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Product Definition for Future Electricity Supply Auctions: The 2006 Illinois Experience

Much of the discussion about new markets for electricity contracts focuses on the auction format to be used. Far less attention has been paid to the contract definition itself. An analysis of the 2006 Illinois Electricity Auction shows how a poorly formulated product definition can erode the performance of such markets. The authors propose an improved product definition to overcome the key problems they have identified.

Luciano de Castro, Matias Negrete-Pincetic and George Gross

I. Introduction

The introduction of auction markets for the purposes of defining terms and prices of electricity contracts has given rise to a series of new questions and challenges. Several of these questions and consequent research efforts focus on the nature of competitive bidding processes and on what auction formats and rules should be adopted. Such discussion is important, since previous experience in spectrum auctions suggests how the adopted rules can affect the performance of the market.[1] Thus, the strong interest in the auction rules, as several papers illustrate,[2] is understandable. It is surprising, however, how little discussion has been devoted to the products negotiated in those auctions, i.e., the terms of the contracts for future electricity supply.

We can give at least two reasons for this. First, auction formats have been discussed by economic theorists

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since the 1960s and a considerable body of literature has been established.[3] It is, therefore, natural to say more about things about which more is known. Second, in most instances, the objects in a market are clearly specified, and there is no need for discussing ''product definition.'' An additional reason may be that the product definition is not important. As we will argue here, for the case of electricity supply such an assumption is false: the definition of the contracts is central to the well-functioning performance of the auction market for electricity contracts.

We focus particularly on the definition of the so-called tranche contracts used in the 2006 Illinois Electricity Auction.[4] Such contracts differ markedly from those used in other locations such as in South American countries, whose results have been discussed extensively.[5] The main difference is that, while typical contracts specify the total amount of the energy and/or power to be provided, tranche contracts specify the percent of demand that the supplier must satisfy during the contract period. However, the amount of demand is unknown at the time the contract is signed. The tranche-based product, therefore, shifts all the uncertainty from the distribution companies to the generation sellers. From the viewpoint of the distribution companies, such a shift seems convenient, but there are some problems with its implementation, as we discuss below.

The fair price of a tranche contract includes the premium for the uncertainty regarding the total load. This fact implies that the price will be above the expected spot price of electricity and this prediction is confirmed by what happens in Illinois after the Auction, as we discuss in Section III. Since risk-averse consumers do not care about the total load risks, the consumers would prefer to underinsure in face of the tranche-based products. However, the Auction obliged full contract, thus being sup-optimal from the consumers' viewpoint.

The definition of contracts is central to the well-functioning performance of the auction market for electricity contracts.

The migration risks are transferred from the distribution companies to the generation sellers, causing problems of information asymmetry. The most important aspect is the moral hazard problem that large consumers face. Generation sellers will require a premium to provide energy for large consumers that may leave – a fact also observed in our analysis – higher prices for large consumers. Such prices will be incentives for large consumers to procure direct contracts with generators, which is likely to further increase prices asked by generators for the tranche contracts, creating a vicious circle.

The tranche contracts are *artificial*, in the sense that they entail the delivery of electricity with no consideration of the way in which electricity is actually produced. Some plants, such as nuclear units, cannot modify their operating outputs according to the requirements defined by the tranche-based product, i.e.: a percentage of the volatile shape of the yet-to-be-known demand. The inability of such generators to satisfy such contracts by themselves requires the use of various schemes to overcome this deficiency. One possible approach is aggregation, via acquisition, or coordination, via side contracts, of different generator outputs. Since the negotiation of side contracts incurs transaction costs, these markets favor large companies with a portfolio of different generation techniques. But even if small generation entities can be coordinated with side contracts, possibly by a financial intermediary, the result is likely to be the reduction of the number of distinct competitors and the concentration of market power into a smaller set of market sellers. Over time, such effects reduce the competitiveness of the outcomes.

A further problem with the tranche-based product definition is the lack of informational content about the load. It is well recognized that an important function of a market is to provide the correct price signal to current and potential future market participants. Since the tranche is defined in terms of the percent of the future unknown demand, the price of such a contract fails to convey the level of information that a typical contract contains. As we show in more detail in Section IV, this fact undermines the important market function of providing price signals.

In light of these identified problems, we propose a product definition that is more consistent with the way electricity is actually produced. Our product definition overcomes the problems cited above and is in line with terms of contracts used in many jurisdictions.

This article contains five additional sections. In Section II, we briefly review the principal facets of the 2006 Illinois Electricity Auction and present the exact product definition used. In Section III, we analyze the results of the Auction. In Section IV, we study in detail the issues associated with the product definition and the impacts on the Auction outcomes. We explain an alternative product definition for auctions of contracts for future electricity supply in Section V. We conclude with some remarks and the directions for future studies in Section VI.

II. The 2006 Illinois Electricity Auction[6]

The 2006 Illinois Electricity Auction was created to procure supply for the Illinois distribution companies after the conclusion of the transition period of the Illinois electric industry. The basis of the Illinois electric industry is the enactment of the Electric Service Customer Choice and Rate Relief Law of December 1997. The restructuring of the Illinois electric industry led to the eventual establishment of the Ameren and Exelon holding companies with their respective generation assets removed from the regulated companies to form ''speculative'' market entities under the holding company structure. During the transition period, which was legislatively extended and lasted nearly a decade, the tariffs of residential and small commercial customers were artificially frozen and the Illinois utilities met their demand using long-term contracts. In 2004, the Illinois Commerce Commission (ICC) started a series of workshops and forums to study what steps to take following the end of the transition period. One of the recommendations was to introduce auctions in the procurement process for mid-term-duration contracts, along the lines of other states such as New Jersey and Maryland.[7]

One of the recommendations was to introduce auctions in the procurement process for mid-term-duration contracts.

