AGGREGATE INDUSTRIAL ENERGY CONSUMER RESPONSE TO WHOLESALE PRICES IN THE RESTRUCTURED TEXAS ELECTRICITY MARKET (DRAFT)

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Abstract

The aggregate response of consumers to wholesale price signals is very limited in the restructured Electric Reliability Council of Texas (ERCOT) market. An overall average own-price elasticity of demand of -0.000008 for industrial energy consumers served at transmission voltage is estimated using a Symmetric Generalized McFadden cost function model. To date, ERCOT has sought to promote demand response to price signals without reliance on "stand alone" demand response programs, but with a market structure that is designed to facilitate economic demand response. This very limited responsiveness to wholesale price signals may prove problematic in light of policy decisions to pursue an "energy only" resource adequacy mechanism for ERCOT.

Keywords: Demand Response, Price Elasticity, Restructured Market, Symmetric Generalized McFadden Cost Function.

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INTRODUCTION

As noted by U.S. Federal Energy Commission (2002): "Demand response is essential in competitive markets, to assure the efficient interaction of supply and demand, as a check on supplier and locational market power, and as an opportunity for choice by wholesale and end-use customers." Through the Energy Policy Act of 2005, the U.S. Congress affirmed the importance of expanding demand response opportunities as a matter of national policy. [2]

Nearly-vertical demand curves contribute to price spikes and volatility and can provide suppliers with greater market power if competition is imperfect. Studies repeatedly demonstrate that even a small amount of demand response to wholesale electricity prices can mitigate price spikes.[3]

In markets where an "energy only" approach is adopted to maintain resource adequacy, demand response plays an important role in maintaining a balance between supply and demand. This is particularly important in light of the cyclical nature of power plant construction activity. During periods when a market is left with inadequate reserve margins, demand response can provide an important backstop.

As electricity markets are redesigned to foster competition, stakeholders and policymakers are faced with the challenge of ensuring that consumers are presented with

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[2] *Energy Policy Act of 2005*, Section 1252(f). See also U.S. Department of Energy, *Benefits of Demand Response in Electricity Markets and Recommendations for Achieving Them: A Report to the U.S. Congress Pursuant to Section 1252 of the Energy Policy Act of 2005*. February 2006.

[3] For example: Ahmad Faruqui and Stephen S. George, "The value of dynamic pricing," *The Electricity Journal*, July 2002; Douglas Caves, Kelly Eakin, and Ahmad Faruqui (2000) "Mitigating Price Spikes in Wholesale Markets through Market-Based Pricing in Retail Markets," *The Electricity Journal*, April 2000; and ISO-New England, Staff White Paper, "Controlling Electricity Costs," June 1, 2006.

accurate price signals and the appropriate incentives to react to those prices in a manner that promotes economic efficiency and the efficient operation of the electricity market.

As the ERCOT market was redesigned in the 1999 to 2001 period to introduce retail competition and to refine wholesale operations, fostering demand response emerged as a policy objective. The Public Utility Commission of Texas (PUCT) ordered ERCOT to "Develop new measures and refine existing measures to enable load resources a greater opportunity to participate in the ERCOT market." (PUCT, 2000)

Due to features of the new market structure, some larger energy consumers who were formerly insulated from wholesale price signals through regulated tariffs with fixed pricing are now exposed to market-based wholesale market prices via creative contractual arrangements between retail electric providers (REPs) and consumers. A number of REPs offer "MCPE products" which enables a consumer to purchase power from the near-real-time balancing energy market through the REP and its scheduling entity. This is facilitated by ERCOT's "relaxed balanced schedule" policies, particularly since this policy was formalized in October 2002. The direct assignment of transmission costs to industrial energy consumers based on their contribution to monthly system peak demand in four summer months also provides a strong price signal.

