

# RTP and demand-side bidding in restructured electricity markets

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# Outline of Presentation

- RTP in the England & Wales market (Patrick and Wolak 1997, 2001)
  - The E&W market
  - Estimating-customer level demands
  - Demand side bidding
  - Designing pricing options
- Sufficient RTP can mitigate market power but not likely to eliminate it, price caps or RTP and price caps won't either

# RTP in the E&W electricity market

- “Pool Price Contract” (RTP) option initially offered to customers with greater than 1MW demands in 1991/92
- MEB had 370 commercial and industrial customers (of approx. 500) under RTP, with approx. 25% replacement
- 1994 MW demand limit reduced to 100KW, resulting in approximately 150 additional MEB customers
- 2001 all customers can now choose RTP

**Table 1: Two-Digit 1980 BIC Codes and Total Number of Customer-Year Pairs**

<b>BIC</b>	<b>Description</b>	<b>Total Customer Years</b>
14000	mineral oil processing	11
16000	prod. & dist. of electricity, gas, & other forms of energy	9
17000	water supply industry	31
22000	metal manufacturing	138
23000	extraction of minerals not elsewhere specified	31
24000	manufacture of non-metallic mineral products	180
25000	chemical industry	44
31000	manufacture of metal goods not elsewhere specified	427
32000	industrial plant and steelwork	75
33000	manufacturing of office and data processing equipment	10
34000	electrical and electronic engineering	70
35000	manufacture of motor vehicles and parts thereof	66
36000	manufacture of other transport equipment	13
37000	instrument engineering	5
41000	food, drink & tobacco manufacturing industries	55
42000	sugar and sugar by-products	52
43000	textile industry	29
45000	footwear and clothing industries	1
46000	timber and wooden furniture industries	31
47000	manufacture of paper & paper products; printing & publishing	73
48000	processing of rubber & plastics	72
49000	other manufacturing industries	130
61000	wholesale distribution (except in scrap & waste materials)	58
63000	commission agents	22
64000 & 65000	retail distribution	67
66000	hotels and catering	4
67000	repair of consumer goods and vehicles	2

# E&W RTP customers pay

- Half-hourly market prices which are largely known with certainty from the day-ahead perspective
- Demand charge coincident with system peaks, only known ex-post of consumption

# E&W Market Prices

- Half-hourly price paid to generators per kWh is determined the day-ahead:

$$PPP = SMP + CC$$

SMP determined by supply = forecast demand

$$CC = \text{LOLP} \max\{0, \text{VOLL} - \text{SMP}\}$$

- Unless hedged, the price paid by retailers purchasing electricity from the pool:

$$PSP = PPP + \text{UPLIFT}$$

- UPLIFT covers availability payments for generation not called on line, demand forecast errors, etc., and is only known *ex post* of consumption

<b>Table 3</b>			
<b>Sample Means and Standard Deviations of Components of PSP</b>			
	<b>Year</b>	<b>Mean</b>	<b>Std Dev</b>
SMP	1	19.52	4.10
CC	1	1.29	8.76
UPLIFT	1	1.61	2.31
PSP	1	22.42	12.72
SMP	2	22.64	4.24
CC	2	0.17	1.70
UPLIFT	2	1.39	1.12
PSP	2	24.19	5.75
SMP	3	24.16	6.71
CC	3	0.28	2.97
UPLIFT	3	2.18	1.62
PSP	3	26.62	8.76
SMP	4	20.78	12.28
CC	4	3.22	24.49
UPLIFT	4	2.38	4.53
PSP	4	26.38	35.08

# Information to Pool Price (RTP) Customers

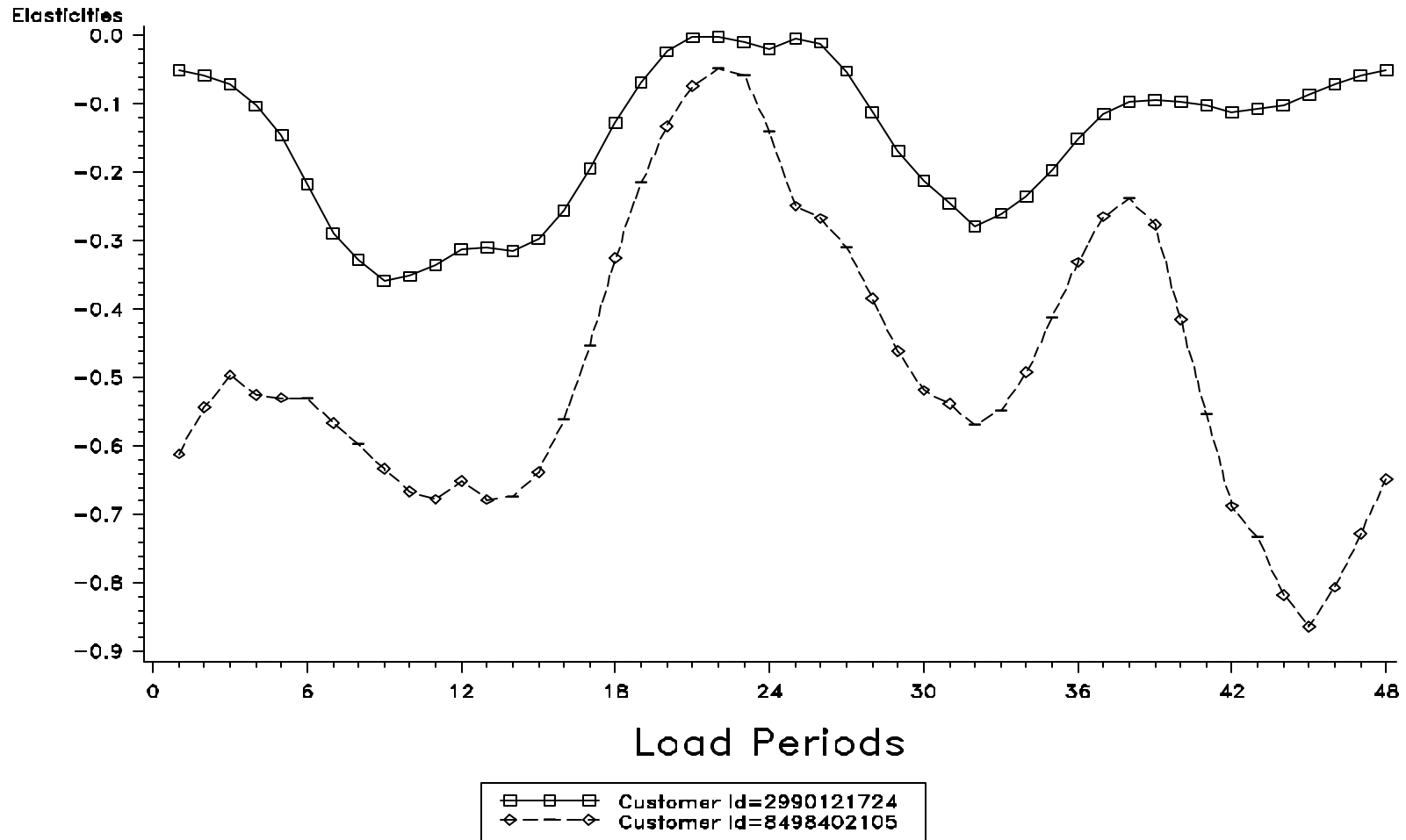
- Day-ahead fax containing components of price, including a forecast of UPLIFT
- Week-ahead warnings for potential demand charge periods
- Day-ahead warnings for likely demand charge periods

Time Ending	Period No.	FORECAST PPU FOR : 10/10/94 AND 11/10/94				Final PSP for 12/9/94 & 13/9/94
		SMP	Capacity Payment	Uplift	PSP	
5:30	11	0.992	0.000	0.000	0.992	0.954
6:00	12	0.997	0.000	0.000	0.997	0.955
6:30	13	1.003	0.000	0.000	1.003	0.994
7:00	14	1.670	0.000	0.245	1.915	1.586
7:30	15	2.857	0.068	0.248	3.113	1.913
8:00	16	3.835	0.042	0.257	4.134	1.981
8:30	17	4.000	0.068	0.260	4.320	1.993
9:00	18	4.000	0.081	0.268	4.349	1.996
9:30	19	3.835	0.071	0.265	4.171	2.144
10:00	20	3.835	0.072	0.266	4.173	2.682
10:30	21	3.835	0.066	0.265	4.166	2.684
11:00	22	3.835	0.063	0.264	4.162	2.686
11:30	23	3.835	0.059	0.263	4.157	2.688
12:00	24	2.999	0.051	0.261	3.311	2.688
12:30	25	2.999	0.036	0.256	3.291	2.684
13:00	26	2.999	0.024	0.253	3.276	2.144
13:30	27	2.992	0.011	0.249	3.252	2.139
14:00	28	2.660	0.006	0.247	2.913	2.137
14:30	29	2.660	0.003	0.246	2.909	2.137
15:00	30	2.992	0.003	0.246	3.241	1.977
15:30	31	2.660	0.002	0.246	2.908	1.977
16:00	32	2.660	0.003	0.246	2.909	1.978
16:30	33	2.660	0.011	0.249	2.920	2.750
17:00	34	2.992	0.018	0.251	3.261	2.753
17:30	35	3.193	0.024	0.253	3.470	2.751
18:00	36	3.193	0.044	0.259	3.496	2.748
18:30	37	4.280	0.120	0.280	4.680	1.976
19:00	38	4.700	0.150	0.285	5.135	1.971
19:30	39	4.700	0.128	0.282	5.110	1.971
20:00	40	4.280	0.046	0.258	4.584	4.042
20:30	41	3.193	0.008	0.248	3.449	4.042
21:00	42	2.176	0.002	0.246	2.424	4.042
21:30	43	1.987	0.001	0.245	2.233	1.970
22:00	44	1.919	0.000	0.245	2.164	1.970
22:30	45	1.670	0.000	0.245	1.915	1.970
23:00	46	1.670	0.000	0.245	1.915	1.941
23:30	47	1.670	0.000	0.245	1.915	1.586
0:00	48	1.000	0.000	0.000	1.000	1.441
0:30	1	0.998	0.000	0.000	0.998	0.992
1:00	2	0.997	0.000	0.000	0.997	0.960
1:30	3	1.081	0.000	0.000	1.081	0.960
2:00	4	2.495	0.008	0.245	2.740	0.960
2:30	5	2.495	0.000	0.245	2.740	0.960
3:00	6	2.495	0.000	0.245	2.740	0.960
3:30	7	2.495	0.000	0.245	2.740	0.960
4:00	8	1.670	0.000	0.245	1.915	0.960
4:30	9	0.998	0.000	0.000	0.998	0.960
5:00	10	0.998	0.000	0.000	0.998	0.960