In 2006 the ICC approved the use of the auction mechanism proposed by the Illinois utility subsidiaries of Exelon and Ameren. The Auction was held in September 2006 and the impacts on the tariffs started to be felt from January 2007. The Auction outcomes were nearly universally disliked in light of the high prices that resulted.

The rationale for the Illinois Auction was to ensure reliable supply over the next 17 to 41 months, starting on Jan. 1, 2007, for Illinois distribution companies owned by Ameren – CILCO, CIPS, and IP – and the Exelon-owned ComEd. Two auctions, one for fixed-priced customers and other for hourly-priced customers, were run in parallel. This article focuses only on the fixed-price section because the outcomes of the hourly-priced section were immediately rejected by the ICC.[7]

The 2006 Auction was designed and managed by NERA Economic Consulting, and uses the format of the New Jersey electricity Auction begun in 2002.[6] The 2006 Illinois Electricity Auction is a multiple-product reverse simultaneous descendant ''clock'' auction. The reverse refers to the fact that the sellers, rather than the buyers, have the active role, and the descendant ''clock'' indicates the deployment of price decrements in the auction.[8] The parties involved in the Auction are the regulated

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distribution companies (the buyers), the 21 selling entities including the Exelon and Ameren generation subsidiaries, and NERA, serving as Auction Manager. In addition, there are the observers: the ICC and the Auction Monitor. The role of the Auction Monitor is to review the Auction results and to provide specific recommendations to the ICC. The ICC takes the final decision whether to accept or reject the Auction results.

The multiple products of the Auction are differentiated in terms of the distribution company, the customer class,[9] and the contract duration. The unit of each product is specified in terms of the so-called *tranche*. The tranche of the chronological load over a given period is defined to be a *specified* fraction of the load at each point in time during that period. We illustrate the supply of a week-long load in terms of 10 percent tranches in **Figure 1**. The total load is supplied by four sellers who provide one, two, three and four tranches, respectively. The number of tranches required by the 2006 Illinois Electricity Auction and the expected peak of the procured power[10] for each of the products are summarized in **Table 1**, which clearly indicates the appreciable differences of the two distribution company loads.[11]

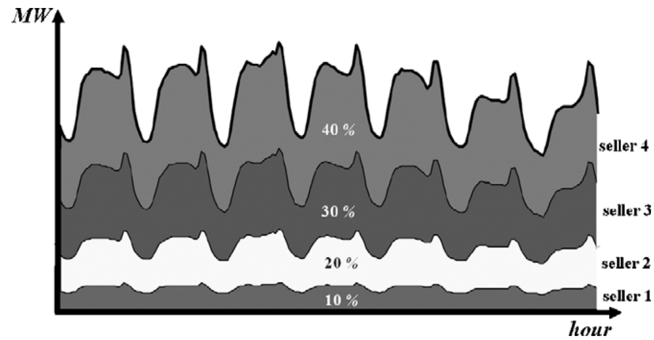

Figure 1: Meeting the Week-Long Chronological Load Using 10 Percent Tranche Products

We now present the outcomes of the 2006 Illinois Electricity Auction. The Auction began on Sept. 5, 2006, with initial prices set by the Auction Manager. The Auction went through 39 rounds and terminated on the fourth day. The initial prices were $104/MWh for the large and $100/MWh for the small to medium customers of Ameren and ComEd.

The Auction was performed in rounds in which the Auction Manager set the prices for the eight products for each round and each seller was allowed to offer one or more tranches of each of the eight products. The only information released by the Auction Manager following each round was the price level for the next round and the range of oversupply for the total number of products.[7] As long as there was an oversupply of any single product, a new round was launched by the Auction Manager with the prices in the new round modified from those in the previous round using non-negative decrements. The attainment of the supply-demand equilibrium in the eight products signaled the end of the Auction. Each seller of a specific product received the identical price for each unit of the product sold. We

Table 1: Peak and Procured Tranches for Each Customer Class

Distribution Entity	Customer Class	Duration (months)	Peak (MW)	Load Fraction %	Tranches Procured	Total Load Procured[11] %
ComEd	CPP-B, 0–400 kW	17	13879	0.36	92	33.04
		29			93	33.48
		41			93	33.48
	CPP-A, over 400 *kW*	17	4376	1.14	88	100
Ameren	BGS-FP, 0–1 MW	17	5366	0.93	35	33.04
		29			36	33.48
		41			36	33.48
	BGS-LFP, over 1 MW	17	1853	2.70	37	100