The degree to which energy consumers react to wholesale price signals is not well known. Energy consumers do not presently announce to the market that they are responding to prices. There presently is no active economic demand response program which would encourage demand response to prices and quantify the magnitude of such responses. Customer-specific load data are regarded as confidential. Prior to the completion of this study, analyses of the price elasticity of demand in ERCOT were limited to a study of the twenty largest industrial energy consumers in the Houston area (Zarnikau *et al*, 2007), and some observations provided by ERCOT's system operations staff (Jones, Wattles, and Krein, 2006; and Wattles, 2007).

While the response of energy consumers to price signals in ERCOT is not well understood, this is a topic that is increasing in importance. The PUCT has adopted an "energy only" resource adequacy mechanism (with a number of backstops) which relies greatly on demand response to price signals to maintain planning reserves and reliability. ERCOT has suffered from unacceptably high errors in its short-term load forecasts (which contributed to blackouts in April 2006), and some insight into aggregate price elasticities could potentially improve forecast accuracy. There is presently a debate over whether the present strategy of fostering demand response without formal demand response programs attracts an adequate level of demand response or whether a stand-alone program based on priority service concepts should be established. Finally, ERCOT's transition to a nodal market structure will eliminate any advance notice of real-time wholesale market prices, and some have questioned whether the level of demand response that the market presently enjoys will be sacrificed as a result.

A quantification of the magnitude of aggregate demand response in the ERCOT market may be of considerable interest to researchers outside of Texas. ERCOT is widely viewed as the most successful of North America's attempts at electricity market restructuring and is often studied as a model for restructuring initiatives elsewhere. Thus, the success or failure of the Texas market in fostering demand response to wholesale prices may have lessons for other markets struggling with this same task.

ERCOT MARKET RULES

ERCOT's market rules provide a variety of possible incentives to encourage industrial energy consumers to respond to wholesale electricity prices. "Voluntary load response" or "passive load response" are terms used to refer to a customer's deviation from its scheduled or anticipated load level in response to price signals in situations where the customer has not formally offered this response to the market as a "resource." How and whether an industrial energy consumer is compensated or credited for responding to price signals is a contractual matter between the customer and its REP. A further explanation is provided in Demand Side Working Group, 2006.

The energy consumer's qualified scheduling entity (QSE) may earn a credit or payment when the generation it schedules into the market exceeds the generation requirements of the consumers for which it provides scheduling services. A consumer's REP will typically also serve as the consumer's QSE. While supply-side resources (e.g., power generation plants) are required to follow ERCOT-approved schedules, consumers are free to deviate from scheduled load levels (provided the consumer is not providing an ancillary service). This causes the consumer's QSE to go out of balance, *ceteris paribus*. When a QSE goes "out of balance," a payment or credit to the market is incurred. If a QSE's actual load level turns out to be lower than its scheduled load level during a given 15-minute interval (while its actual generation resources equal its scheduled generation), then the scheduling entity is entitled to a payment or credit based on the energy imbalance multiplied by the balancing energy market price. This provides loads with an incentive to respond to wholesale market prices, provided the consumer has an arrangement with its REP to share in the rewards associated with such response.

Some industrial energy consumers rely on balancing energy (essentially, spot market power) to meet some or all of their electricity needs, actively monitor the 15-minute balancing energy prices, and reduce electricity purchases when prices exceed threshold levels. Many REPs will simply pass-through the balancing energy costs, with a small mark-up. These are referred to as "MCPE products," since pricing is based on the market-clearing price of energy or MCPE. Under ERCOT's relaxed balanced schedule policy, QSE's are not required to fully arrange to a supply of generation to meet the anticipated needs of its consumer clientele, and may elect to purchase a share of their generation requirements from the balancing energy market. Many consumers find this strategy of relying on balancing energy to be advantageous, particularly if they possess the capability to reduce energy usage in the face of high market prices. Although balancing energy prices can be very volatile, the average cost of balancing energy tends to be lower (over the long run) than the cost of firm generation resources obtained via bilateral contracts. Energy consumers can view the Electric Reliability Council of Texas (ERCOT) web site to monitor near-real-time balancing energy (wholesale spot market) prices.[4] These prices are set about 10 to 15 minutes in advance of each 15-minute settlement interval.

