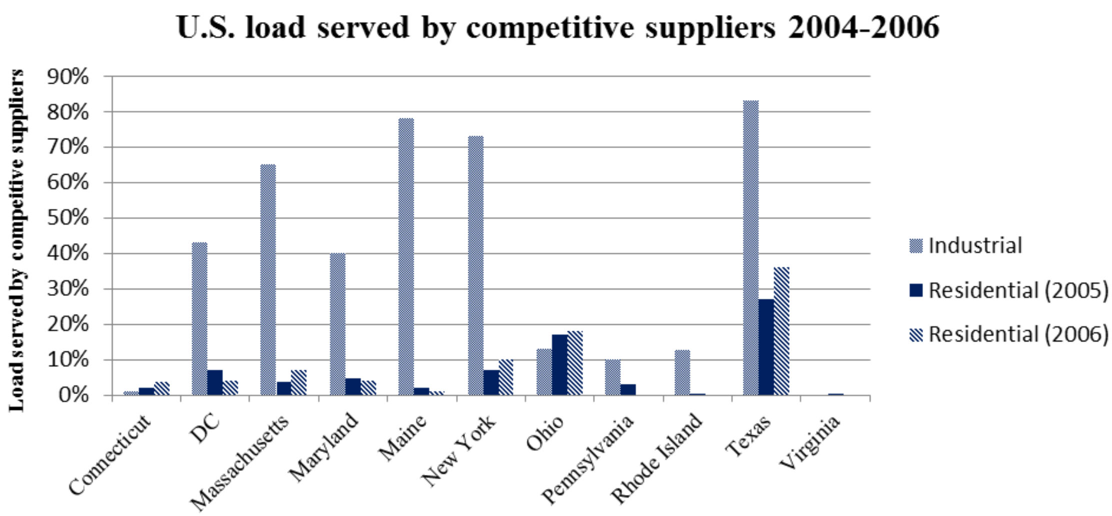

Figure 2: Rose (2006), U.S. industrial and residential load served by competitive suppliers

In many cases, though, it is still surprising that some states have such low industrial swithcing rates, even though *they* were supposed to benefit primarily from deregulation. However, many industrial customers had already benefited from cross-subsidization under regulated markets and then signed long-term contracts a year or two before deregulation was to begin. It is also interesting that Pennsylvania's switching rates are so low, although Pennsylvania customers are given the most freedom with switching electric suppliers. While some states only allow customers to switch suppliers once within a certain time period without penalty, Pennsylvania customers may do so as often as they like, but may be subject to early termination fees (Blumsack 2009). However, Chen (2005) suggests that the number of customers switching is not an accurate metric for determining the success or failure of restructuring. Some regulatory regimes set artificially high "prices to compare" in order to achieve high switching rates, but perhaps it is more important to analyze reductions in price in order to determine the effectiveness of a restructuring policy. He does note though, that for high-cost utilities, higher prices to compare attract more competition.

Deregulation in Other Parts of the World

The U.S. was not the first to deregulate its electricity markets. Chile is credited with first introducing retail competition in 1982 for its transparency in prices but has since then had various energy crises due to market design (Hall et. al, 2009).

Ontario, Canada's largest providence, faced problems to the scale that California experienced, closing its restructured markets only six months after their opening in May 2002. While a Market Surveillance Panel of the IMO concluded that abusive market power was not the agitator, Trebilcock et. al (2005) blames various market design elements, such as reduced domestic generation capacity, limited import capacity in the face of growing reliance on electric imports, and extreme temperatures that forced prices so high that the government imposed price caps for low volume customers (even for those that had fixed-price contracts). The effect of these price caps resulted in a lack of incentives for new generation and transmission investments by the private sector in addition to extraordinary financial obligations by the providence.

Europe has experienced mixed results from opening retail competition. Blumsack et. al (2009) discusses some of the retail restructuring undertaken in Europe, noting that industrial customers exhibit the highest switching rates to competitive suppliers. Finland, Sweden and the UK exhibit the highest switching at around 75 percent, and France and Spain the lowest at 25 percent and 15 percent, respectively, although they were some of the earliest restructurers in Europe. Competition on the residential side was, like in the U.S., a lot lower, with Germany only having around 5 percent switching.