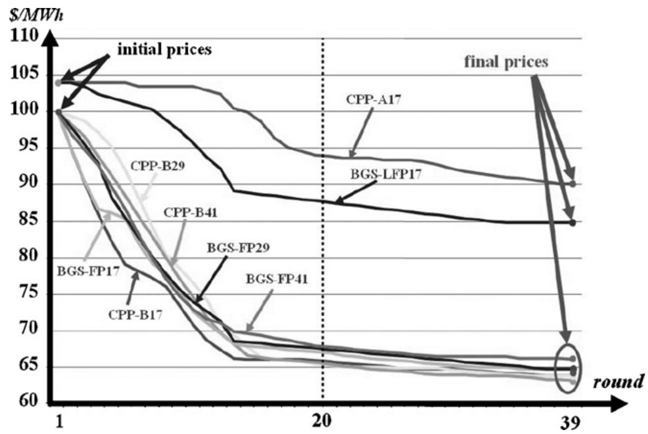

Figure 2: Round Price Dynamics in the Auction

Table 2: Initial and Final Prices, ComEd Products

Product	CPP-B17	CPP-B29	CPP-B41	CPP-A17
Initial price ($/MWh)	100	100	100	104
Final price ($/MWh)	63.96	64.00	63.33	90.12

Table 3: Initial and Final Prices, Ameren Products

Product	BGS-FP17	BGS-FP29	BGS-FP41	BGS-LFP17
Initial price ($/MWh)	100	100	100	104
Final price ($/MWh)	64.77	64.75	66.05	84.95

provide a plot of the sequence of prices in Figure 2. The final prices for each product are specified in Tables 2 and 3.

III. Analysis of the Results

The dominant characteristic of the Auction results is the uniformly high prices for all the eight products. The high prices are readily evident from the wholesale electricity market prices in 2007, the first year covered by the Auction outcomes. In fact, the prices set by the 2006 Illinois Electricity Auction were considerably higher than the average market prices in the Midwest ISO and PJM[12] at the Illinois locations. The high level of prices is evident from a comparison of the Auction prices with the daily locational marginal prices (LMP)[13] on particular nodes of such system operators. We present the results of the comparison for the Ameren products of the Auction with the LMP at the so-called Illinois-Hub in the Midwest ISO.[14]

The Midwest ISO evaluates LMPs on a five-minute basis and determines the hourly LMP as the time-weighted average of the five-minute values.[15] We define the daily LMP to be the average of the 24 hourly LMP values. The Illinois–Hub is not a physical node but, rather, a fictitious node whose LMP is computed by the Midwest ISO, using the LMP values from about 150 nodes located in the central, southern, and southwestern parts of Illinois – essentially covering the service of the three Ameren distribution companies. The Illinois-Hub LMP is a useful proxy for wholesale electricity prices in the Ameren locations.

We use the daily Illinois-Hub LMPs nodal prices for the period from Jan. 1–Dec. 31, 2007, to represent the market prices. We present the plot of these prices together with the price levels associated with the four Ameren products over the same period in Figure 3. We observe that the price of each product exceeds the average

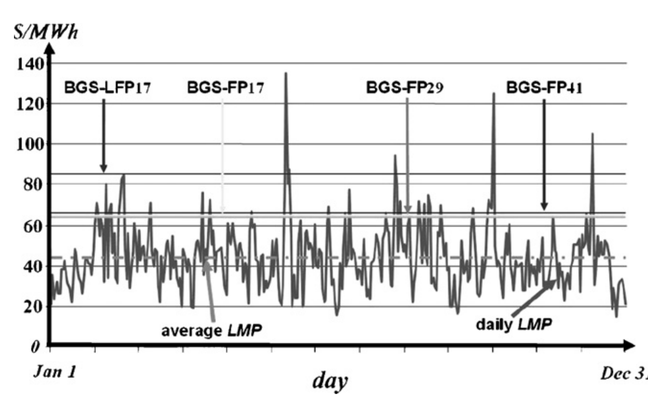

Figure 3: Comparison LMPs at the Illinois-Hub for Year 2007 and Ameren Final Auction Prices

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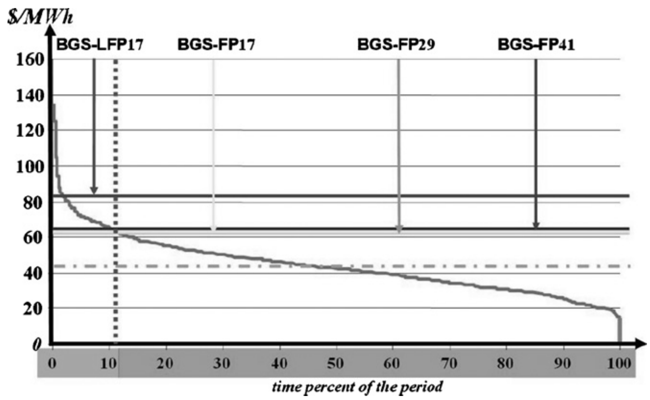

Figure 4: The Illinois-Hub LMP Duration Curve for Year 2007 and Ameren Final Auction Prices

Illinois-Hub LMP for 2007. In fact, throughout the year, the daily LMP is below the Auction prices expected for some short periods.

We can actually measure the fraction of time the exceptions occur. We do so by rearranging the average daily LMPs from the highest to the lowest to create a so-called *price-duration curve*.[16] We present the Illinois-Hub LMP duration curve in **Figure 4** together with the Auction prices for the four Ameren products. The LMPs exceed the Auction prices no more than 10 percent of the time. In other words, the market prices are below the Auction prices 90 percent of the days in 2007. Indeed, the Auction price of the BGS-LF17 product is above the market price about 97 percent of the days in 2007. These conclusions clearly point out that MWh of each of the four Ameren products may have been purchased at considerably lower prices in the market than those set by the Auction.