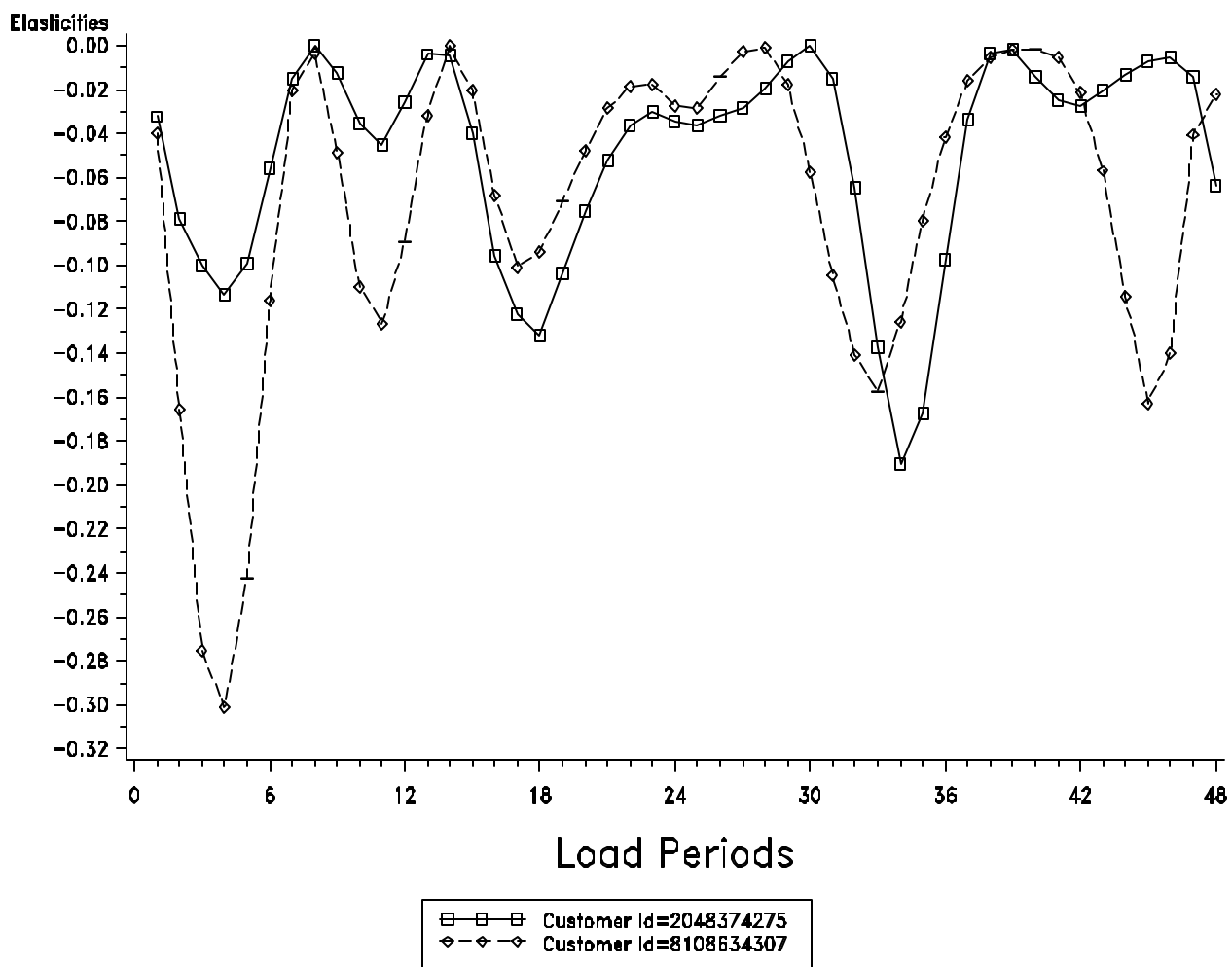
Except for pool price customer demands, demand functions faced by RECs (and therefore generators) do not depend on the PSP.

- Ⓒ approximately 95% of electricity sold to final customers on fixed-price contracts.
- Ⓒ these fixed tariff schedules vary over time of day, week, or year, but not on the value of the PSP.
- Ⓒ Each REC sets its own retail tariffs resulting in potentially hundreds of different prices.
- Ⓒ RECs hedge against PPP volatility by purchasing contracts for differences (CFDs).

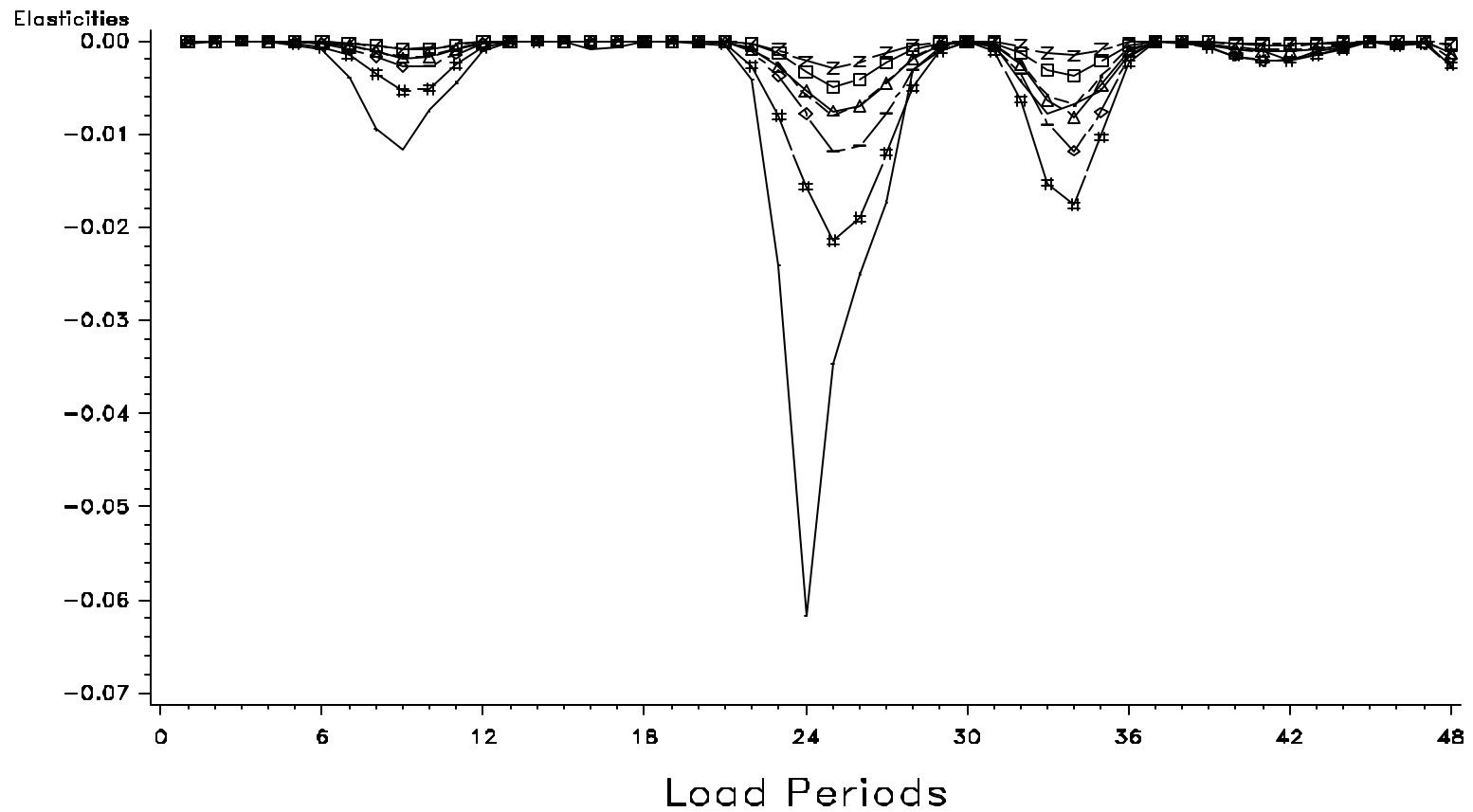
## Mean Own Price Elasticities of Demand for UK Industries Bic = 17000 : Water Supply Industry



