

# **Frank Wolak's Contribution to Understanding the State of the New Zealand Electricity Market**

Lewis Evans

(with Graeme Guthrie)

Presentation Prepared for the Electric Power Optimization Centre (EPOC),  
Auckland University Winter Workshop Series:  
3 September 2009

*School of Economics, Victoria University of Wellington  
and  
NZ Institute for the Study of Competition and Regulation ([www.iscr.org.nz](http://www.iscr.org.nz))*

## **Content**

- **Background on Essential Features of Electricity Market Operation**
- **Wolak's conceptual model**
- **Wolak's statistical analysis and the hypothesis of market power**
- **Wolak's factual and counterfactual and implications for excess profits**
- **Concluding Remarks**

Focus on essential elements

## Stylised Model of the New Zealand Electricity Market I

### Assume

- geothermal and wind generation are base load ( fixed or exogenous)
- hydro and gas generation are variable
- that there are stochastic inflows to storage lakes
- that gas is available “on demand” at a known increasing marginal cost; and
- that there is equivalently
  - a social planner that seeks to maximise dynamic efficiency. That is maximise the expected present value of the total of consumers’ and producers’ surplus ( $W$ ) into the foreseeable future;
  - there is perfect competition.

## Stylised Model of the New Zealand Electricity Market II

If  $s_t$  is the amount of stored water at date  $t$

$w_s$  is the change in the expected present value of the total of consumers' and producers' surplus into the foreseeable future (conditional on inflows and storage at date  $t$ ) resulting from a unit change in the quantum of stored water at date  $t$ ,

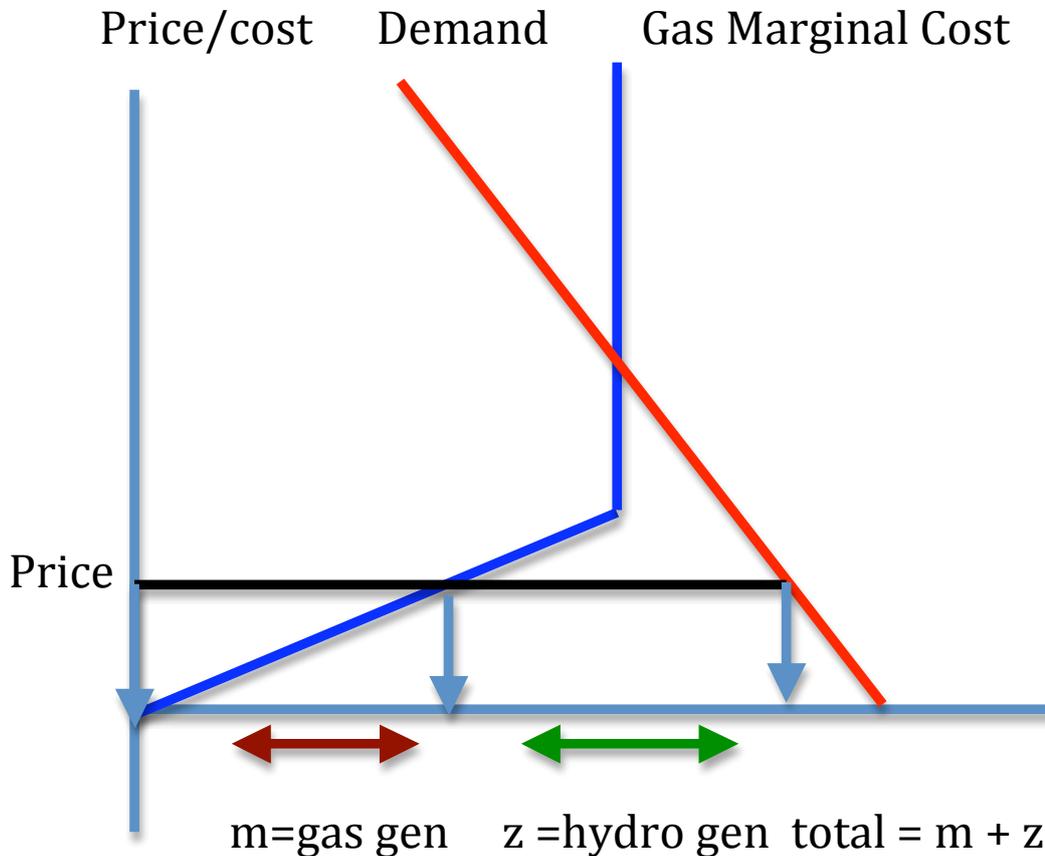
then dynamically efficient generation should simultaneously satisfy