The final Auction prices show a clear decoupling between the prices of the products for small and medium-size customers and those of the products for large industrial and commercial customers for both distribution companies. Even though the initial Auction prices for the two sets of products started at nearly the same level – $100/MWh and $104/MWh, respectively – the final prices are at the level of 65 and $64/MWh for the small and medium customers of Ameren and ComEd, respectively, and 85 and $90/MWh for the large industrial and commercial customers of Ameren and ComEd, respectively. The higher prices of the latter products aimed at the large industrial and commercial customers of Ameren and ComEd reflect the uncertainty issues associated with this class of customers, with their greater flexibility to switch loads to alternative energy service providers. Since the latter customers are more likely to migrate their loads, they represent another source of uncertainty to the sellers. The difference between the price for these products and those for the small and medium customers is, in effect, the premium charged by the sellers to cover this additional uncertainty.

There is also a counterintuitive outcome in the ComEd product prices, in that the longer contracts are priced lower than the shorter ones. Since over the longer period the uncertainty is higher, the expectation is that the price associated with longer-term contracts would tend to be higher than those covering shorter period. The only explanation for this anomalous behavior is the desire of the large amount of nuclear generation in Illinois to find assured markets for a longer period, even if the sales occur at lower prices.

Our analysis thus indicates that product definition is one of the key issues in the auction design. An obligation that requires a fixed quantity of energy is vastly different from one requiring a fixed percentage of a given class load, as is the case of the tranche-based product in the 2006 Illinois Electricity Auction. The high prices attained in the 2006 Illinois Electricity Auction are therefore attributable, in part, to the problems entailed by the tranche-based product definition in use. We devote the next section to an analysis of these problems.

IV. Product Definition Problems

Forward contracts have been used in many electricity markets around the world. The main objectives of such contracts are to:

• reduce the volatility of the price of electricity to end users;

• provide an assured market to generators at a specified price,

• decrease the market power of certain companies in electricity markets; and

• provide effective price signals to stimulate investments in new generation assets.

The objective of reducing volatility of final prices serves the interest of risk-averse consumers who wish to avoid the huge price fluctuations that are usual in the spot markets. Such risk-averse consumers are willing to pay a moderate risk premium for the security of less volatile prices.[17] On the other hand, the economic literature suggests that the introduction of forward contracts may act as a pro-competitive device, with a possible reduction in final prices, thus also benefiting consumers.[18] Also, the markets provide good mechanisms to aggregate information and provide reliable signals for the necessity of further investments in generation.

Unfortunately, the contracts emanating from the tranche-based products used in the 2006 Illinois Electricity Auction fail to achieve the above-named objectives for a number of reasons all entailed by the product definition problems. The main problems include:

• The tranche contracts provide full protection to the distribution companies by transferring all the uncertainties to the sellers. However, from the consumer's viewpoint, this protection is beyond what consumers are interested in.

• The uncertainty associated with the migration of distributors' consumers has a component of information asymmetry that likely will drive prices up.

• The products delivered under the contracts are highly artificial since they involve the production of electricity that no single generating unit is capable of producing or doing so efficiently.

• The satisfaction of such contracts provides the impetus for consolidation of generation assets, leading to the concentration of the market into fewer entities. Such moves raise market power concerns and result eventually in reduced competition.

• The product definition does not allow comparison of demand provision among sellers because it refers to the unknown demand just in percentage terms. Thus, the information aggregation function of the market is undermined.

We next discuss in detail each of these problems.

A. The contracts provide more protection against uncertainty than what the consumers are interested in[19]

The tranche definition places all the uncertainty on the sellers' shoulders. The role of the distribution companies is reduced to being simply the delivery channel to the end users, without carrying any uncertainty for the commodity delivered. The uncertainty in the tranche-based product is a function of the yet-to-be-realized loads in the period of interest since each seller must meet a specified fraction of the loads and thus carries a fraction of the energy delivered and the maximum capacity required to meet the peak. We illustrate in Figure 5 the impacts of uncertainty using the four seller case presented in Figure 1. For the weekly period, the actual load differs from that forecast and the impacts on each of the sellers are indicated for this case. The loads and the resulting load shape are inherently random, as they are dependent on various sources of uncertainty. Consequently, the power and energy associated with

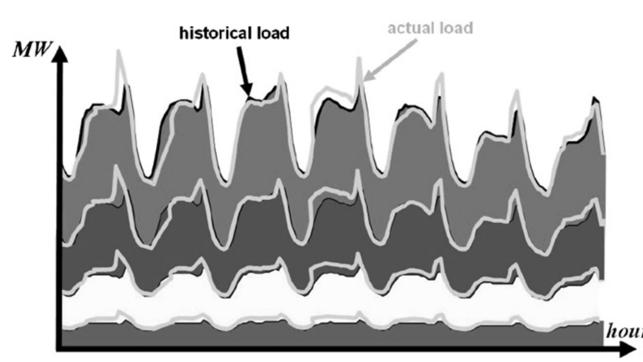

Figure 5: The Impacts on the Tranche-based Product Sellers of the Capacity and Volumetric Uncertainty in the Load