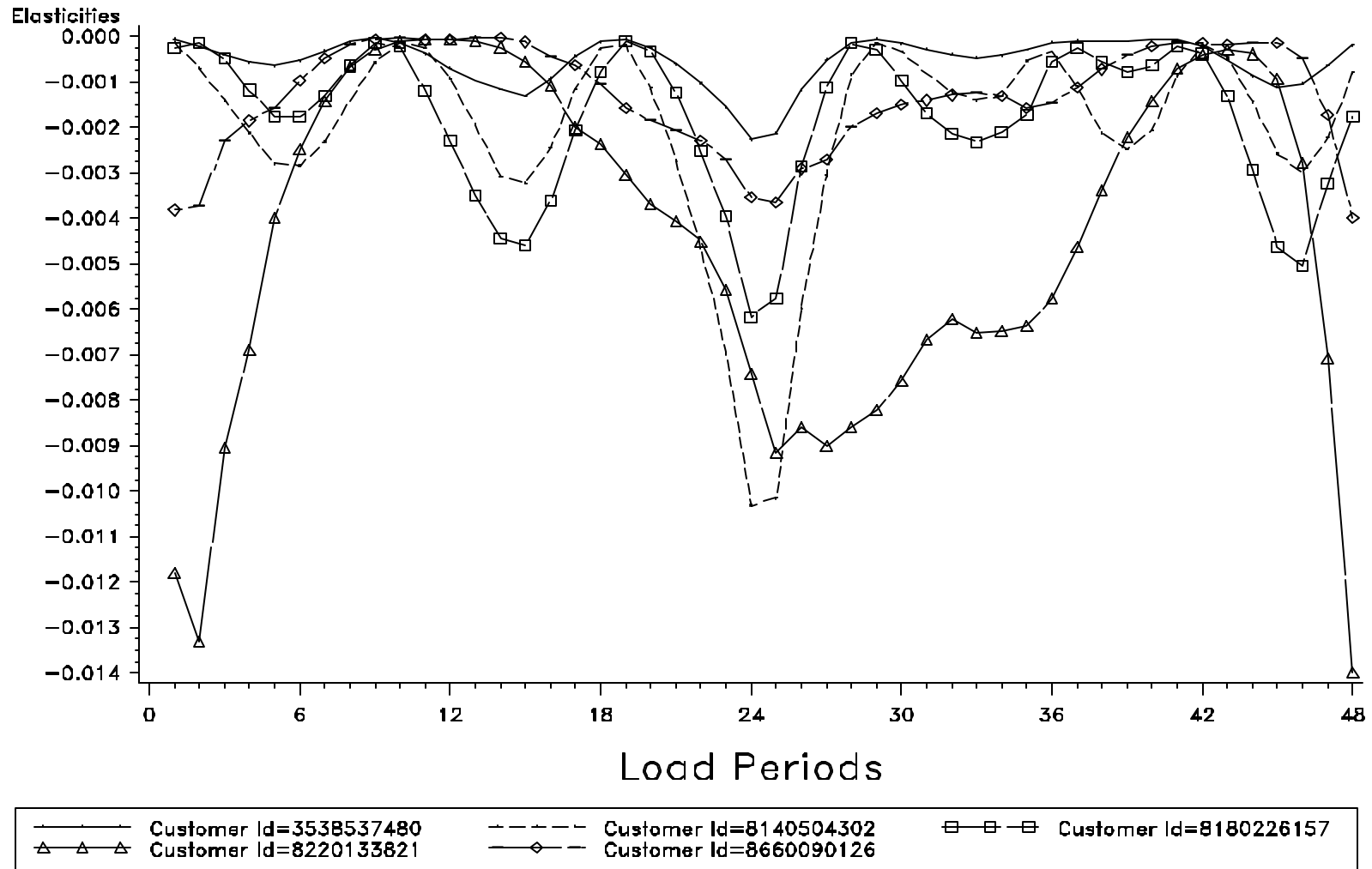
## Mean Own Price Elasticities of Demand for UK Industries Bic = 22460 : Copper, Brass, and Other Copper Alloys