1.  $w_s$  the (forward looking) shadow price of water being consistent with storage, inflow, and generation policies for gas and hydro that yield:
2. spot electricity price = marginal cost of gas
3. spot electricity price = marginal cost of stored water ( $w_s$ )

### **2. and 3. Imply**

marginal cost gas = marginal cost stored water

## Stylised Model of Market III: *Competitive Spot Market*



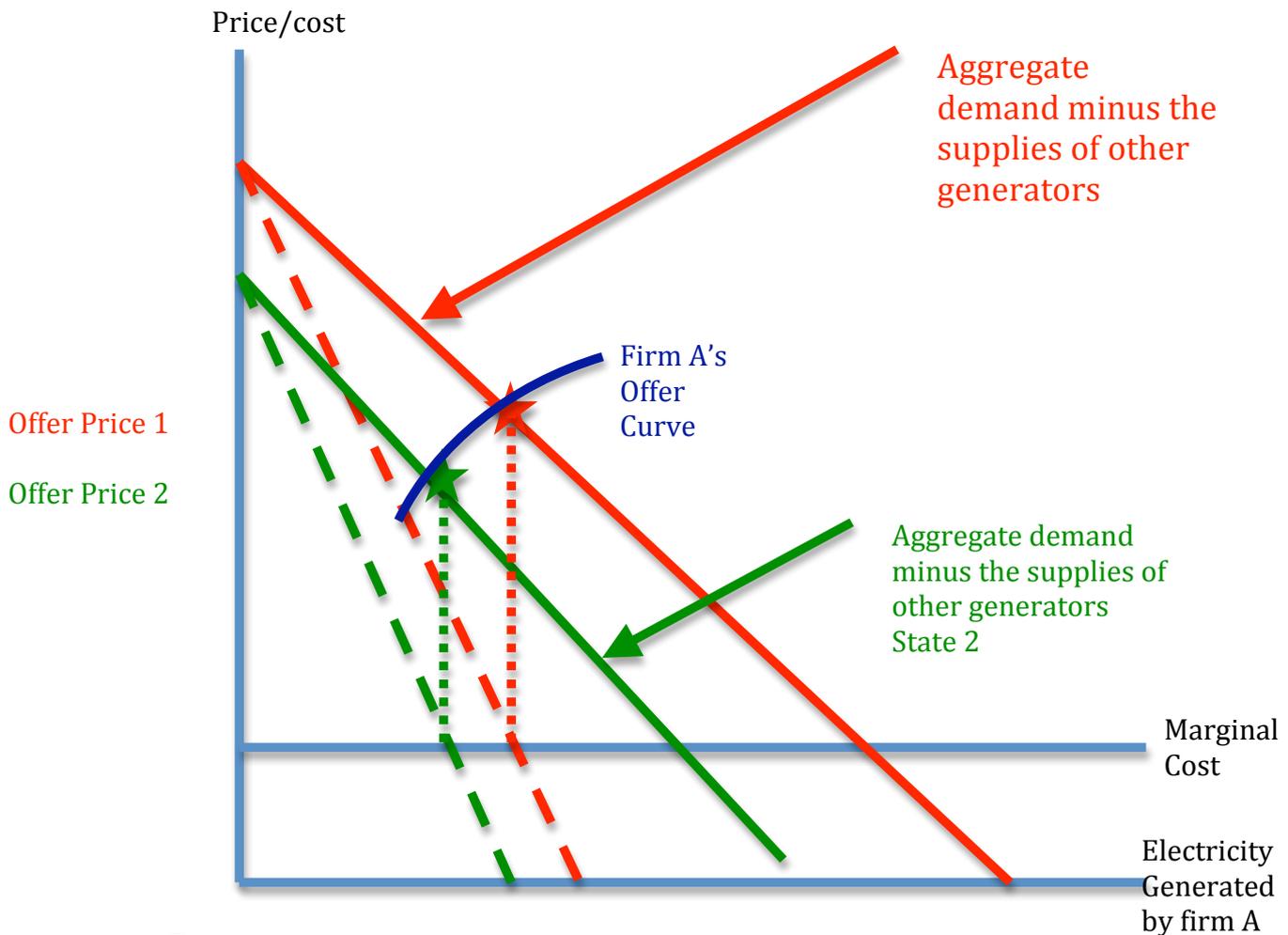
A) Lower storage and/or inflows lead to

- reduced hydro, increased gas generation;
- lower total generation and higher prices.