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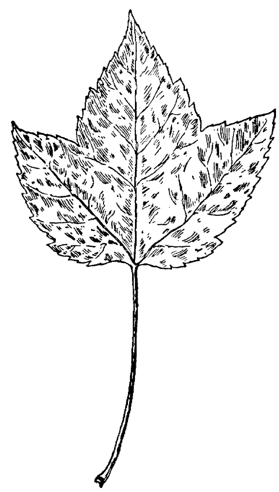
a tranche are uncertain. A tranche seller has a volumetric and a capacity uncertainty in what he sells.[20] The volumetric uncertainty impacts the expected revenues, and the capacity uncertainty entails uncertainty in the utilization of the generation resources required to meet the tranche obligation. Such capacity and volumetric uncertainty was historically faced by the ''utility'' in the vertically integrated utility structure together with the uncertainty in generation such as forced outages and fuel price escalation.

The concentration of uncertainty into the sellers' hands suggests that one of the objectives of the definition of contracts using tranches is to provide insurance to the distribution companies. Such an objective may be viewed as legitimate, given the goal of price volatility reduction. However, this mistaken view arises from a confusion between the distribution companies and consumers. The distinction between the risks faced by consumers and the distribution companies is clear. While the former care only about the price that they will pay, the latter faces uncertainty on the total load that must be served.[21] Also, while consumers are naturally assumed to be risk-averse, and thus willing to pay a premium for less volatile prices, economists in general classify companies as risk-neutral.

Now, risk-averse agents will buy full insurance if and only if the premium of the insurance is *actuarially fair*, that is, equal to the value that the insurance pays in expected term. If the premium is higher than its actuarially fair value, the risk-averse consumers will underinsure.[22] Since tranche products carry both the uncertainty of the load and the uncertainty of electricity prices,



its actuarially fair value will be above just an insurance premium for the electricity price. Since the uncertainty faced by end users is restricted to the electricity price and does not include the uncertainty about the load, the tranche products provide more protection than the end users are interested in. In this situation, they would consider this ''premium'' above the fair value and would prefer to underinsure. However, in the Auction, 100 percent of the load was procured, with full insurance to the distribution companies. Of course, the distribution companies may be interested in having insurance for their total load risks.[23] However, if they want to hedge these risks, they can do this through normal financial mechanisms.

B. Migration risk involves asymmetric information

The presence of migration risks in the contracts for the larger commercial and industrial consumers is an additional factor for the higher prices for the products for those customers. The Illinois restructuring legislation permits any customer to shift its load from the incumbent provider to an alternative. While such freedom has had no impact on small residential customers, there have been major shifts of commercial and industrial loads over the past decade.[24] The fact that such shifts may continue implies that the contracted energy consumed by the shifting customers will be supplied by other sources than the distribution company. Of course, while shifts into the distribution company may also occur, the integration of the new loads by the distribution entity entails changes in the total supply that must be delivered by the tranche sellers.[25] Therefore, there are considerable uncertainties for the contract sellers that the loads in the future may change from the historical load shape. In particular, the uncertainty faced by small generation entities is far more marked than that faced by companies with many generation units since small entities have far less flexibility in dealing with such uncertainty. Such migration-

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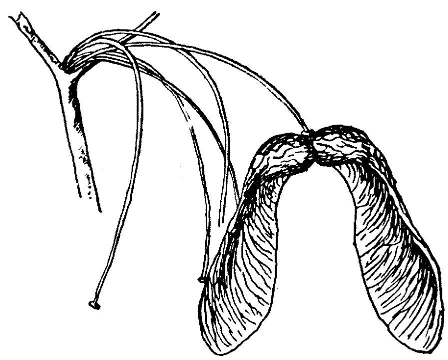
risk impacts the valuation that each seller assesses for the products associated with large customers. The sellers have no choice but to charge an additional insurance premium to cover against such additional uncertainty.

There are informational asymmetries in the market for the contracts to supply medium and large customers loads of the type economists classify as either adverse selection or moral hazard.[26] Large consumers have the best information about their willingness to shift their loads from the distribution company. Given the direct contact between the distribution companies and the medium and large customers, the distribution companies are likely to be better informed than the sellers. As the seller of the contract is less informed than the buyer, it is possible market problems occur that lead to high prices or even absence of trade.[27]

A far more acute problem that the adverse selection is the one with the moral hazard issues, with respect to the large consumers and the distribution companies. A generator requires a price that pays for the impacts of the expected migration, thereby leading to higher prices to large consumers. Such prices provide an incentive for such medium and large customers to negotiate a direct deal with another generator for a period explicitly not allowing any migration. The existence of such contracts further adds to the uncertainty of the contracts for the large customers' products and consequent high prices that encourage large consumers to leave the distribution companies. There exists another less serious, moral hazard problem for the distribution company, which will have less incentive to hold on to the large customers, since no direct losses are attributable to them.



C. The artificiality of the contracts favors a concentrated market structure

The tranche contracts are artificial, because they do not correspond to the way electricity is actually produced. Each tranche contract requires the seller to deliver energy in a fixed proportion of the total load. As the demand fluctuates during the day, the seller obligation to deliver electricity requires the ability to track such fluctuations. However, physical constraints and considerations prevent many generators from changing their outputs to respond to changing demand. For example, some large units require long startup times and, once in operation, cannot violate the minimum up-time constraints. Similarly, when some thermal units are shut down, they cannot operate over some time periods. Such constraints require the use of a portfolio of different generators that together are capable of meeting the variations in demand.