For most large industrial energy consumers with a billing demand in excess of 700 kW, their transmission charge is based upon their contribution to ERCOT's coincident peak demand in four summer months of the previous year. Consequently,

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[4] See: http://mospublic.ercot.com/ercot/jsp/balancing_services_mcp.jsp

many consumers actively try to reduce energy consumption during expected peaks. Consultants now offer “4-CP forecasting models,” to assist industrial energy consumers in the avoidance of transmission charges. Often, transmission charges are treated as a “pass-through” cost in the contracts offered by REPs. Consequently, larger energy consumers may see direct benefits by avoiding the four summer peaks. Avoiding transmission charges provides a further incentive for voluntary or passive load response.

Many large industrial energy consumers possess the capability to interrupt or curtail its electricity purchases from the market at ERCOT’s request or in response to an under-frequency event. Consumers with this capability can provide an operating reserve through ERCOT’s markets for ancillary services and receive payments from the market or from a REP (through a bilateral contract). If an industrial energy consumer provides an ancillary service, then its ability to react to wholesale price signals will be constrained. The load is then relied upon by ERCOT to meet operating reserves needs. If the load is providing responsive reserves (the most popular type of ancillary service provided by industrial interruptible energy consumers), ERCOT will monitor the load’s level every three seconds to ensure that the load is available for interruption should the system need to rely upon the interruption of the load to maintain frequency. At any given time, about 1,150 MW of industrial load is providing an ancillary service to ERCOT. Thus many of the ERCOT’s most flexible, interruptible, or potentially price elastic electric loads are constrained from reacting to prices.

STATISTICAL ANALYSIS

To quantify the reaction of participants to changing hourly prices, statistical analysis was performed. Price elasticities, measuring the average responsiveness of the demand side of ERCOT's market to price changes, were estimated.

The degree of demand response exhibited by energy consumers may be affected by a variety of factors, including the consumers' flexibility in scheduling production, whether some of the consumers have committed to providing their interruptibility to the market as an ancillary service, the relative importance of electricity to the consumers, the consumers' other energy options (e.g., using natural gas as a substitute, backup generation, etc.), labor commitments, the magnitude of the price fluctuations, and the firms' daily production goals. In the statistical approach adopted here, electricity consumed in different time periods is treated as different inputs into the consumers' production function. The degree to which electricity purchases in different time periods are substitutes or compliments is measured empirically.

In developing a model to estimate customer responsiveness to wholesale electricity prices, a short-run daily production function is assumed:

$$Y = G(H(E_1, \ldots ,E_n), \boldsymbol{Z}) \qquad (1)$$

Here, production is determined by n various electricity inputs, where the inputs represent purchases of power during different periods of a day. H represents the electricity input function. E_i represents the amount of electricity consumed during time period i. $\boldsymbol{Z}$ is a vector of all other inputs (labor, raw materials, other energy resources, etc.). The production function is designed to describe only the consumer's short-run operating decisions. Production capacity and other capital inputs are assumed to be fixed. Weak separability or zero elasticity of substitution is assumed between the electricity inputs and all other inputs, $\boldsymbol{Z}$. This assumption is necessary because data on the prices and quantities used of these other inputs are not available.

A two-stage decision process is implied here. In the first stage, the industrial energy consumers determine their desired electricity consumption for the day, based upon production goals. In the second stage, consumers determine how to schedule operations and purchase electricity to meet daily output target.

The dual concave positively linear homogeneous cost function for the electricity input function may be expressed as:

$$C = c\,(P_1, \ldots, P_n; \boldsymbol{Q}; E^*) \tag{2}$$

C is the total cost of electricity. $\boldsymbol{Q}$ is a vector of exogenous factors affecting demand (e.g., daytype, weather, and natural gas prices). Following Aigner and Hirschberg (1985) and much of the literature, E^* representing total energy consumed, is used as a proxy for output. $P_1,\ldots,P_n$ denote the prices of the n different electricity inputs. Input levels are endogenous, while the hourly prices are exogenous (determined by the ERCOT market for balancing energy 10 to 15 minutes in advance of each 15-minute interval and based on the likelihood of a transmission charge).