The Japanese market was partially deregulated in 2000, and has had similar competitive results as many other deregulated regimes have experienced. It has had the most success in its public sector, but new competitive suppliers have been hard to come by. More often than not, the local incumbent utilities bid on the contracts because competitive suppliers and new entrants lack the administrative support and financing to compete in the public sector. The competitive effects are therefore limited, and since incumbents know that alternative suppliers cannot compete, they do not lower their prices. Studying various government entities shopping for electricity, Hattori (2010) explains that when competitive suppliers *were* able to bid, they won 70 to 80 percent of the contracts. Why? New entrants are generally drawn to specialized contracts with very high voltage and demand levels and are therefore able to offer a sort of differentiated product and then become more competitive over time. One would think then, that the number of bidders should increase in the future. However, Hattori warns that future high oil prices and eventual greenhouse gas legislation could hinder the competitiveness of these new-entrant suppliers because they usually rely on fossil fired generation, the target of greenhouse gas legislation. They do not have the large-scale nuclear or hydropower that incumbent competitors do, so it could be that long-term competition becomes unfeasible if the new entrants are already phased out in the short-term.

Market Design for Successful Retail Competition: How Does Pennsylvania measure up?

As discussed above, many deregulatory regimes either "succeeded" or failed, mainly due to the way their markets were designed, which had an ultimate effect on prices and the competitiveness of the market. There are various theories of the best way to organize a competitive retail market, but there is no widely accepted theory. Blumsack et. al (2009) outline five critical design elements, based on policies that have seemingly worked in existing retail markets.

First, open access to transmission and distribution must be guaranteed in order to prevent individual suppliers from having access advantages based on the set up of the transmission grid.

Pennsylvania is part of the PJM RTO, which ensures grid reliability and access to all generators based on their costs. Second, the default service rates that follow the price caps should not be set artificially low as to discourage entry of new competitive suppliers. The third necessary element is to limit the transition period to as little time as possible, and to index the price caps on fuel prices. Unfortunately, Pennsylvania's rates were set in periods of low prices, which, as mentioned, forced third-party suppliers out of the market. Fourth, switching policies must encourage free switching of suppliers, but only to the extent that the increased volatility of switching customers does not result in passing the cost of this risk onto the remaining customers. Pennsylvania, as stated, has a completely open switching allowance. The last component that Blumsack et. al (2009) describes is that the number and type of contract options that suppliers can offer their default customers be limited so they do not force competitive suppliers out of the market. However, suppliers should be allowed to offer differentiated products, such as electricity from renewable sources. Pennsylvania has some companies that claim to produce power from renewable sources, and with its recent dive into increased natural gas operations with the Marcellus Shale, for example, there may be a lot more in the near future. Once competitors *have* entered the market, their success will depend on prices and who they can out-bid for contracts. The question we now try to answer is, how do they structure their prices and what market conditions most affect them?

Chapter 2

Data

This paper examines supply bidding in the Pennsylvania retail electric market, looking at a variety of factors that influence bidders, including some of those employed by Hattori (2010). The data for this research was obtained from the Penn State Facilities Engineering Institute (PSFEI), which acts as a technical advisor for the Pennsylvania Department of General Services Bureau of Procurement (DGS) to secure electricity contracts for a large number of state agencies and public entities across the state. Starting in October 2009, the organization began to host various shopping events throughout the year for suppliers and utilities to offer bids for electricity contracts for various facilities. The platform provides bidders with the name, location, allowable bid type, and historical consumption of each facility in the bidding package. Bidders can offer bid prices over a contract length of the bidder's choosing.

Generally, accounts within the same electric distribution company are shopped in the same year, and facilities with similar electricity demand are put up for bidding within the same shopping event. On average, shopping events are held on a monthly basis, and PSFEI chooses which facilities are to be bid on at each event. Each bidding window is open for several weeks, and at the conclusion, PSFEI recommends to the Department of General Services which contracts and bidders to award. The Institute's recommendations often emphasize the annual avoided costs (the cost savings of choosing the supplier contract over the utility) and a comparison with the *price to compare* or the "price to beat," which takes into account distribution fees. According to PSFEI, DGS then awards contracts most often based on both avoided costs and the term length of the contract. However, contracts are not always awarded on solely these two criteria and sometimes no contract is awarded. This research therefore aims to analyze the factors that influence 1) the probability of a contract being awarded, 2) the winning bid price, and 3) the number of bidders on each account.