We categorize demand into three distinct classes: base, cycling, and peak. The baseload portion is served by generating units that operate around the clock either at full capacity or fractions thereof. The baseload is strongly dependent on the economics of a region and the work/leisure pattern of the population and may be considered to be more or less constant. Intermediate load is, in general, served by more expensive blocks of the baseload units. The principal factors that impact cycling load are economics and weather. Over different seasons we may expect differences in the cycling loads but some regularity in the patterns of their recurrence. The peaking loads are served by the most expensive segments of the committed units or dedicated generators that operate only during peak demand periods.

The artificiality of the tranche-based product arises from the fact that such products can be efficiently ''created'' only by a set of generators for base, cycling,

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and peaking applications. The product definition requires that each seller become an aggregator of the outputs of several types of generation resources. Therefore, each seller of tranche-based products is forced to take the role of a ''mini-distribution'' company serving a scaled replica of the buying entity's load for a particular customer class. Such a requirement constitutes a serious problem for small generation companies or companies that specialize in a single generation technology. To allow such entities to participate in the forward contracts market, the companies need to negotiate agreements among themselves so as to be capable of providing the energy required by the tranche contracts. Note that this is not a problem for large generation entities with many units of different generation technologies that can be deployed to efficiently supply the shape of the load.

We conclude that the tranche contracts favor big companies. While these companies already have the capability of supplying the shape of the load, small companies have to incur transaction costs in finding and negotiating agreements to participate in the auctions for tranche-based contracts.[28] If this market design persists for a sufficiently long time, the market structure will naturally become more concentrated, so as to allow players the cost advantages of big companies.

D. Tranche-based products undermine aggregation of information

The use of tranche-based products undermines the market function of aggregation of information. To understand this effect, let us assume for simplicity that the contracts are negotiated in a competitive idealized financial market, many days before its realization. We will show that the typical contracts for electricity have the property that the contract price reflects the information about its expected future price, but that this is not true for tranche-based contracts.

Consider a contract for the delivery of 1 MWh of future energy, negotiated today at $20/MWh. Since we are considering a competitive market, this means that the expected price of the contract tomorrow is also $20/MWh. If this were not the case – that is, if most participants in the market expect that price of the contract will be, say, $25/MWh – it would make sense for those participants to buy this contract and make an expected profit tomorrow. As the demand for the contract increases, the price increases, eventually reaching the new equilibrium of $25/MWh. In this fashion, the competitive market for the contracts reflects the aggregation of the information available to market participants. In other words, the efficient market hypothesis holds, that is, the market for contracts is ''informationally efficient'' in the sense that prices already reflect all known information.[29]

Now, consider the contract of a tranche-based product of, say, 1 percent of load. Assume also that its current price is again $20/MWh and the estimated total load is 100 MWh. This situation is similar to the previous one, where the owner of the contract expects to receive $20. However, this does not mean that most participants think that tomorrow's price will be $20/MWh, as before. To see this, suppose that most participants believe that tomorrow's price will be $25/MWh, but that the total load will be only 80 MWh. If those market participants care only about the total revenue of the contract, then they have no incentive to buy the contract. If they buy at the current prices and the estimated load, they expect to pay $20 for the 1 percent tranche contract; if they expect tomorrow a price of $25/MWh but believe a load of 80 MWh, they will receive exactly the same $20. Thus, there is no opportunity to make profits and there will be no excess demand for the contracts today. That is, the price of the contract remains \$20/MWh, despite the belief of most participants that it will be \$25/MWh. This strange fact occurs because the tranche contract has an extra dimension of uncertainty in addition to the uncertainty in price, that is, the actual load shape, which cannot be collapsed into a single-dimensional price. This problem undermines the market function of providing price signals for future investments. Since they cannot convey proper information, an important advantage of the use of contracts is lost.

The problems qualitatively discussed in this section are important and are likely to explain most of the problems that occurred in the 2006 Illinois Electricity Auction. However, this list of problems is not exhaustive: other problems not discussed here, such as efficiency, can also be important. Although it seems almost impossible to provide *quantitative* figures for the relevance of these problems, it is clear that their existence calls for a careful consideration of alternative product definition. We offer an alternative product definition in the next section.

V. An Alternative Product Definition Proposal

We propose a product definition for electricity auctions for future supply that is aligned with the way electricity is generated. Our proposed product definition focuses on the three load segments – base, cycling, and peaking – and we define unitary product for each segment of load. We introduce two threshold load levels expressed in MW to specify the three segments. The threshold $\mathbf{l}_b$ determines the base load segment of the specified period. The threshold $\mathbf{l}_p$ determines the peak load segment of the specified period. The loads between the levels constitute the cycling load segment during the specified period. The thresholds and the load segments are illustrated in **Figure 6**.