# Mean Own Price Elasticities of Demand for UK Industries Bic = 31600 : Hand Tools and Finished Metal Goods

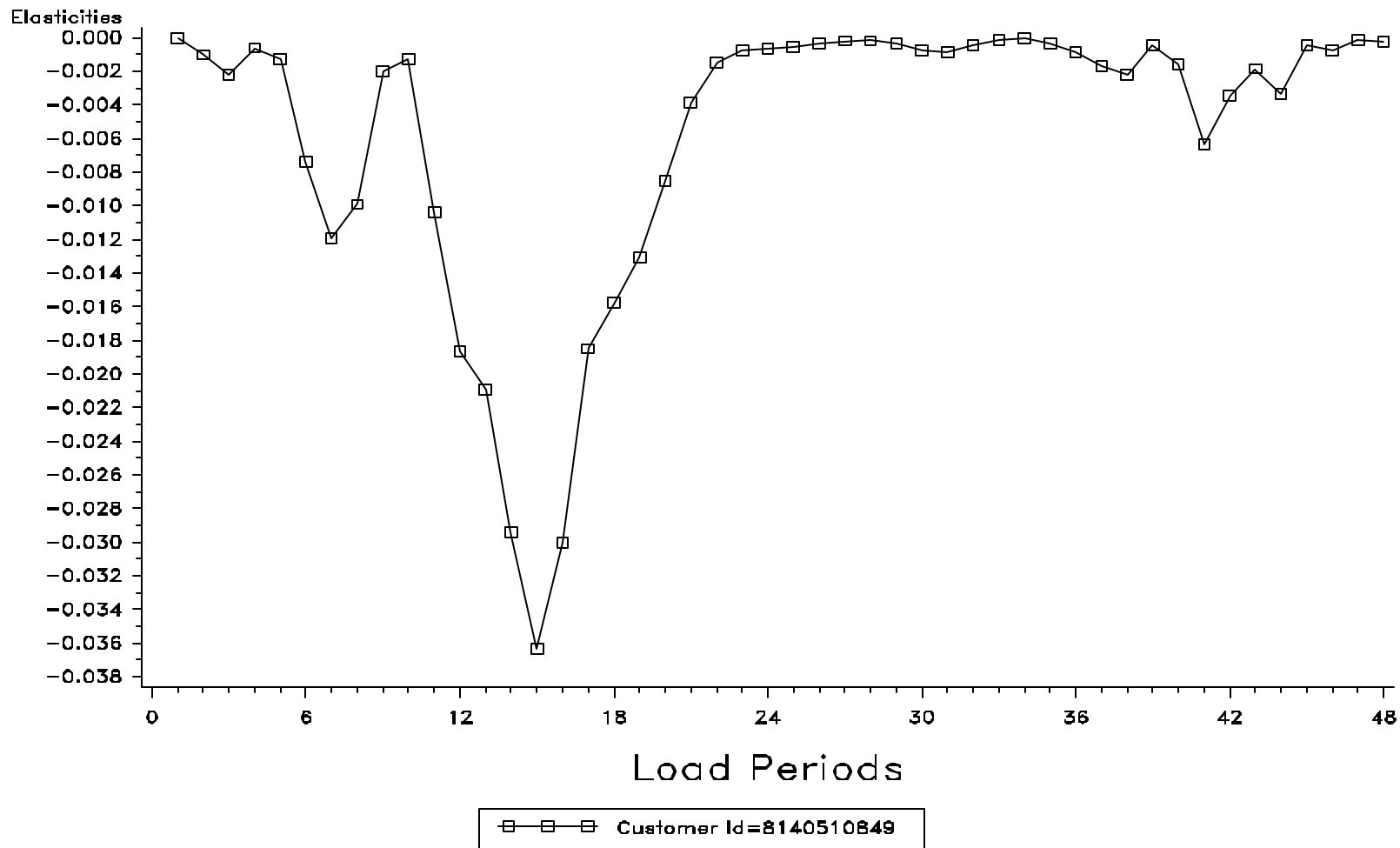


## Mean Own Price Elasticities of Demand for UK Industries Bic = 22200 : Steel Tubes



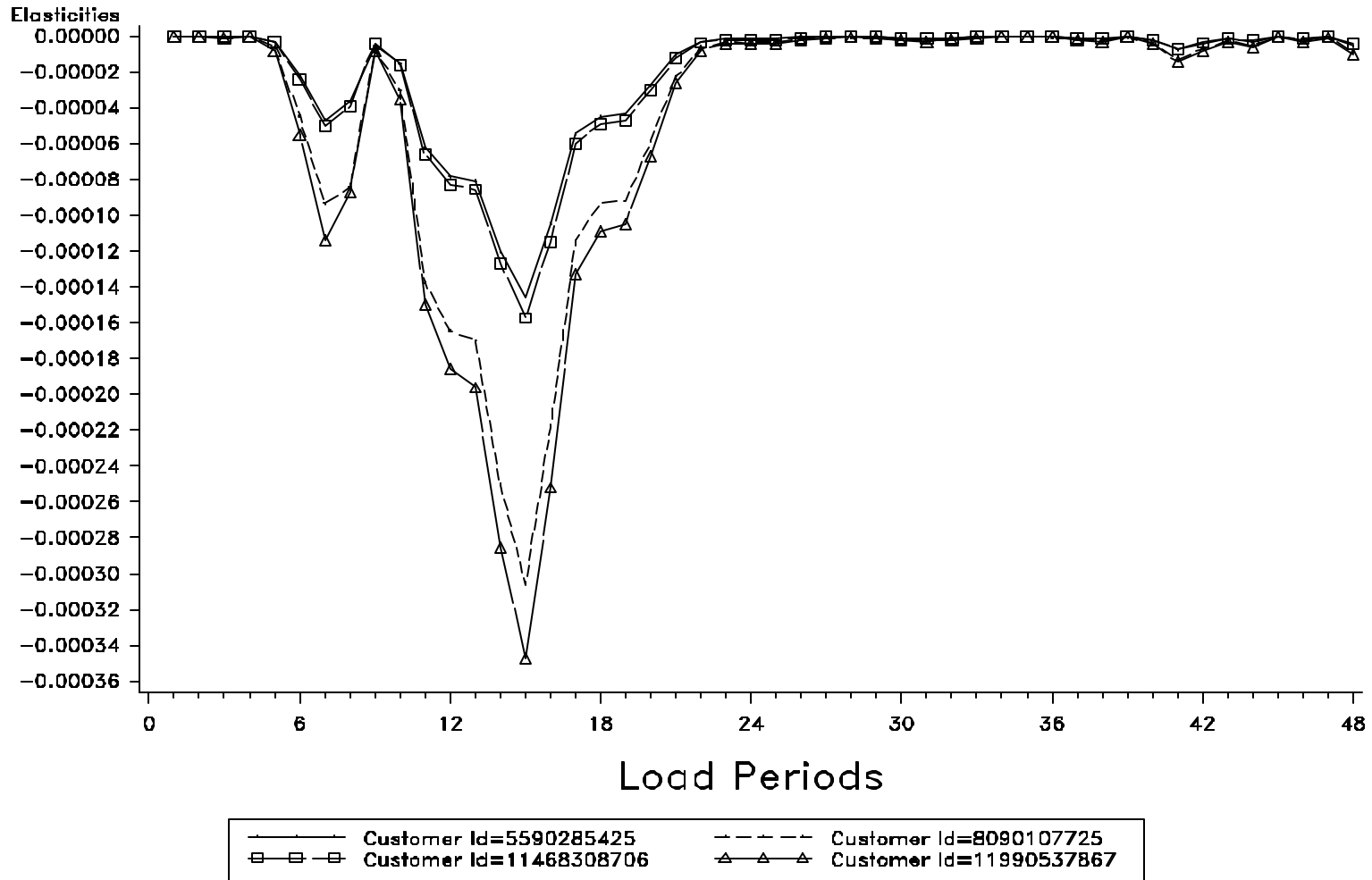
# Mean Own Price Elasticities of Demand for UK Industries

Bic = 46000 : Timber and Wooden Furniture Industries

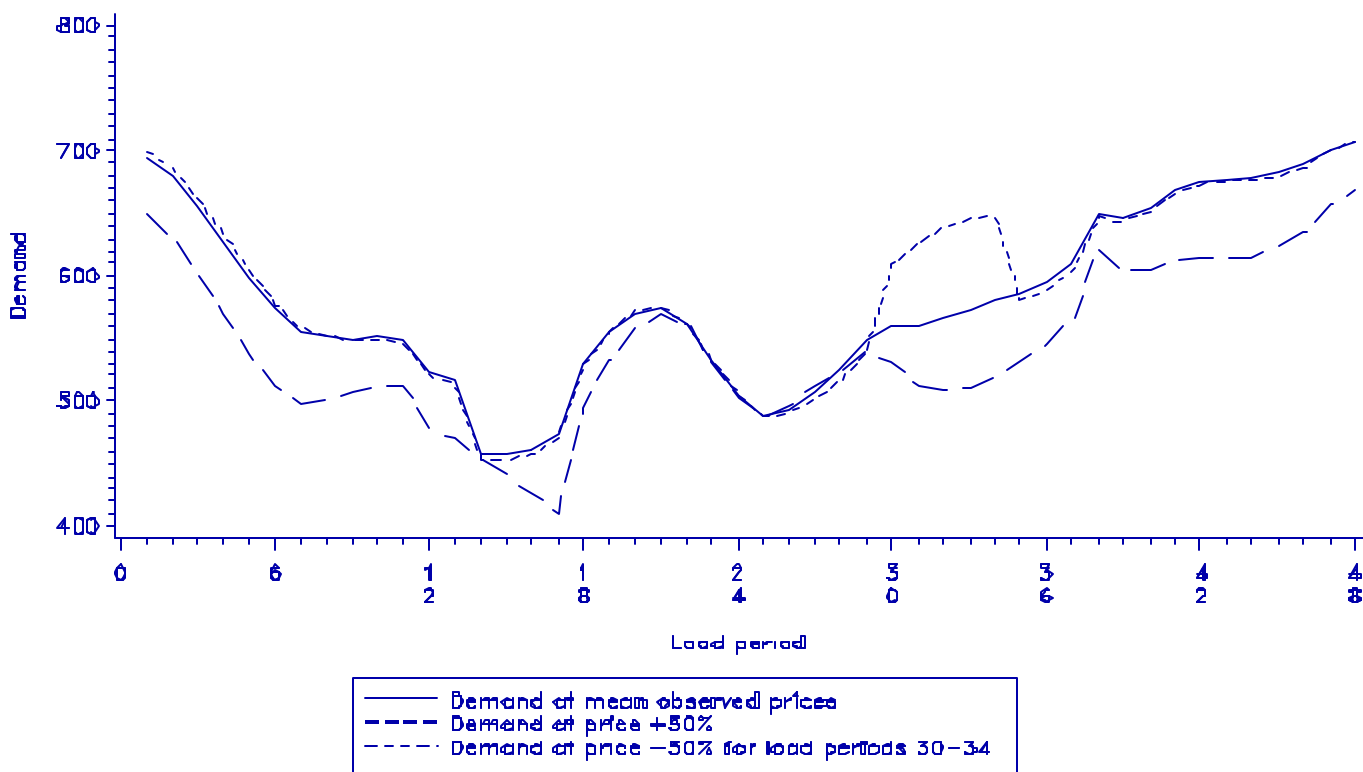


## Mean Own Price Elasticities of Demand for UK Industries

Bic = 41000 : Food, Drink and Tobacco Manufacturing Industries



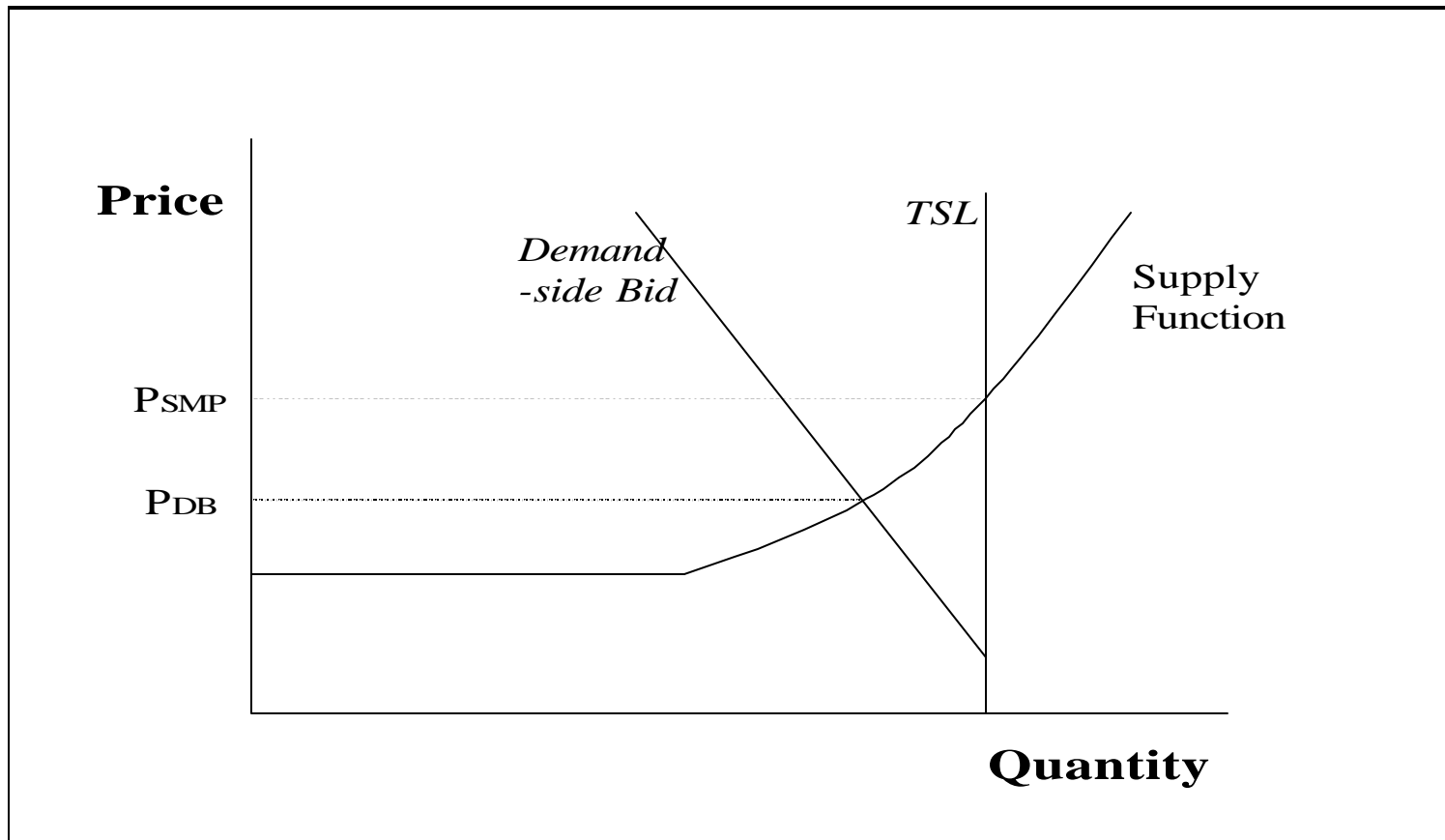
## Price responses: BIC 17000 Water Supply



**Figure 11. Demand throughout day under alternative prices.**

# Demand-side Bidding

- Why we see little to no price response in restructured electricity markets is that few if any retail customers pay according to the market prices (hence it is meaningless to estimate aggregate market demand as a function of market prices).
- Demand-side bids can build a price response into the market demand used to determine the market-clearing wholesale electricity and ancillary services prices.
- Potential benefits to retailers and their customers include
  - the reduced magnitude and variability of market prices
  - decreased costs of contracts protecting retailers (selling to customers at fixed prices) from relatively large market prices.