The data used in this project contains PSFEI's first round of shopping results from October 2009 to March 2010 for the DGS's accounts within the Pennsylvania Power and Light (PPL) utility's territory. The accounts had a range of consumption patterns from large government complexes (greater than 500 kW usage) to small individual liquor stores (less than 100 kW), all of which can be classified as "commercial" customers. Many of the smallest accounts were aggregated, often by utility tariff rate to facilitate competition. Summary statistics for the data and a description of the variables are available in Chapter 3.

Research Hypotheses

In order to study retail electric competition and its effect on prices in the scope of the entities for which the Department of General Services procures electricity in Pennsylvania, the following hypotheses were made:

1. The probability of a facility being awarded a contract depends mostly on the facility's demand. Assuming that the awarder is looking for the greatest cost savings, large facilities can expect to be awarded contracts more readily.
2. The winning bid price depends on contract length, the location of the facility, and the future cost of serving electricity. The longer the contract, the less the supplier will charge, as a sort of bulk discount. Facilities located in areas with higher power congestion (higher nodal prices) will see higher awarded bid prices because the marginal cost of delivering each unit of electricity will be higher. Also, the more expensive electricity will be to serve in the future, the higher the awarded bid price will be.
3. The probability of whether more than one bidder submits a bid for the facility is contingent upon the facility's location and whether the account is aggregated. Facilities located in congested areas will see less competition. Aggregated accounts will also see less bidding behavior because there is more diversity in consumption and location.

Chapter 3

Description of Variables

There are various factors that affect the probability of a bid being awarded, the winning bid price, and the level of competition. The factors focused on in this research are those specifically related to the facilities' electricity demand and location, the bid characteristics, and other market influences.

Electricity Demand

Consumption

In the short term, large demand should attract more competitive suppliers (Abel et. al, 2001). PSFEI provides bidders with data on the previous year's consumption by month for each facility; this analysis uses consumption data gathered from 2008-2009, which was accordingly aggregated for each of the aggregated accounts. Ideally, daily volatility of demand would have been an interesting factor to analyze, but PSFEI could provide hourly interval data for only a dozen or so very large accounts (over 500 kW). To represent the facility's load profile in the regression analysis, a percentage standard deviation of monthly consumption and January and July proportions of annual consumption were calculated. All facilities had peak consumption in either July (70 percent) or January (30 percent). High summer temperatures combined with a use of air conditioning cause July peaking and the prevalence of electric resistive heat throughout the state causes January peaking. Most of the facilities are far north enough that more efficient means of electric heat (like air-source heat pumps) are not practical for larger applications. Traditional inefficient electric baseboard heating can also cause January demand to soar over July demand. However, if a facility has an alternate fuel for heating (such as gas, oil, biomass, or coal), electric consumption will be much higher in the summer.

Location

Nodal Price

Due to transmission constraints and resulting congestion, it may be more expensive to deliver a marginal unit of electricity to certain facilities, depending on where they are located. Hattori (2010) found that competition increased in large city areas vs. rural areas. Average annual nodal prices are a good indicator of this congestion, which suppliers may take into account when bidding on a contract. Nodal prices were obtained by cross-referencing each facility's zip code with PJM nodal busses and calculating the average annual nodal prices at each node using data from the PJM Market Operations website. For zip codes without a node, a geographically close substitute zip code and according node were located.

Bid Characteristics

Contract Length

The price of a bid and its likelihood of being awarded can depend on how long the facility has to commit to an electricity price. Hattori (2010) did not observe much change in competition based on contract length, but perhaps we will have different results. Since bidders choose the contract length when offering a price on the PSFEI platform, this variable can not be used to analyze the probability of a facility being awarded, but serves as an important factor in the winning bid price.

Allowable Bid Type

The accounts in question have specifications of what kind of bid they may accept. Given the choice, the bidder's submission of a certain bid type may affect the likelihood of the bid being awarded and the number of bidders on the contract. There are two different kinds of bids—Fixed and Block & Index bids—and the indicator variable used in the regressions represents whether a bid allows only Fixed bids or not (both).