We decompose each load segment into multiple horizontal blocks. The duration of each block may be specified in terms of the percentage of the total contract duration. For example, the baseload, cycling and peaking products can require a supply of 100 percent, 70 percent, and 20 percent of the time, respectively. Moreover, a specification of the block size expressed in MW is made. For the specified period, the product is sold in multiples of the block size. Consequently, the demand is specified in terms of the total number of blocks for each segment. We conceptually illustrate this block-based product definition in Figure 6.[30]

In contrast to the tranche-based product, the block-based product reduces considerably the volumetric and capacity uncertainty faced by the sellers from that in the tranche-based product definition. For one, the dependence on the load shape is not present in the block-based product definition. Each seller has to face only the typical uncertainties encountered by generation entities having to do with forced outages and fuel costs. However, the distribution utility buying entities will have to face the uncertainty in the load shape and the load forecast. Therefore, it is the buyer's responsibility to deal with the mismatches between supply and actual load. For the case where the actual load differs from that driving the block-based product definition, the distribution entity must cover the differences, as illustrated in Figure 6. The distribution entity can deploy bilateral transactions and market purchases/sales to deal with such mismatches.

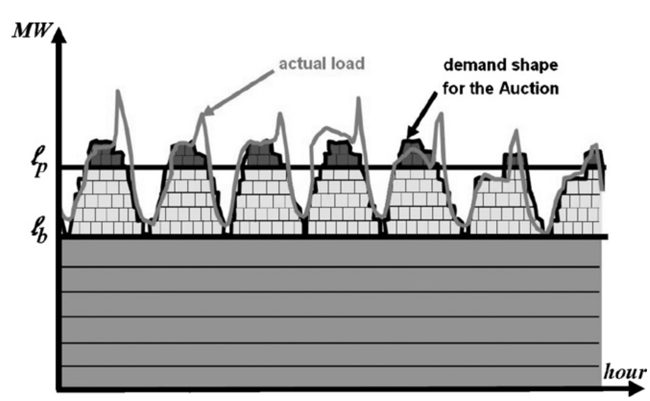


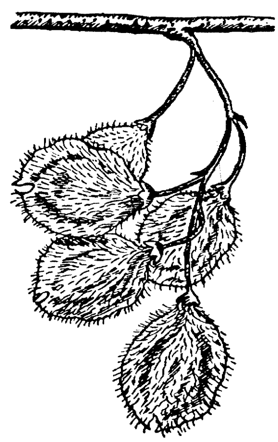
Figure 6: Meeting the Demand of the Distribution Entity using the Proposed Product Definition

Under the block-based product definition, a seller need not have resources to participate in all three load segments. Since a seller is no longer serving a scaled version of the whole load, as is the case in the tranche-based product, the valuation of the expected cost to supply the products can be better estimated. Additionally, the block-based product definition produces a decomposition of the supply system into three related components. Such a decomposition can introduce competition into the market for each segment so as to not result in a high price for each load segment.

In addition to the specific values of the parameters associated with the block-based product definition such as load thresholds, capacity level, and duration, which depend on the characteristics of the auction target jurisdiction, there are several issues to be studied in specifying the format and the rules for the auction mechanism using block-based products. Key issues include the simultaneity or the sequence of the auction for the three segments and the payment rules.

VI. Concluding Remarks

We described in this article the insights and lessons we learned from our assessment of the 2006 Illinois Electricity Auction. This article sheds light on the central importance of product definition, an aspect of the market design that has been overlooked in the literature. We found major shortfalls in the ability of the Auction to meet the objectives of forward markets to economically and reliably meet future supply needs. The tranche-based contracts shield the buyers from uncertainty, at what turned out to be excessive prices based on the



first-year experience. We show that this risk shifting is not in the interest of the consumers. We further show that the auction outcomes lead to a higher concentration in the market and undermine the information aggregation function of the designed market. We propose a block-based definition for overcoming the problems identified so as to improve the outcomes of mid-term supply contracts. Our proposed product definition is able to capture the salient characteristics of electricity in a more natural way. Future research efforts have to focus on the implementation of the block-based product definition and the appropriate auction format to trade such products.■

Endnotes:

1. See Paul Klemperer, *What Really Matters in Auction Design*, J. Econ. Perspectives, Vol. 16, No. 1 (2002), at 169–189.

2. See Natalia Fabra, Nils-Henrik von der Fehr and David Harbord, *Modeling Electricity Auctions*, Elec. J., Aug./Sept. 2002, at 72–81, and Chantale LaCasse and Thomas Wininger, *Maryland versus New Jersey: Is There a 'Best' Competitive Bid Process?*, Elec. J., April 2007, at 46–59.

3. The seminal paper of William Vickrey, *Counterspeculation, Auctions, and Competitive Sealed Tenders*, J. Fin., Vol. 16, No. 1 (1961), at 8–37, already discusses different auction formats and their impact in terms of revenue. Since then, so many results were obtained that important economists consider that ''by any standard measure, auction theory has been an enormous success''; see Erik Maskin, *The Unity of Auction Theory: Milgrom's Masterclass*, J. Econ. Literature, Vol. 42, No. 4 (2004), at 1102–1115.

4. Similar contracts are also used in New Jersey and Maryland, but we will focus on the Illinois experience.

5. See Luiz A. Barroso, Jose Rosenblatt, Andre Guimaraes, Bernardo Bezerra and Mario V. Pereira, Auctions of Contracts and Energy Call Options to Ensure Supply Adequacy in the Second Stage of the Brazilian Power Sector Reform, Power Engineering Society General Meeting, 2006, IEEE, June 18–22, 2006; Hugh Rudnick, and Sebastian Mocarquer, Contract Auctions to Assure Supply Adequacy in an Uncertain Energy Environment, Power Engineering Society General Meeting, 2006. IEEE, June 18–22, 2006; and Luiz A. Barroso, Hugh Rudnick, Rodrigo Moreno and Bernardo Bezerra, Ensuring Resource Adequacy with Auctions of Options and Forward Contracts, Power Engineering Society General Meeting, 2007. IEEE, June 24–28, 2007.