Effect of demand side bids on the market clearing spot price

# Results and implications from our analyses include:

- Day-ahead price elasticity estimates vary substantially by time-of-day, industry, and firms within industries; with sample mean averages ranging from essentially zero to .86 in absolute value.
- Significant across period price effects are also found, indicating substitution possibilities exist across some pricing periods, while complementarities exist across other pricing periods.

- Spot price customers may provide a significant price response in restructured electricity markets.
- E&W RTP customers generally paid lower overall electricity bills than fixed price customers, their incentive for choosing RTP and reward for accepting price risk.
- A significant price response in the price determination process may reduce the magnitude and volatility of spot prices in restructured electricity markets, the extent depends upon the price responsiveness of spot price customers and how demand side bids are considered in the market price determination process.

- Retailer incentives for demand side management and conservation result during peak system demand periods, when the spot prices are greater than the fixed prices at which most retail power is sold. Conversely, any time the spot price is below the fixed price, the retailer has the incentive to encourage electricity consumption. Substitution of consumption from the former to the latter pricing periods increase retailer profits.
- Contracts, while allowing retailers to hedge against losses during peak system demand periods, may undermine these incentives for demand side management and conservation.

# Unilateral Market Power

- Firms will only sell in the market if price covers the marginal production (opportunity) cost.
- In competitive markets firms do not control prices, they react to them in making production and investment decisions.
  - however, this does not mean that they should not seek opportunities to increase profits.
- Unilateral market power exists when a firm has the ability to increase market prices through its own actions and to profit from this increase.

# Sources of Market Power

Given the rules and structure of restructured electricity markets, under certain demand, capacity, and marginal cost conditions, generators may manipulate market prices and increase their profitability through their choices of

- Capacity availability and/or
- Prices at which they will make capacity available.

# Restructured Wholesale Markets

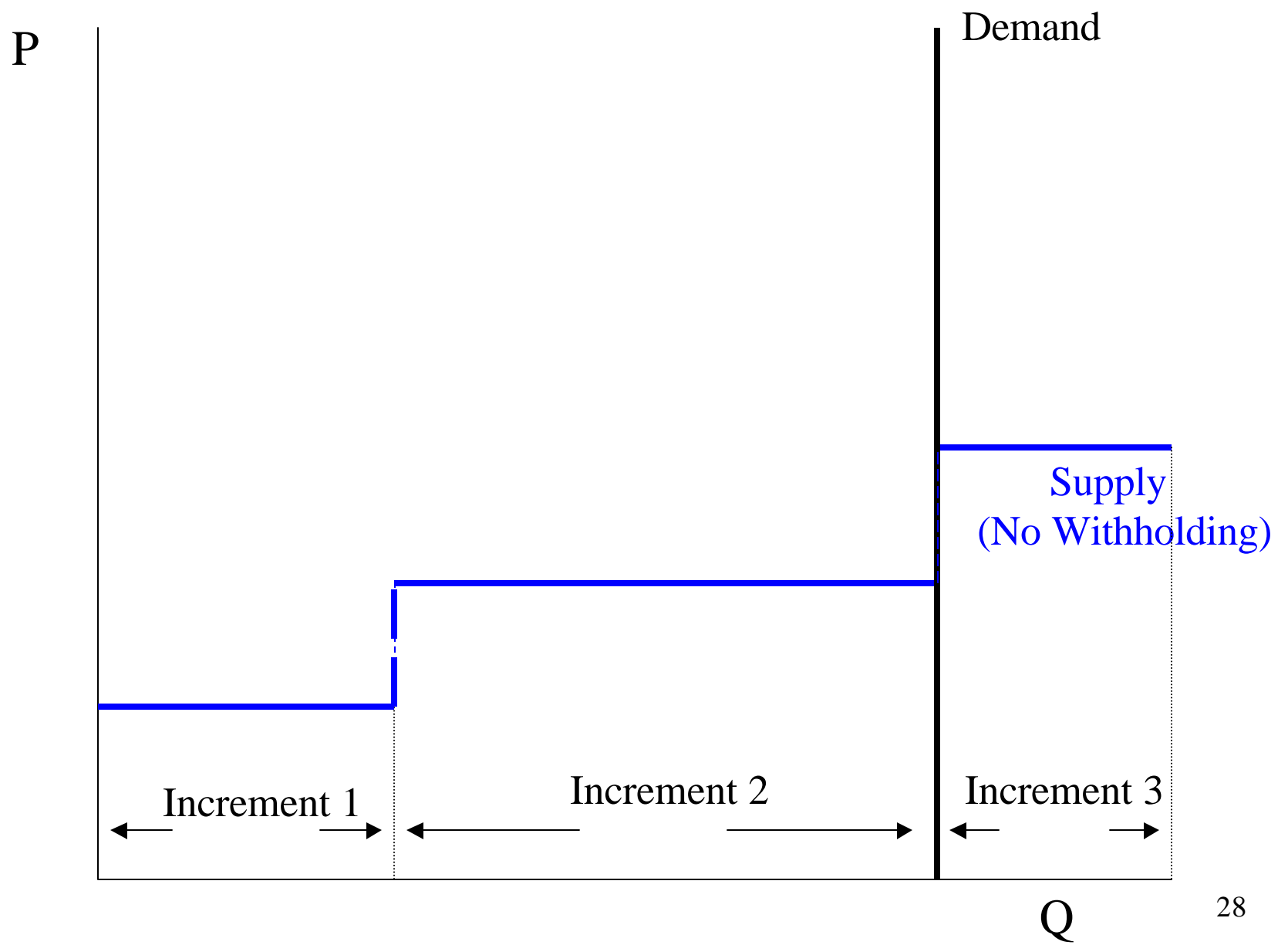
- Uniform (nondiscriminatory) price auction.
- Demand is at least close to perfectly inelastic.
- Each generator bids prices and the level of capacity it will make available at these prices.

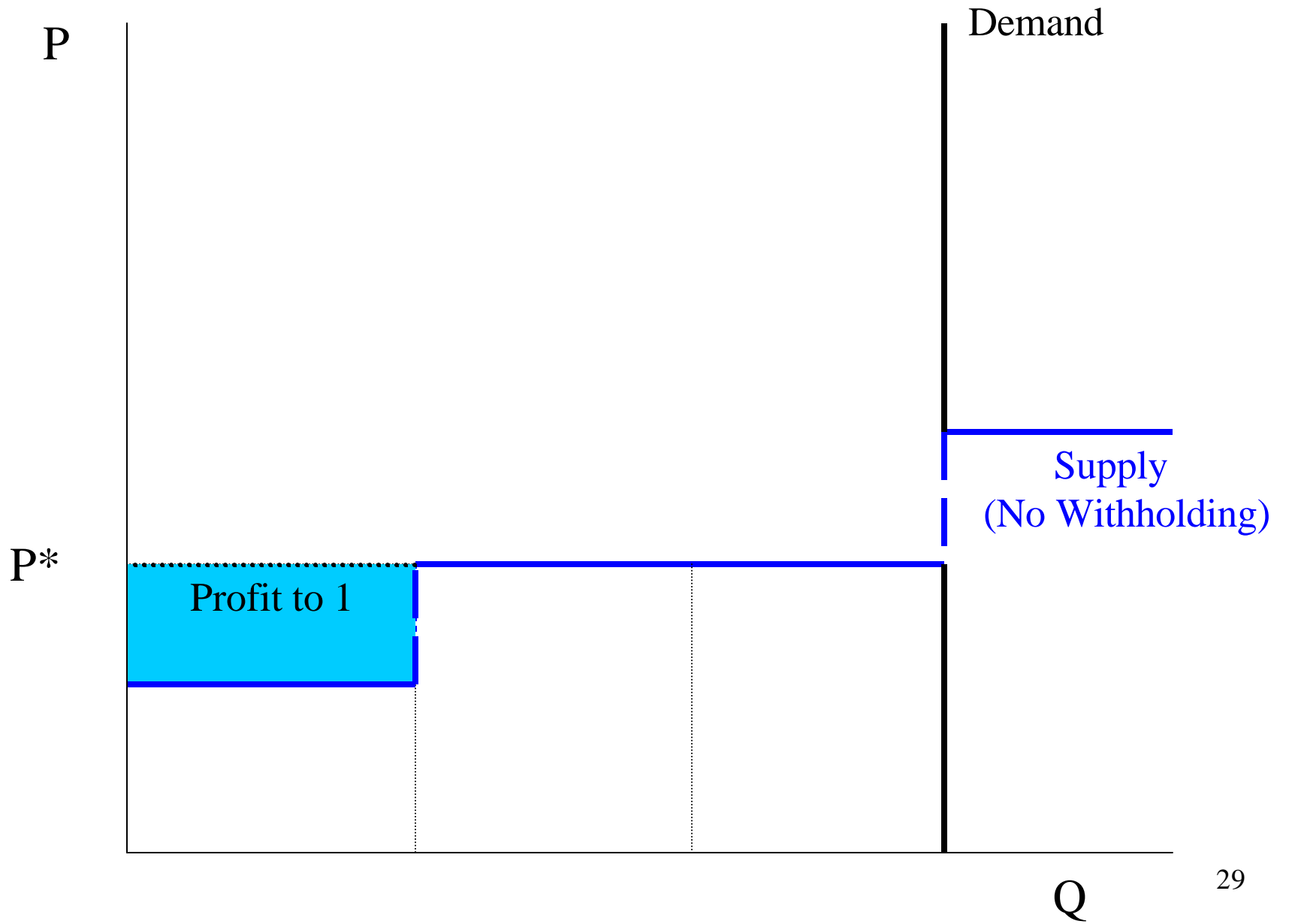
# Profitable capacity withholding requires