Fixed Bids

The price submitted by the supplier applies to all kilowatt-hours used at every hour of the day. Since there is no demand that the supplier is left to purchase at spot prices from the market and then pass on to the consumer, fixed bids tend to be more risk-averse. PSFEI states that DGS generally almost always solicits only fixed bids for its smaller (less than 150 kW) facilities, but larger consumers are also often provided this "Fixed Only" nomination.

Block & Index Bids

There are two unique aspects of block & index bids. First, they have fixed (block) and variable (index) demand components that the supplier must satisfy. The block, which PSFEI determines based on a visual assessment of the daily load profile curves over the course of a month, is the amount of demand that the supplier charges its awarded bid price. The index portion of the bid is the portion of demand above the block (generally the peak hours) that the supplier must provide and charge the consumer for by purchasing from the market.

Second, the bid is broken into on-peak, off-peak, and management charge components, all of which are taken into consideration in the awarding process. The on- and off-peak prices apply to the respective hours when demand is realized within the peak or off-peak hours of the day and the management charge applies to every kilowatt of demand satisfied, regardless of the time of day.

Other Market Influences

NYMEX Price

Electricity prices are often correlated with natural gas prices (Kiesling 2009). With most of the bids occurring on the ending date of the shopping event, Henry Hub NYMEX 2-year forward prices were calculated over the average length of the contract.

Aggregated

PSFEI and DGS facilitate competition for its small accounts by bundling multiple contracts to increase the size of contract demand. This is an interesting variable to study in the scope of competition, as Hattori (2010) had suggested bundling in his study of competition in the Japanese retail electric market. For the Pennsylvania data, of the 112 PPL accounts shopped, 80 prcent were Single Accounts (individual facilities) and the remaining 20 percent were Aggregated Accounts, which were packages that combined anywhere between five and 722 facilities.

Summary Statistics of Variables

Three separate regressions were run using the above variables to analyze 1) the probability of a facility being awarded a contract, 2) the winning bid price, and 3) the probability that competition existed in the bidding process. The "Awarded" and "Number of Bidders" regressions were binary logistic regressions (0 = one bidder and 1 = more than one bidder on the contract for "Number of Bidders" regression).

Since awarded block and index bids have three components (on- & off-peak and the management charge), one cannot compare block & index prices to the awarded fixed bid prices. The "Awarded Bid Price" regression is therefore only run with *fixed* awarded bid prices. A regression for only block & index bids could not be constructed with the amount of data provided.

Table 3: *Data set used in "Awarded" Regression – binary logistic*

Sample size of 99

Variable Name	Description of Statistic	Mean	Min	Median	Max	Standard Deviation
On Peak Demand	Annual On Peak Historical Consumption (kWh)	11,094,815	348,217	7,596,321	71,257,224	12,642,385
Demand Volatility	Percent Standard Deviation of Monthly Demand	30%	8%	28%	79%	13%
July Demand	July Consumption as a percentage of Annual	11%	0.6%	10%	18%	3%
January Demand	Jan Consumption as a percentage of Annual	9%	0.8%	9%	20%	3%
Nodal Price	Average Annual Nodal Price ($/MW)	62.95	45.25	66.42	75.27	8.05
NYMEX	Average forward NYMEX price ($/MMBTU)	5.504	4.988	5.471	6.026	0.227
Fixed Only Bid Allowed	0 = both fixed and block/index bids accepted 1 = fixed bides only	0.49	0	0	1	0.50

Table 4: *Data set used in Winning (Fixed) Bid Price – multi-variable*

Sample size of 70

Variable Name	Description of Statistic	Mean	Min	Median	Max	Standard Deviation
Bid Price	Fixed winning bid price (cents/kWh)	7.60	5.25	7.64	10.91	0.89
Contract Length	(months)	13.7	6	12	24	4.7
On Peak Demand	Annual On Peak Consumption (kWh)	9,304,963	348,217	5,024,200	53,433,600	11,251,788
Demand Volatility	Percent Standard Deviation of Monthly Demand	32%	8%	31%	79%	14%
July Demand	July Consumption as a percentage of Annual	11%	1%	11%	18%	3%
January Demand	Jan Consumption as a percentage of Annual	9%	1%	9%	20%	3%
Nodal Price	Average Annual Nodal Price ($/MW)	65.35	45.25	66.80	75.27	6.66
NYMEX	Forward NYMEX ($/MMBTU)	5.5303	4.9884	5.5051	6.0263	0.2428
Fixed Only Bid Allowed	0 = both fixed and block/index bids accepted 1 = fixed bides only	0.40	0	0	1	0.49
Bidders	Number of bidders 0 = one bidder 1 = more than one bidder	0.21	0	0	1	0.41