Diewert and Wales (1987) introduced the Symmetric Generalized McFadden (SGM) functional form, through which concavity can be globally enforced. Thus, the SGM form can introduce an important microeconomic condition that is not often satisfied in applied econometric analysis. Kumbhakar (1990 and 1992) provides example applications. Patrick and Wolak (1997) used an SGM form in their study of the responsiveness of energy consumers to price signals in the restructured UK electricity market, and Nemoto and Goto (2004) used an SGM model in an analysis of economies of scope in vertical integration among electric utilities. Zarnikau *et al* applied an SGM model to estimate the responsiveness of the 20 largest industrial energy consumers in Houston to wholesale electricity prices.

It should be noted that the global concavity of the SGM comes at a cost, especially when concavity conditions are imposed through reparameterization (as discussed below) and the number of inputs is large. In such a case, the system of demand functions is difficult to estimate. Computational requirements are great and convergence problems are common. Consequently, using the SGM requires much greater research time and attention than application of the popular alternative functional forms (e.g., translog, constant elasticity of substitution, generalized Leontief, and almost ideal demand system models).

Following the exposition provided by Kumbhakar (1990 and 1992), the SGM cost function may be written as:

$$C(.) = g(\boldsymbol{P})E^* + \sum_i b_i P_i + \sum_i b_{ii} P_i E^* + \sum_i \sum_j d_{ij} P_i Q_j E^* + \sum_j a_j (\sum_i \phi_{ij} P_i) Q_j + b_{YY} (\sum_i \beta_i P_i) E^{*2}$$
$$+ \sum_k \sum_j \delta_{kj} (\sum_i \lambda_{ijk} P_i) Q_k Q_j E^* \qquad (3)$$

Where

$$g(\boldsymbol{P}) = \boldsymbol{P'SP/2\theta'P} \qquad (4)$$

$\boldsymbol{S}$ is an N x N symmetric negative semi-definite (NSD) matrix such that $\boldsymbol{S'}\ \boldsymbol{P}^* = 0$ with $\boldsymbol{P}^* >> 0$.

The parameters ϕ_{ij}, b_{yy}, and λ_{ijk} are assumed to be exogenously determined, and are therefore not estimated. The remaining parameters are estimated. As noted above, E^* represents total daily electricity consumption and is used as a proxy for the firm's output. Variables in the set $\boldsymbol{Q}$ include: CDH (cooling degree hours), a measure of weather; NGP, the daily natural gas price; and DAYT, a binary dummy variable with a value of 1 for weekdays. All variables have a daily time frequency, although the time subscript on the variables has been dropped to simplify this presentation.

To ensure that the cost function is globally concave in the input prices, $\boldsymbol{S}$ must be NSD. This is ensured by reparameterizing $\boldsymbol{S}$ as $\boldsymbol{S} = -\boldsymbol{\Gamma}\boldsymbol{\Gamma}'$ where $\boldsymbol{\Gamma}$ is a lower triangular matrix, the parameters of which are directly estimated.

Via Shephard's Lemma ($\delta C / \delta P_i = X_i$), partially differentiating the cost function with respect to the factor prices yields the derived demand functions for the factors of production. This yields:

$$X_i = E^* \{ [\boldsymbol{S}^{(i)} \boldsymbol{P}] / (\boldsymbol{\theta' P}) - (\theta_i / 2) [\boldsymbol{P'SP}] / (\boldsymbol{\theta' P})^2 \} + b_{ii} E^* + b_i + b_{YY} \beta_i E^{*2} + \sum_y \gamma_{ij} Q_j E^*$$

$$+\sum_j a_j \phi_{ij} Q_j + \sum_k \sum_j \delta_{kj} \lambda_{ijk} Q_j Q_k E^* + \varepsilon \tag{5}$$

Where ***S' P*** = *0* and *ε* is a random disturbance term. $\boldsymbol{S^{(i)}}$ is the i^th^ row of the ***S*** matrix.