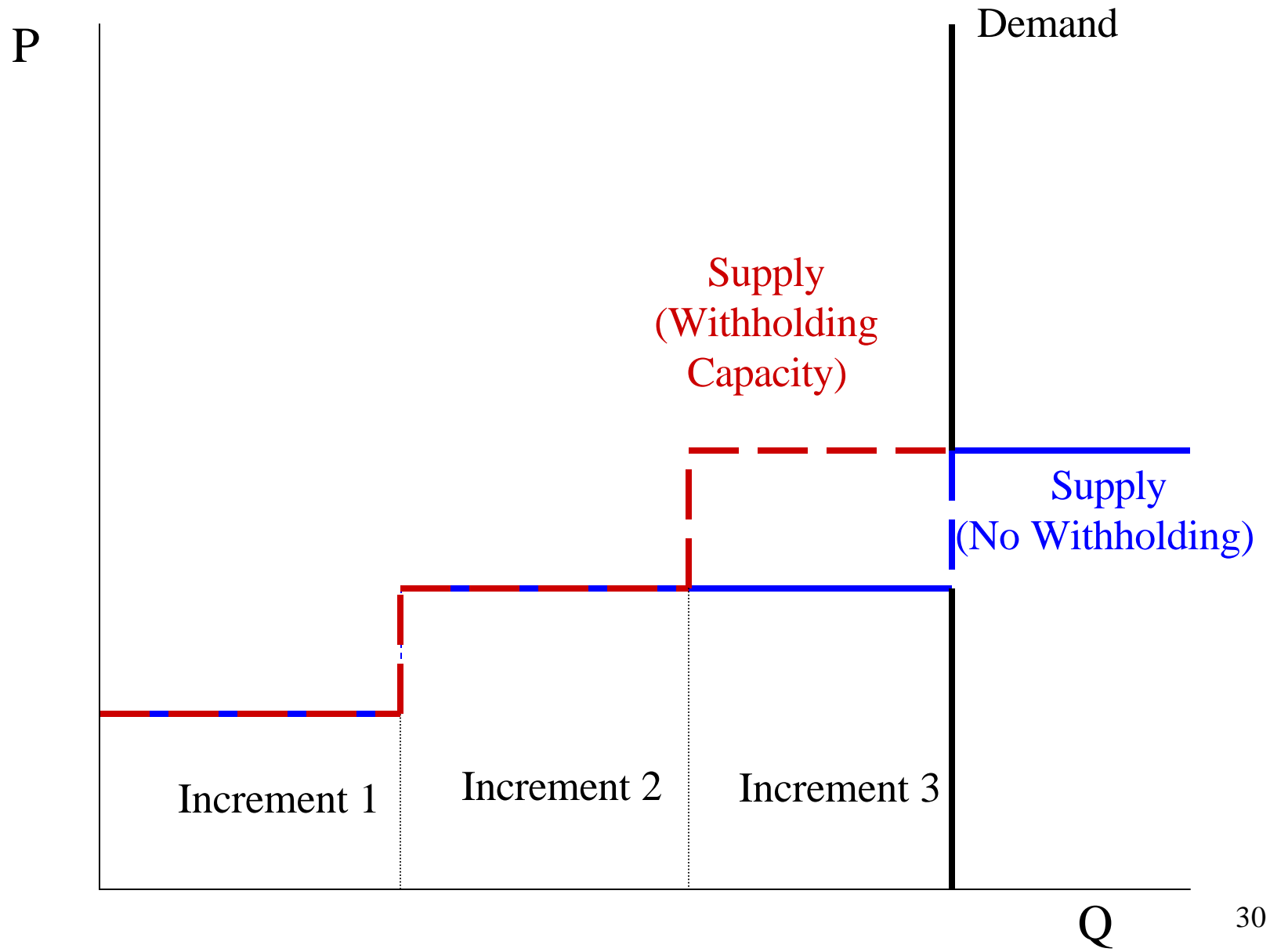
- Demand sufficiently close to an increasing portion of the supply (aggregate bid) function.
- A range of marginal costs within and/or across generators' capacity.
- The withholding firm(s) to have sufficient capacity to withhold to bring a higher cost generating unit into the market.
- The withholding firm(s) to have sufficient capacity remaining in market so that the additional profit from the increased price is greater than the forgone profit from the withheld capacity.