Table 5: *Data set used in "Number of Bidders" Regression – binary logistic*

Sample size of 78

Variable Name	Description of Variable	Average	Min	Median	Max	Standard Deviation
Contract Length	(months)	13.6	6	12	24	4.5
On Peak Demand	Annual On Peak Consumption (kWh)	10,933,105	348,217	6,329,250	94,542,000	14,862,230
Demand Volatility	Percent Standard Deviation of Monthly Demand	31%	8%	31%	79%	14%
July Demand	July Consumption (kWh)	11%	0.6%	11%	18%	3%
January Demand	Jan Consumption (kWh)	9%	0.8%	9%	20%	3%
Nodal Price	Avg Annual Nodal Price ($/MW)	64.51	45.25	66.67	75.27	7.44
NYMEX	Forward NYMEX ($/MMBTU)	5.551	4.988	5.507	6.026	0.242
Fixed Only Bid Allowed	0 = both fixed and block/index bids accepted 1 = fixed bides only	0.36	0	0	1	0.48
Aggregated	0 = single account 1 = aggregated accounts	0.21	0	0	1	0.41
Bidders	Number of bidders 0 = one bidder 1 = more than one bidder	0.23	0	0	1	0.42

Chapter 4

Regressions and Results

Each of the regressions, Contract Awarded, Awarded Bid Price, and Number of Bidders were tested using MiniTab® statistical software to yield the following results. By applying a simple p-test, significance is reported here at the 10% (*), 5% (**), and 1% (***) level.

Table 6: Regression Results

Predictor	**Contract Awarded**		**Awarded Bid Price**		**Number of Bidders**	
	(1A)	(1B)	(2A)	(2B)	(3A)	(3B)
	Binary Logistic Regression		*Multi-Variable*		*Binary Logistic*	
Constant	-43.12*** (15.56)	-42.43*** (15.42)	-4.67 (0.68)	-4.8989*** (0.67)	0.26 (9.22)	0.622188 (9.11)
On Peak Demand	-0.42** (0.14)	-0.44** (0.18)	-0.03** (0.01)	-	-0.11 (0.15)	-
Demand Volatility	1.326 (1.73)	-	0.07 (0.1)	-	-2.15 (1.56)	-2.009 (1.53)
July Demand	-9.02 (8.25)	-9.74 (8.13)	0.23 (0.49)	-	11.57 (8.53)	9.9 (8.02)
January Demand	16.07 (10.24)	11.33 (7.84)	0.2 (0.44)	-	-12.21 (8.86)	-11.36 (8.75)
Nodal Price	3.13** (1.33)	3.25** (1.32)	0.17 (0.12)	0.19 (0.12)	-2.13 (1.36)	-2.01 (1.34)
NYMEX	22.23*** (7.97)	22.25*** (7.95)	1.16*** (0.33)	0.95*** (0.33)	5.53 (5.21)	4.2 (4.81)
Fixed Only bid allowed	-1.24** (0.5)	-1.34*** (0.49)	0.07** (0.03)	0.07** (0.03)	0.72 (0.49)	0.7 (0.49)
Contract Length	-		-0.01** (0.003)	-0.008*** (0.002)	0.02 (0.04)	-
Log-Likelihood	-31.43	-31.72	-		-35.24	-35.56
R-squ value Adj. R-squ value	-		33% 24%	25% 21%	-	
No. of observations	99	99	70	70	78	78

Analysis of Awarded regression

Surprisingly, these results indicate that the greater the facility's demand, the less likely it is that it will be awarded a contract. Here we can assume that DGS, the awarder, was looking for better prices for its larger facilities. *Regression 1* shows that monthly variability does not seem to influence the outcome, but there is a slight indication that the more volatile the consumption, the less likely it is that a contract will be awarded. There is also an indication that winter-peaking facilities are more likely to be awarded a contract, and July-peakers are less likely to be awarded a contract. Again, 30 percent of awarded facilities are peaking in the winter.