Within-day electricity consumption was modeled as 96 commodities (one for each 15-minute interval within a 24-hour day) to permit analysis of consumption shifting behavior in response to price fluctuations. Thus, i = 96 in this application.

Following Patrick and Wolak (1997) and Taylor, Schwarz, and Cochell (2005), Fourier series are used to reduce the set of parameters to be estimated to a manageable number. The matrix ***Γ*** is decomposed into three components:

$$\boldsymbol{\Gamma = D + G + H} \tag{6}$$

Matrix ***D*** is diagonal. Matrices ***G*** and ***H*** are lower triangular with zeros on the main diagonal. The elements of each of these three matrices are represented by Fourier series, as follows:

$$D_{ii} = d_{00} + \sum_{j=1}^{Nd} (d_J * \cos(i * 2\pi * j / 96) + d_{j+Nd} * \sin(i * 2\pi * j / 96)) \tag{7}$$

$$G_{ij} = G_i * G_j, i \geq j, else 0 \tag{8}$$

$$G_k = g_{00} + \sum_{l=1}^{Ng} (\phi_l * \cos(k * 2\pi * l / 96) + g_{l+N\phi} * \sin(k * 2\pi * l / 96)), k = i, j \tag{9}$$

$$H_{i,j} = h_{00} + \sum_{k=1}^{Nh} (h_k * \cos(X_{i,j} * 2\pi * k / 4560) + h_{k+Nh} * \sin(k * 2\pi * k / 4560)),$$

$$i \succ j, else 0 \qquad (10)$$

$$X_{i,j} = 191 * j/2 - 96 - j^2/2 + i \qquad (11)$$

Following Taylor, Schwarz, and Cochell (2005), we set Nd = 5, Ng = 3, and Nh = 3. These same values worked quite well in this application.

Following Kumbhakar (1990 and 1992) and Nemoto and Goto (2004) a variety of parameters that are assumed to be exogenous to the system or that cannot be uniquely identified are set equal to the mean of X_i. These parameters are θ_i, ϕ_{ij}, β_i, and λ_{ijk}. One of the variables in the set $\boldsymbol{Q}$ is a binary dummy variable, namely DAYT. Because DAYT^2 = DAYT, there is perfect multicollinearity among these two variables. Consequently, the parameter $\delta_{DAYT,DAYT}$ is not estimated.

The within-day electricity demand functions (Eq. 5) for each of the 96 15-minute time periods were estimated using Zellner’s iterative seemingly unrelated regressors method (which is asymptotically equivalent to a maximum likelihood estimator) using SAS software. The parameters within the matrix $\boldsymbol{\Gamma}$ are shared by the demand functions constructed for each of the eight time periods. In this application, there are 486 model variables, of which 390 are exogenous. There are 1,368 parameters to be estimated.

The price elasticity of demand for electricity in period i based on a change in the wholesale price of electricity in period j is:

$$E_{ij} = \{P_j E^* / X_i\}[s_{ij} / \boldsymbol{\theta' P} - [S^{(i)}\theta_j + S^{(j)}\theta_i]\boldsymbol{P'/\theta'P}]^2 + \theta_i\theta_j[\boldsymbol{P'SP]/(\theta'P)}]^3 \qquad (12)$$

In this paper, elasticities are reported at the mean values of each input vector. Since concavity is imposed globally, the own-price elasticities are negative at each data point.

DATA SOURCES

Aggregate 15-minute interval demand data for all energy consumers served at transmission voltage from January 2, 2002 through April 7, 2005 were used in the estimation. The aggregated load of this group of energy consumers tends to be in the 10 GW to 11 GW range. Data from the first day of the new market, January 1, 2002, were not used because technical problems resulted in an anomalous price spike during that day.