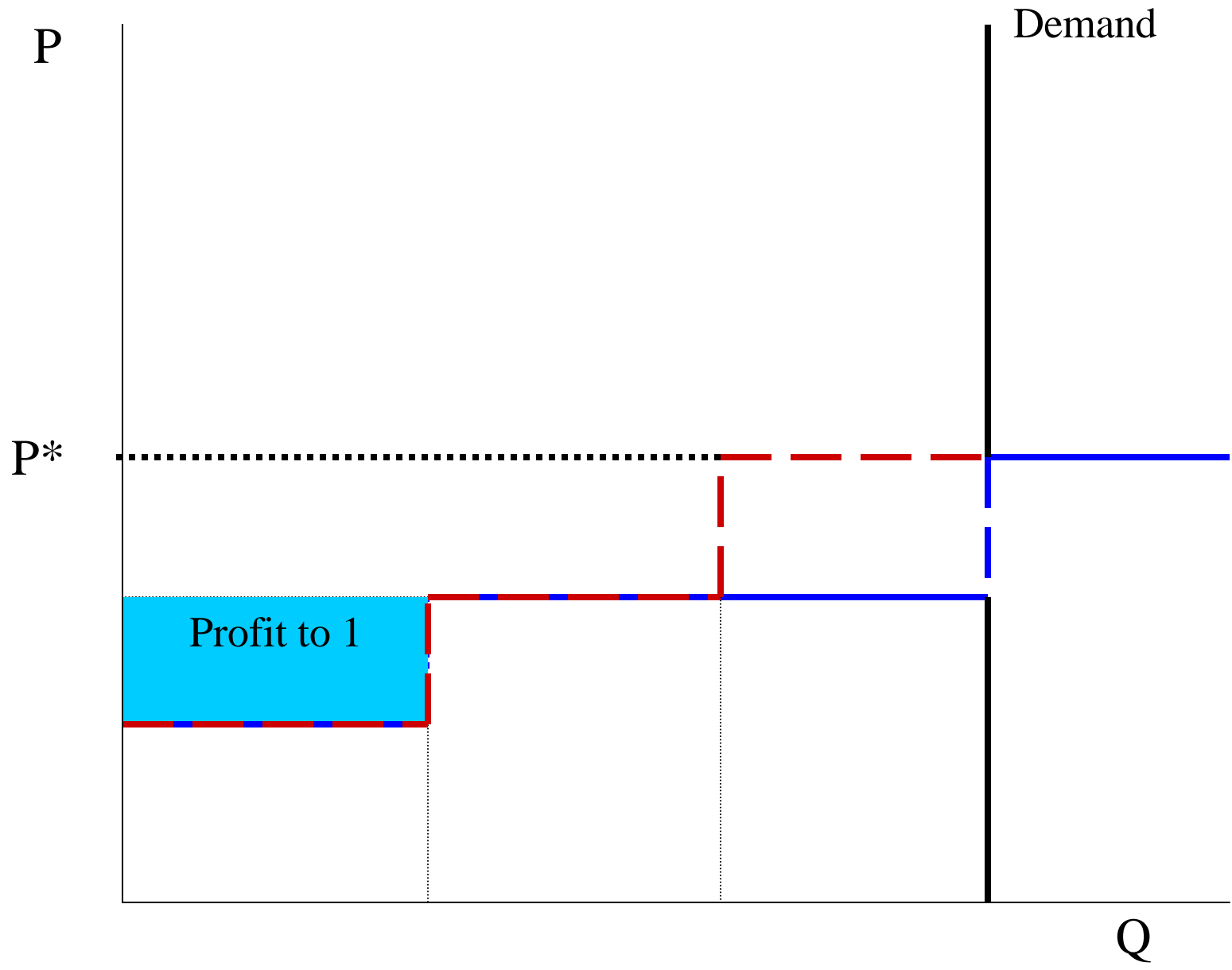
# Capacity Availability and Price Caps

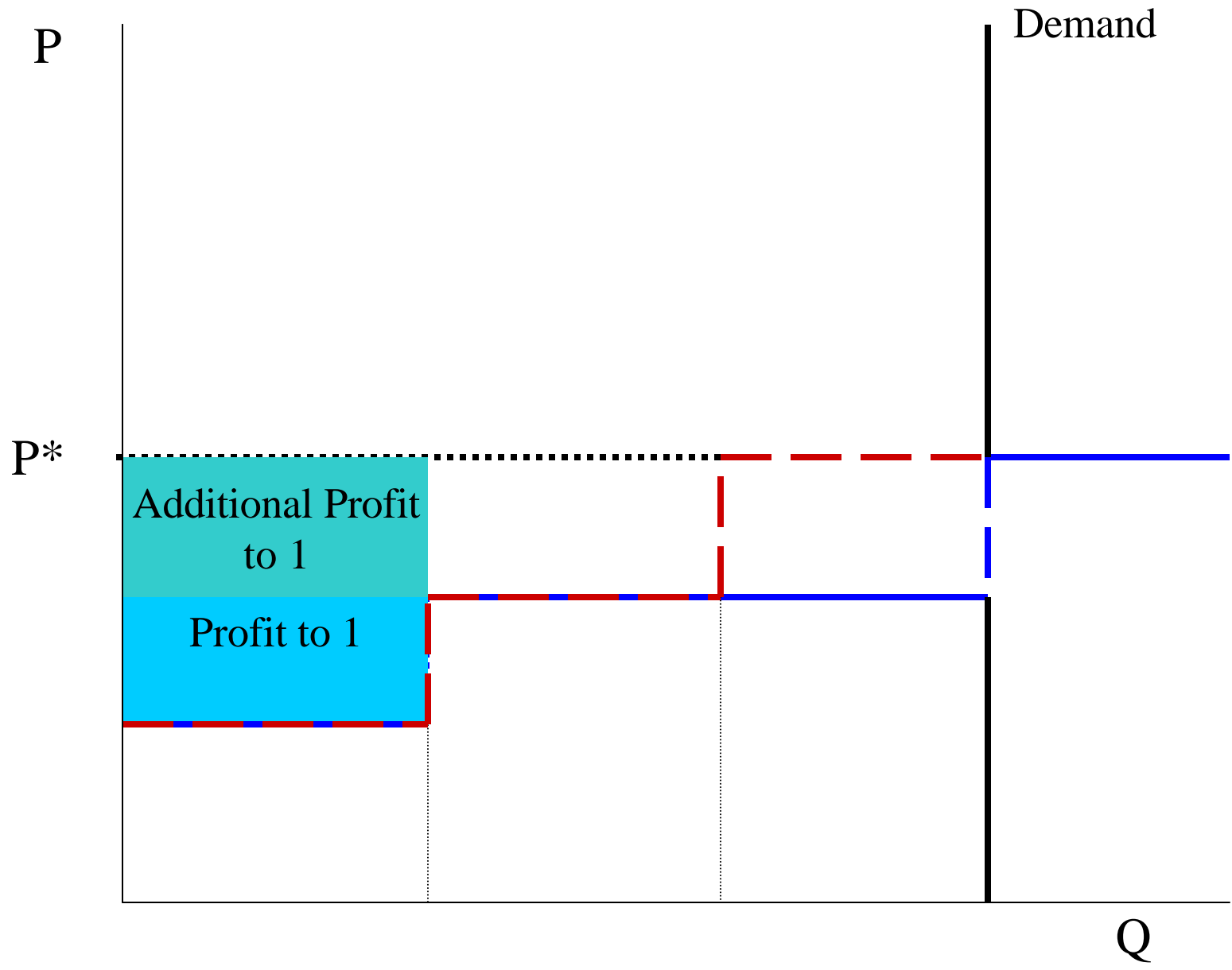
- Whether capacity is unavailable for strategic or other reasons is not observable.
- To focus on capacity withholding incentives and illustrate the effect of price caps, take prices bid by each generator as capped the MC of each generating unit.