DGS also seems to be backward-looking, as increases in the average annual nodal price (based on historical data) increase the probability of a facility being awarded a contract, which can be seen as risk aversion. Moreover, the significance in the average *forward* NYMEX price over the length of the contract indicates that as electricity becomes more expensive to serve in the future, the more likely a contract will be awarded. Facilities would prefer to lock in at a price than have exposure on a market where prices are rising.

These results also seem to indicate that DGS is facilitating the market by "looking out" for both sides of the market; meaning, the awarder is not *just* concerned with the facilities for which it is procuring electricity. It has an interest in both the consumer *and* the supplier. Obviously, DGS is looking for competitive prices for its consumers, but given that there is a greater probability of being awarded when bidding on winter-peaking facility (larger fraction of total annual demand), suppliers ultimately benefit because electricity prices in January are not quite as volatile and high as in the summer.

Facilities allowing only fixed bids are also more likely to be awarded. One reason for this may be centered on risk aversion in that DGS looks to procure a fixed price for all hours of a facility's consumption and to avoid any exposure to the spot market. PSFEI sometimes offers suppliers the option to provide block and index bids in the hope that the bid prices will be lower, but it seems as though DGS was looking for lower prices to able to award a block and index bid.

Analysis of Awarded Bid Price regression:

For winning bid price, the results for a facility's demand make more sense: the greater the total annual usage, the lower the awarded bid price. The contract length specified by the bidder seems to be a more important factor in the price of the winning bid: the longer the contract, the lower the price, which can be seen as a kind of bulk discount for the supplier.

These results seem to indicate that bidders are forward-looking, as they structure their bids around forward NYMEX prices: the higher the NYMEX price, the higher the bid price. Using the natural gas market as an indictor, suppliers take into consideration that the more expensive electricity will be to supply in the future, the more expensive their bid price will have to be.

The allowable bid type also plays an important role in the price of the awarded bid, as it does in the "Awarded" regression. Facilities allowing only fixed bids will generally see higher bid prices because the supplier has to supply all hours at the same price. Most likely, bidders try to bundle on- and off-peak prices into one fixed price because they cannot separate the components as they would in a block and index bid.

Overall, price considerations seem to drive bid prices and there is a hint that competition has a downward effect on prices if we look at the number of bidders (one or more than one bidder). Bidders do not seem overly considerate of consumption nor the physical delivery of the electricity they are offering to supply, but rather just the price and market for electricity.

Analysis of Number of Bidders regression

None of the variables are significant in either of the two regressions, and we therefore cannot make any conclusions in terms of the extent of competition. There are a few indications that should be investigated further with future studies.

Chapter 5

Conclusion

This paper demonstrates that there are various factors that influence supply bid behavior—most notably, consumer demand, the future cost of serving electricity, and the type of bid allowed. Each has revealed characteristics about bidders in electricity markets, but also about the awarder, who seems to be looking out for both the supply and demand sides of the market. Bidders seem concerned with demand volatility and future electricity costs, but surprisingly, the greater the demand, the less likely a contract is to be awarded. The analysis also suggests that facilities only accepting fixed bids are awarded more often, again, perhaps because the awarder is risk-averse and seeking the least price volatility for its customers.

Overall, though, competition does not currently seem to play a significant role in the bidding process, as the majority of the contracts were only bid on multiple times by the incumbent utility. While we do see that later shopping events in 2010 resulted in more bidders placing offers (but perhaps only due to greater awareness among new bidders about the platform), in total there were only five bidders, each of which was a large utility (or a retail branch of a larger utility company). This absence of competitive alternative suppliers may be a consequence of the long transition period of regulated rates and that regulator's established rate caps in the 1990s, when prices were low. Since prices increased, many of these competitive generators were forced out of the market before the rate caps even expired, perhaps in the same way that Hattori (2010) found in Japanese markets: most competitive suppliers relied on coal and other expensive generation types, while incumbents had almost grandfathered in stranded costs of low-cost nuclear generation. Retail competition may have led to very different results had rate caps been established differently.

It is important to remember that this data only deals with specific accounts within the PPL territory, and that the accounts are all entities under the Department of General Services. The facilities examined only represent a miniscule, almost insignificant, portion of all Pennsylvania electric commercial electric customers. Since the start of this research, DGS and PSFEI may have solicited more bids and bidders throughout the months for which this project's data exists, and it is very possible that they will see increased competition as the shopping events continue. PSFEI and DGS may also have changed some of their approaches of analyzing and awarding contracts. At the beginning of the bidding process in 2009, they had little experience and their use of historical consumption data to predict future consumption (dependent on, essentially, unknown future weather patterns) has been questioned. This may, perhaps, explain why the two demand variables, consumption and volatility, in this research's regressions did not seem to yield expected or definitive results, so further study should be done to investigate this phenomenon.