During this period of time, all customers with a billing demand of over 1 MW were required to have IDRs capable of collecting 15-minute usage data and scheduling entities were settled based on this data. All of the transmission voltage energy consumers were above this threshold, and thus 15-minute data were available. Further, transmission costs were allocated on a customer-specific basis to energy consumers with a billing demand over 1 MW, so all of the consumers in this group had an economic incentive to respond to 4-CP transmission price signals. Thus, this group of energy consumers has the metering infrastructure and market settlement rules necessary to enable them to participate in arrangements which could reward their response to wholesale price signals. This is in contrast to smaller energy consumers who are settled based upon profiles reflecting the average temporal pattern of energy usage for a particular customer classification.

The wholesale price (market-clearing price) of electricity in ERCOT's balancing energy market in dollars per MWh for each 15-minute interval was obtained from ERCOT. Note that these prices are exogenous. Prices are set prior to each interval, and a price response by the group of industrial energy consumers does not affect the price. Further, ERCOT's short-term load forecasting models lack variables to account for price response.

Expected transmission prices, based on the costs that are assigned to industrial consumers that purchased electricity during the four summer coincident peaks, were added to the balancing energy prices. The expected transmission prices were estimated using a logit model. It was assumed that during the four summer months the likelihood of a 4-CP was a function of the temperature in a given hour relative to the average temperature in the month. The logit parameters and odds ratios were estimated and predicted values – providing an estimate of the probability of the 4-CP occurring during any interval within the month – were obtained. These probabilities were multiplied by the actual transmission costs to provide an estimate of the expected value of the transmission costs during each interval of each summer month.

Hourly temperature data for Austin (a central location within the ERCOT market) were obtained from the National Oceanic and Atmospheric Administration. Cooling degree hours were calculated using a base temperature of 65 degrees F. These data were converted into a time series of cooling degree hours. Cooling degree hours were assumed to be the same for each 15-minute interval within each hour.

The daily price of natural gas on the NYMEX Exchange was also included as a variable, to account for possible fuel switching behavior. Many large industrial energy consumers have cogeneration facilities fueled with natural gas. Thus, it is conceivable that an energy consumer could adjust cogeneration levels and/or switch between electricity and natural gas in order to minimize energy costs.

Estimation and simulation of the model requires about 10 hours of run time on a personal computer with a 1.6 GHz processor and 1 GB of RAM.

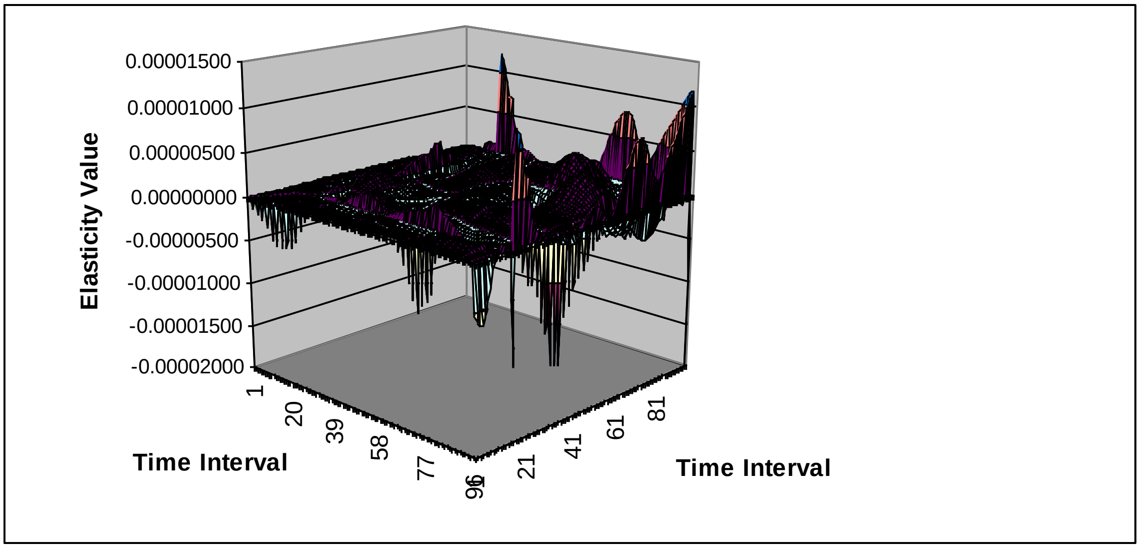
RESULTS

Figure 1 graphically presents the estimated price elasticities of demand, evaluated at the mean of each input vector. In this representation of the symmetric elasticity matrix, the height of the curve represents the value of the elasticity estimate. The numbers on the X and Y axes indicate the associated row or column of the matrix.