6. Further details about the 2006 Illinois Electricity Auction can be found in NERA Economic Consulting, Illinois Auction Rules, at: http://www.illinois-auction.com.

7. See NERA Economic Consulting, *Public Report Presented to The Illinois Commerce Commission*, at: http://www.illinois-auction.com.

8. Some authors define ''reverse'' as the fact that there are more sellers than buyers.

9. There are two customer classes for ComEd, CPP-B and CPP-A, with the following characteristics:

- CPP-A or Competitive Procurement Process – Annual: larger commercial and industrial customers with demand greater than 400 kW;
- CPP-B or Competitive Procurement Process – Blended: residential, designated lighting service, and small commercial customers with demand less than 400 kW.

Analogously, the Ameren subsidiaries consist of two customers classes, BGS-FP and BGS-LFP, that are characterized by:

- BGS-FP or Basic Generation Service – Fixed Pricing: residential and small business customers with demand under 1 MW;
- BGS-LFP or Basic Generation Service – Large Customers Fixed Pricing: large commercial and industrial customers with demand greater of equal to 1 MW.

10. The expected peak volume was evaluated using historical data for each load class.

11. All the contracts had the same starting point. Hence, 100 percent of the load was procured for the first 17 months.

12. Midwest ISO and PJM are the two independent system operators in Illinois.

13. The LMP at a particular bus is the price at which an additional MWh of electricity can be bought or sold at the node at a specified time.

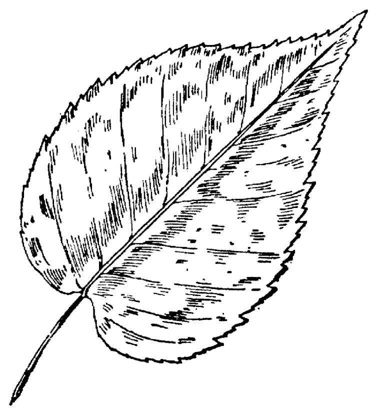
14. We perform a similar analysis for the Chicago-Hub of PJM obtaining similar results.

15. See Staff of the Midwest ISO, Business Practice Manuals for Energy Markets, at: http://www.midwestmarket.org.

16. A rearrangement of the chronological values is performed in the same way of load duration curves.

17. Less volatility also implies less risks of default, thus enhancing the performance of the market. Default is likely in energy market without contracts because the sums involved and the price fluctuations are huge.

18. The reduction of prices is not granted in all cases. For a recent



discussion, see M. Angeles de Frutos and Natalia Fabra, ''On the Impact of Forward Contract Obligations in Multi-Unit Auctions,'' 2008, mimeo, Universidad Carlos III de Madrid and the references provided therein.

19. Since the contracts are negotiated between distribution companies and generators, a reasonable question would be why the consumers' point of view should be considered here. The simplest answer is: for the same reason that this is a regulated market.

20. Volumetric and capacity are related with the uncertain energy and power, respectively.

21. Although consumers also care about the reliability of the service, they do not care about the total load, which is a concern only for distribution companies.

22. This result is well known to economists and may be found in standard microeconomics textbooks. See, for instance, Andreu Mas-Colell, Michael D. Whinston and Jerry R. Green, MICROECONOMIC THEORY (Oxford Univ. Press: 1995), at 187–188.

23. We are not considering the regulatory risks associated with the resistance of the regulatory body to pass the energy costs on to consumers. This is a real risk, illustrated by the California crisis.

24. Switching statistics are available at the ICC Web site at: http://www.icc.illinois.gov/industry/publicutility/energy/switchingstatistics.aspx.

25. However, given the high prices attained in the auction, such shifts have close to zero probability.

26. Information asymmetry occurs when one party to a transaction has more or better information than the other party. Economists classify the information asymmetry as adverse selection when the asymmetry refers to information about the characteristics of the good or service being transacted. Moral hazard arises when the actions of an individual after the transaction may affect the value of the good or service and this individual does not bear the full consequences of its actions. For further discussion, see textbooks in microeconomics, as that cited in endnote 23 above.

27. This is exactly the conclusion of the well known ''market for lemons'' example. See George A. Akerlof, *The Market for ''Lemons'': Quality Uncertainty and the Market Mechanism*, Q. J. ECON., MIT Press, Vol. 84, No. 3 (1970), at 488–500.

28. For a discussion of transaction costs, see OLIVER HART, FIRMS, CONTRACTS, AND FINANCIAL STRUCTURE (Oxford Univ. Press, 1995).

29. Eugene F. Fama *Efficient Capital Markets: A Review of Theory and Empirical Work*, J. FIN., American Finance Association, Vol. 25, No. 2 (1970), at 383–417.

30. Our product definition allows details to be added to the contract, as it may be convenient in specific circumstances. For instance, in a private conversation, Natalia Fabra suggested specifying a fixed daily period of production for some of the contracts in the cycling category.

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