Future studies should address the indications that could be drawn from the regressions because all of the variables in the Number of Bidders regression were insignificant. It would be interesting to explore why the total quantity demanded does not seem as important as the *variability* of demand; perhaps the greater the volatility, the less willing bidders are to supply electricity because that leaves larger unknown quantities for which the supplier must seek electricity in the market or from its own generation, and these prices are ultimately passed to the consumer. If the facility being bid on faces peak demand during hours when most other consumers peak, they would expect these hourly electric prices to be high. It may also be possible to construct new seasonal demand variables in a future analysis. Here, we sought to observe a difference in bidding behavior and prices for winter- and summer-peaking facilities. There many also be a way to better study bidder's attention to whether or not an account is aggregated. One would think that aggregated accounts would receive less bidding attention because the supplier has more facilities for which it needs to secure electricity (meaning more variability across the consumption profile). But this variable was so insignificant that it was not included in the analysis.

In looking how to expand this research as mentioned, the methodology employed in this paper could be repeated and adjusted to study PSFEI's more recent data for the other utility territories in Pennsylvania whose rate caps have expired. By the end of 2011, PSFEI had hosted shopping events for all of the utility territories and stated that they have seen more suppliers participating on the platform. Be it in Pennsylvania or on an international level, the effects of retail competition will certainly not be fully felt for a few years yet, so the importance of studying its evolution will prove to be very interesting and necessary. The expansion of degregulation to other states and its overall future success is still unclear, but for the time being, it seems as though competitive markets are, at least for the time being, the near future of U.S. electricity markets.

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Academic Vitae

EDUCATION

The Pennsylvania State University, Schreyer Honors College — **University Park, PA**
B.S. Energy, Business and Finance — *2008-2012*

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HONORS/SKILLS

Penn State Dean's List — *Fall 2008 – Spring 2011*

- President Sparks Award, Evan Pugh Scholar Award — *Fall 2009, Fall 2010*

Scholarships

- Charles B. Manuela Memorial Scholarship — *2010, 2011*
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Languages / International Experience

- German fluency and strong written/spoken Spanish skills
- Travel in Europe, research trips to Peru and Curaçao
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EXPERIENCE

Alberta Energy Challenge — **Edmonton, Alberta**
Penn State Competition Team — *Fall 2011*

- Case competition focused on the Canadian oil sands industry

General Electric / Energy Financial Services — **Stamford, CT**
Midstream & International Portfolio Summer Analyst — *June 2011 – Aug 2011*

- Analyzed correlation of natural gas liquid and crude oil prices
- Created a hedging model and budget tracking sheets for various portfolio assets

Exelon Generation — **Kennett Square, PA**
Trading and Origination Intern — *June 2010 – Aug 2010*

- Quantified cost of risk of liquidated damages deals into the Entergy grid
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Avanceon Energy — **Eagle, PA**
Intern and IT Assistant — *Dec 2009 – Jan 2010*

- Developed and implemented a research methodology for identifying large fuel users across PA and NJ in order to determine product's potential market size

Vattenfall Trading Services, GmbH — **Hamburg, Germany**
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- Researched independently to extend company's counterpart network and open Intraday electricity trading on the German-Czech and Czech-Slovakian borders

RESEARCH

U.S. Association of Energy Economists — **Washington, D.C.**

- Presented thesis research at the 30th USAEE/IEAA North American Conference, titled "Redefining the Energy Economy: Changing Roles of Industry, Government and Research" — *October 2011*

Assistant researcher — **University Park, PA**

- Gathered data on natural gas company stock performance to help determine the effect of the Fukushima crisis on European and Asian coal and renewables companies — *Fall 2011*

Center for Advanced Undergraduate Studies (CAUSE) — **Curacao, Netherland Antilles**

- Performed underwater observations of various species using Reef Check protocol and comparing to historical studies to determine overall reef health on the island — *May 2011, Fall 2011*

ACTIVITIES

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