The own-price elasticity values (on the main diagonal) are consistently negative, as required by the modeling structure. As alternative or substitute inputs to the customer's production function, positive cross-price elasticities between the electricity inputs would generally be expected. Yet, consumption, particularly in adjacent periods, may often be complements. Rigidities in production scheduling within labor shifts may account for some of the negative cross-price elasticity estimates. A mix of negative and positive cross-price elasticities were estimated.

Figure 1

Estimated Elasticity Values



Results from the SGM model suggest very limited responsiveness to price changes by this group of industrial energy consumers, in the aggregate. The own-price elasticities average -0.000008. All cross-price elasticities are within the range of 0.000015 to -0.00002. There appears to be little pattern to the price elasticities. Many of the cross-price elasticities late in the day were high, relative to other periods. Yet, all of these values are quite low relative to the values reported in recent studies of other restructured electricity markets (e.g., Patrick and Wolak, 1997) and the more credible studies of consumer response to prices under real-time pricing programs (e.g., Taylor, Schwarz, Cochell, 2005; and Goldman *et al*, 2004).

The R^2 statistics for the 96 demand functions were never lower than 0.8, and generally exceeded 0.95. The majority of the model parameters were significantly different from zero at the levels of significance typically employed. Because the parameters of the Fourier series are used in the construction of all of the elasticity estimates, any attempt to associate standard errors with a particular elasticity estimate may be misleading. Yet, the magnitude of the elasticity value may provide some indication of the relative significance of the elasticity estimate.

CONCLUSION

In the aggregate, the demand side of ERCOT's market exhibits very little responsiveness to wholesale electricity prices. A number of factors may be responsible for this limited response, including the types of service typically offered by REPs, the short notice period that consumers receive of price changes, constraints on the ability of interruptible energy consumers providing ancillary service to respond to prices, and the difficulties and costs inherent in monitoring and responding to price signals.

The results reported here are consistent with Zarnikau *et al* (2007) which found that only a couple of the twenty largest industrial energy consumers in Houston were actively responding to wholesale prices. Based on some simple comparisons of the aggregate load levels of transmission voltage energy consumers between days of likely 4 CP charges and adjacent days, the ERCOT staff has identified about 600 MW of aggregate demand response, or about a 1% reduction in demand. (Jones, Wattles, and Krein, 2006). The limited response observed by the ERCOT staff would appear consistent with the findings reported here. An ERCOT staff analysis of the trend in total ERCOT load during a day of multiple price spikes in the market for balancing energy suggested no discernable response to the price changes during the first couple price spikes and some small but noticeable deviations from trends during some later price spikes within April 3, 2007. (Wattles, 2007) ERCOT is presently surveying all load-serving entities participating in the ERCOT market to collect further insights into the demand response activities, including pricing programs and load management programs which are operated on a bilateral basis between load-serving entities and energy consumers and not visible to the wholesale market and ERCOT's system operators.

Market changes are presently being implemented which may increase demand response in ERCOT. The "offer cap" on wholesale prices was increased from $1,000 per MWh to $1,500 per MWh on March 1, 2007. This increase was designed in part to provide energy consumers with a greater incentive to respond to prices. A day-ahead energy market will be implemented around 2009. New metering infrastructure will provide the technology necessary to reward residential energy consumers who respond to price signals. Yet other market changes could further limit demand response. For example, the notice period prior to calculation of a real-time wholesale market price will be eliminated when the ERCOT market transitions to a nodal structure in 2009.

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