

Demand Elasticity in the California Power Exchange Day-Ahead Market

The price elasticity of demand in the California PX is significantly greater than what theory might predict. A structurally induced elasticity in the day-ahead market limits the degree to which a supplier can profitably withhold within that market.

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The responsiveness of demand to price is generally thought to be very low in electric power markets. That is, the elasticity of demand is often thought to range from zero in real-time markets (no response) to about 0.1 to 0.3 in medium- to long-term retail settings. Few studies have been available of the price elasticity of demand in wholesale electricity markets. This article examines the price elasticity of demand in the California Power Exchange's day-ahead market and finds that there is a surprising amount of elasticity. In particular, the elasticity of demand is greater than 1.0 in 27 percent of hours.

I. Introduction

It helps to start with a definition of price elasticity. The price elasticity of demand is, roughly, the responsiveness of demand to changes in price. That is, it is how the quantity that is demanded changes in response to an increase in price. As a measure of demand responsiveness, elasticity is defined to be the percent change in quantity demanded that results from a percent change in price.¹ For example, an elasticity of 1.0 means that a 1 percent increase in price results in a 1 percent decrease in quantity demanded.

Figure 1 shows a demand curve

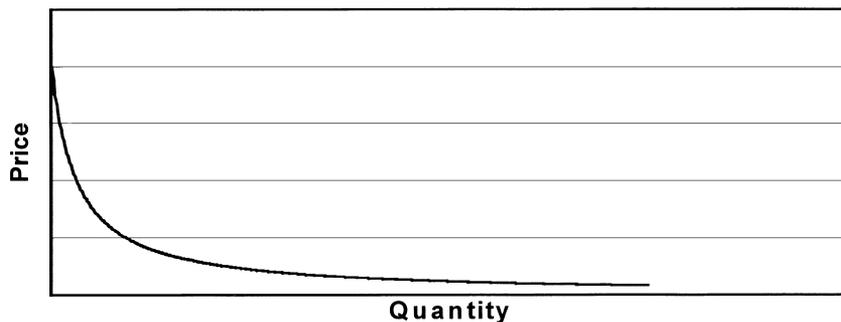


Figure 1: Demand Curve with Elasticity of One for All Quantity Levels

with an elasticity of 1.0 for every quantity level. Note that even though the slope is different at different levels of demand, the elasticity is the same. This is because elasticity is defined as the percentage change in quantity per percent change in price, not the change in absolute level. So, the slope in Figure 1 is greater at lower demand levels than it is at higher levels.

Elasticities over 1.0 mean that when the price rises 1 percent, the quantity demanded *decreases* by more than 1 percent. For example, if the elasticity is 2.0, an increase in price of 1 percent implies a 2 percent decrease in quantity demanded. Conversely, elasticities under 1.0 mean that for a 1 percent increase in price, quantity decreases by less than 1 percent.

Table 1 summarizes the situation.

An elasticity of zero means that the demand curve is a vertical line, as illustrated in **Figure 2**. Real-time demand for electricity is often considered to have zero elasticity, and some modelers of electricity markets use a zero elasticity of demand.² In this situation, no matter what the price, demand is the same.

The importance of demand elasticity is the ability of the market to

respond to price signals. When demand is inelastic, the market is less able to respond to price signals. When demand is more elastic, it is better able to respond to price signals. Moreover, the ability of a producer to profit by raising prices is limited by the elasticity of demand. When demand is inelastic (less than 1.0), a producer can profit by raising prices, since the percent decrease in demand is less than the percent increase in price. On the other hand, when demand is elastic (more than 1.0), if a producer raises its price, it loses more in volume than it gains from the price hike.

Because of the still-low market penetration of real-time meters,³ the ability of end-use consumers to respond to price signals is very limited. As a result, real-time demand for electricity is often considered to have an elasticity of zero. It is unable to respond to price signals. Most studies of the

elasticity of demand for electric power have elasticities in the range of 0.05 to 0.9. The length of the response time varies from study to study. In general, the shorter-term estimates had much smaller elasticities (below 0.3); moreover, many of the studies examined were based on data from real-time pricing experiments.⁴

While it is clear that the retail, end-user demand for electric power remains very inelastic, there appears to be significant elasticity in the day-ahead market of the California Power Exchange (PX). This elasticity might be “structurally induced,” due to the fact that the market in California really consists of a series of markets. Multiple opportunities to buy and sell power could allow buyers to be more elastic in the forward day-ahead market than they are in real-time. Before exploring this idea further, this article briefly explains the structure of the California electricity markets, discusses the methodology for measuring elasticity in the day-ahead market, and presents the results of the study.

II. The California Power Exchange Electricity Markets

The California Power Exchange gives buyers and sellers of electric

Table 1: Relationship of Elasticity Level to Change in Quantity Given a Change in Price

| Elasticity | Change in Quantity |
|------------------|---|
| Less than one | Decrease more than change in price; inelastic |
| One | Decrease equal to change in price |
| Greater than one | Decreases greater than change in price; elastic |

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