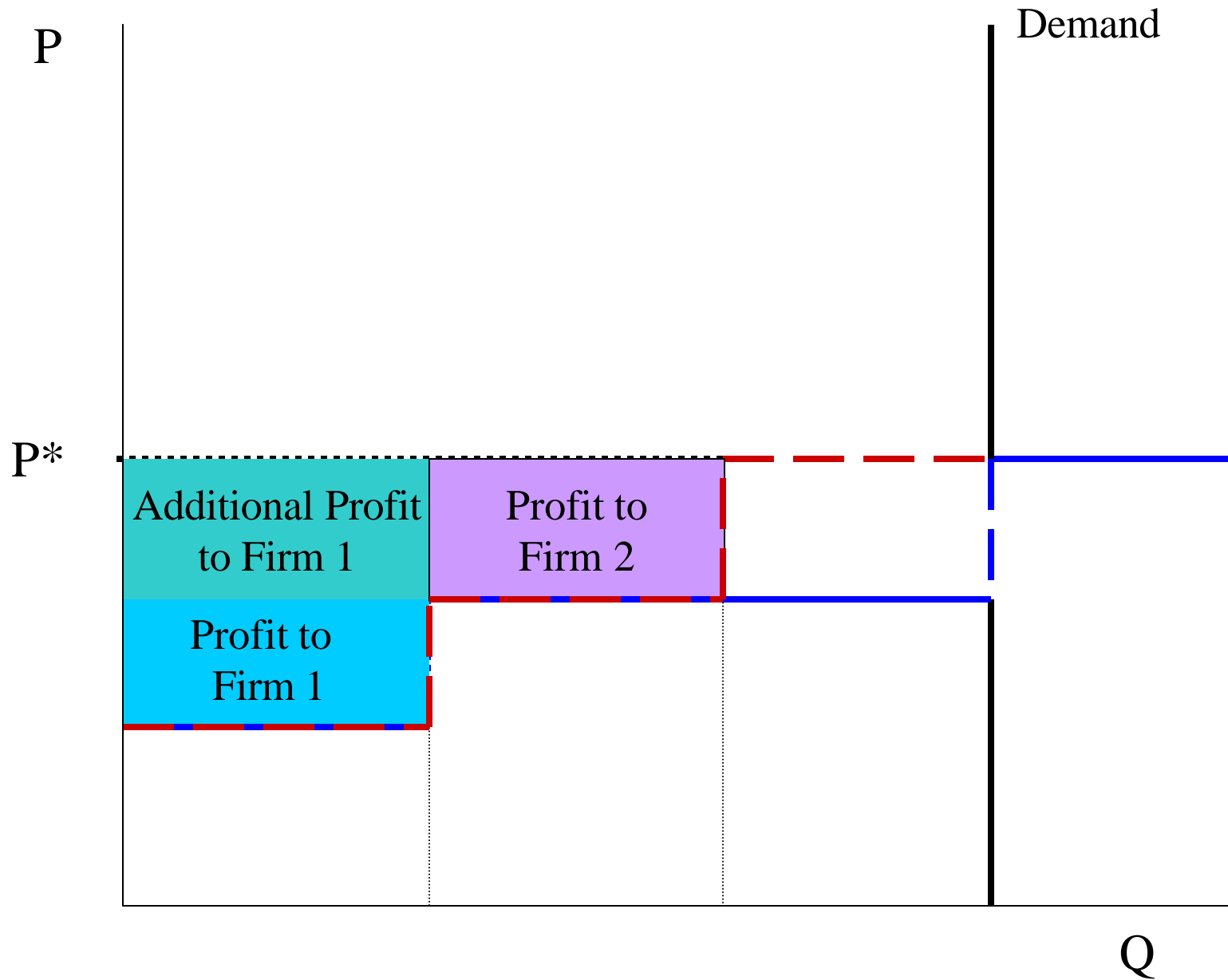


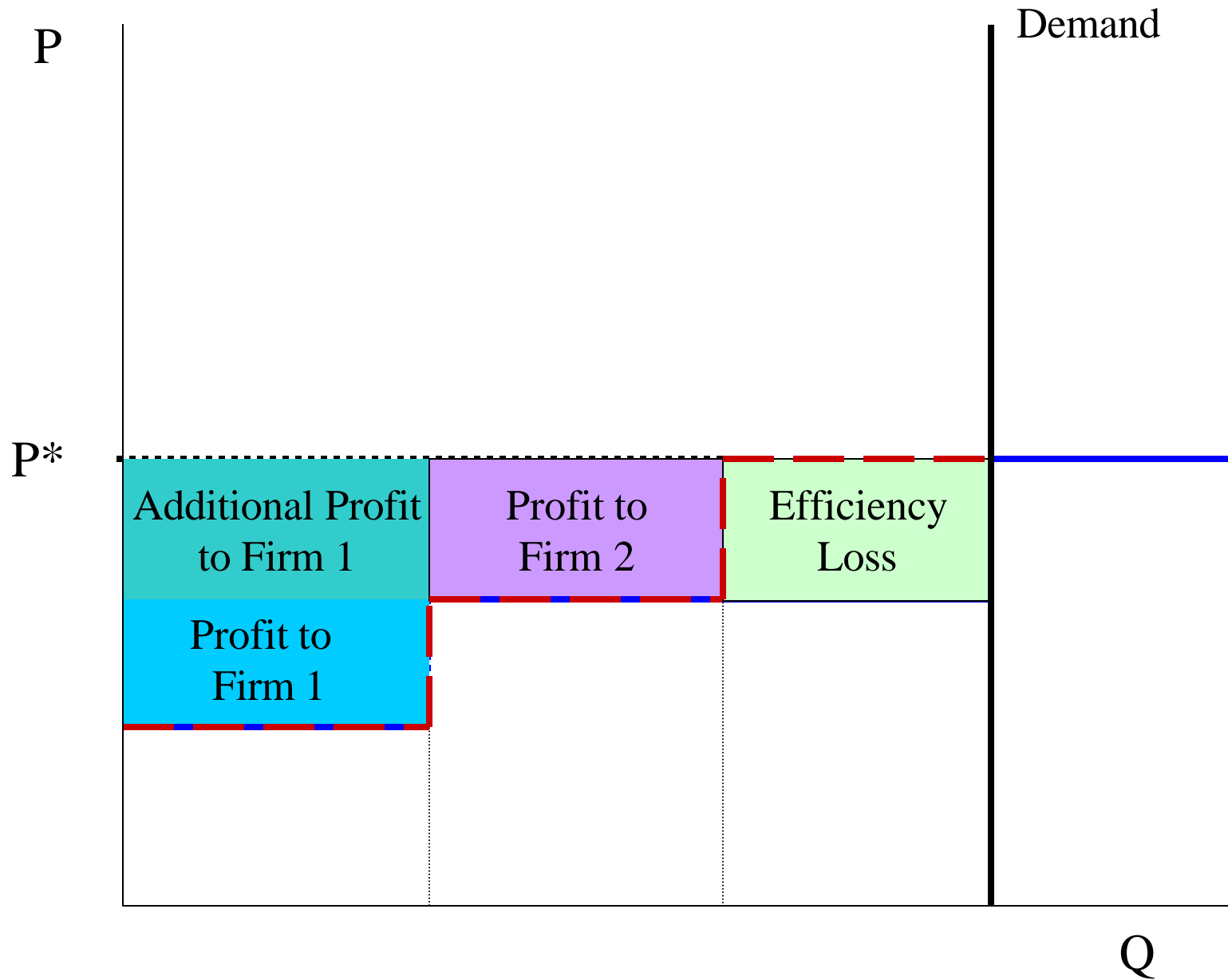












# Some Implications

- Even if prices are capped at marginal cost for each generating unit, capacity withholding may yield higher than competitive prices and profits.
- All generators with marginal cost below that of the marginal (market price setting) generator may have an incentive for unilateral capacity withholding.
- The closer the market demand is to system capacity, the larger the returns from this strategy.

# Some Implications (continued)

- It may only take 1 generator unilaterally reducing available capacity to raise the market price, yet all generators with marginal cost less than the market price gain from this strategy.
- Given prices are capped at MC, collusion among these generators can actually reduce the efficiency loss (as well as increase profits) by insuring that the minimum amount of capacity necessary to achieve the price increase is withheld.

# A Simple Numerical Example

- Generator 1 has
  - 5 units of capacity with  $MC=5$  and
  - 5 units with  $MC=7$ ,
  - output from generator 1 is then  $Q_1=Q_{11}+Q_{12}$ ,
  - this implies  $\text{profit}_1=P*Q_1 - 5*Q_{11} - 7*Q_{12}$
- Generator 2 has
  - 10 units of capacity with a  $MC=6$ ,
  - output from generator 2 is  $Q_2$ ,
  - $\text{profit}_2=(P - 6)*Q_2$

## Unilateral Capacity Withholding Increases Profits

Demand	P=MC	avail1	avail2	gen1	gen2	profit1	profit2
15	6	10	10	5	10	5	0
	<b>7</b>	<b>10</b>	<b>9</b>	<b>6</b>	<b>9</b>	<b>10</b>	<b>9</b>
10	6	10	10	5	5	5	0
	<b>7</b>	<b>10</b>	<b>4</b>	<b>6</b>	<b>4</b>	<b>10</b>	<b>4</b>
7	6	10	10	5	2	5	0
	<b>7</b>	<b>10</b>	<b>1</b>	<b>6</b>	<b>1</b>	<b>10</b>	<b>1</b>

The first row for each demand level gives the resulting market price, capacity availabilities, and profit when all capacity is bid into the market. The second row provides the values of these variables when generator 2 follows a capacity withholding strategy.

For example, when demand=7, even if firm 2 only has a capacity of 2, it can still exercise unilateral market power

## Unilateral Capacity Withholding Increases Profits

**Suppose firm 1 withholds one unit of capacity (MC=5) and firm 2 does not withhold any capacity**

Demand	P=MC	avail1	avail2	gen1	gen2	profit1	profit2
15	6	10	10	5	10	5	0
	7	9	10	5	10	8	10

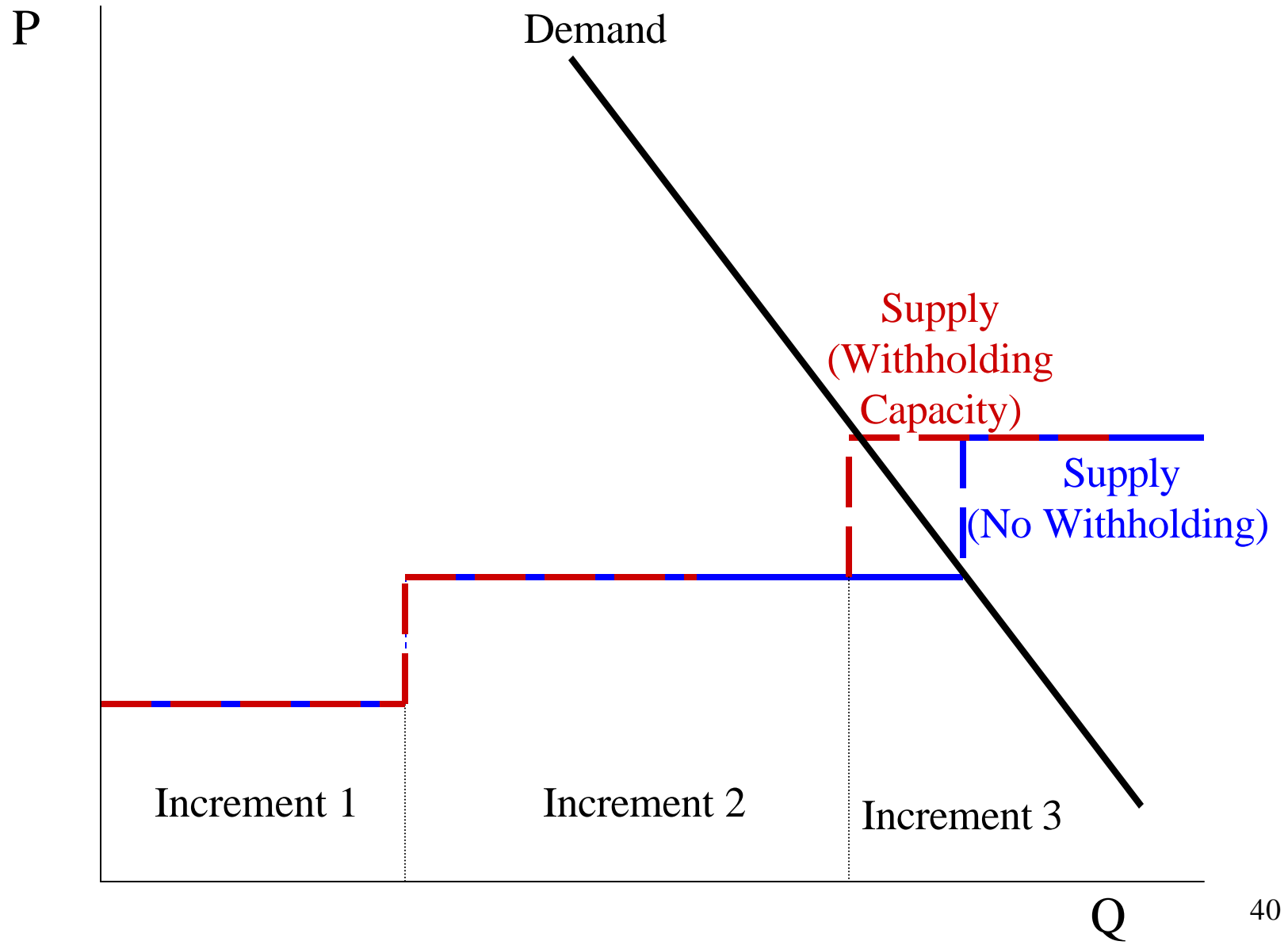
**The efficiency loss is 2 since a unit characterized by MC=5 is replaced by a unit with MC=7.**

**If demand is 11 or less firm 1 has no incentive to unilaterally withhold capacity.**

**If both firms withhold one unit of capacity in this case then**

7	9	9	6	9	8	9
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**The efficiency loss is 3 since a unit characterized by MC=5 and a unit with MC=6 are replaced by 2 units with MC=7.**



# Policy Implications

- Price caps and demand-side bidding can mitigate market power to some degree but
  - Although price caps may reduce rents to market power, they will not eliminate profit incentive for capacity withholding
  - Demand-side bidding can limit the incentive to withhold capacity, but not completely eliminate it