B) The spot and gas prices are measures of the price of stored water: but

C) Gas availability limitations imply gas too has a forward-looking marginal cost typically greater than acquisition cost

## Wolak: Conceptual Analysis



### Comments

a) demand and supply are not conceptually separable where

- there are supply shocks common to generators
- because  $w_s$  relies on assessments of future demand and supply

b) Wolak defines the offer price condition as

$$\text{Price (P)} = \text{Marginal Cost (MC)} + 100 \eta$$

$\eta = \text{price/minus the elasticity of demand}$

## Relationship between the level of inverse semi-elasticity and exercising unilateral market power, when cost and demand are separable

$\eta(p)$  is the increase in net profit if the firm reduces its output by 1 unit at the spot price  $p$ ;

but

given linear demand (that Wolak finds) and marginal cost,

- a.  $\eta(p)$  falls as price increases, and
- b.  $\eta(p)$  is twice as high at  $mc=p$ , than at profit maximisation ( $mc=$  marginal revenue)

**Conclusion:** the level of  $\eta(p)$  *per se* is not informative about whether a firm is exercising unilateral market power: it is relatively high when firms are not exercising unilateral market power.

## ***Wolak's Statistical Investigation***

Wolak estimates by OLS regression

$$\text{price} = \text{dummy variables} + \beta\eta + \text{error}$$

he does not tell us why he takes this step or why he cares about the estimate of  $\beta$  that he obtains. In fact, there is no reason for this step as:

- 1) according to his hypothesis  $\beta = 100$  and no estimation is needed; and
- 2) his regressions do not test that  $\beta = 100$ .

## Background to Appraisal of Estimates

1. Use of residual demand means cost and demand are not separable: all elements of his equation depend on short run marginal cost ( $w_s$ ) as in:

$$P(w_s) = MC(w_s) + 100\eta(w_s)$$

all three components fluctuate with a fourth: namely the shadow price of water ( $w_s$ ).

2. His regressions estimate an equation that gives the *predicted price* for given dummies and  $\eta$  that is he estimates

$$P(\text{price} | \text{dummies}, \eta) = \text{dummy variables} + \beta\eta$$

Wolak recognises he estimates a prediction equation.

## Analysis of Wolak Estimates

$$P(\text{price} | \text{dummies}, \eta) \neq mc + 100\eta$$

because

A) price, mc and  $\eta$  are jointly caused by the shadow price of water that Wolak takes as unobservable. This means

- $\beta \neq 100$  by definition, and
- what  $\beta$  in fact equals depends on all sources of market volatility, nature of the demand/supply curves etc. etc.

B) setting aside the simultaneous determination of the three variables by the shadow price of water (point A), his dummies are a very poor approximation to marginal cost (which will adversely affect his estimate of the entire equation including  $\beta$ ).

## Wolak Regression Findings

Across the four companies  $\beta$  is (0.46, 0.56, 1.41 and 3.81) which means that

A) price and  $\eta$  are positively correlated in the data. The result reflects the influence of sources of variation and the fact that marginal cost and demand are far from independent. Various - even negative - outcomes are possible

B) Assuming

$$P(\text{price} | \text{dummies}, \eta) = mc + 100\eta$$

(ie desirable estimates from OLS)

the estimates are far from 100 which according to Wolak is the  $\beta$  of a profit maximising firm. Indeed the empirical results suggest negligible if any unilateral monopoly power premium in this market. But there is no doubt the estimates are deeply flawed for this purpose.

## **Correlation is not Causality: knowing the market is essential**

- A) Wolak claims that a ***positive association between his semi elasticity and price after controlling on marginal cost is evidence of some unilateral market power***: but
- a. He doesn't control on marginal cost; and
  - b. for a very inelastic aggregate linear demand curve, constant marginal costs and identical firms each firm *offering in at its marginal cost* will produce positive co-variation between the semi-elasticity and price.
- B) Wolak claims that there is ***negative association of gas generator offer prices and lake levels*** and that this implies unilateral market power was exercised: the claim ignores the available capacity of gas plant and illustrates his assumption throughout (and in other papers) that gas generation is available without limit at posted gas prices.

## **Wolak's Factual *and* Competitive Counterfactual**

***The factual is what happened***

*whereas*

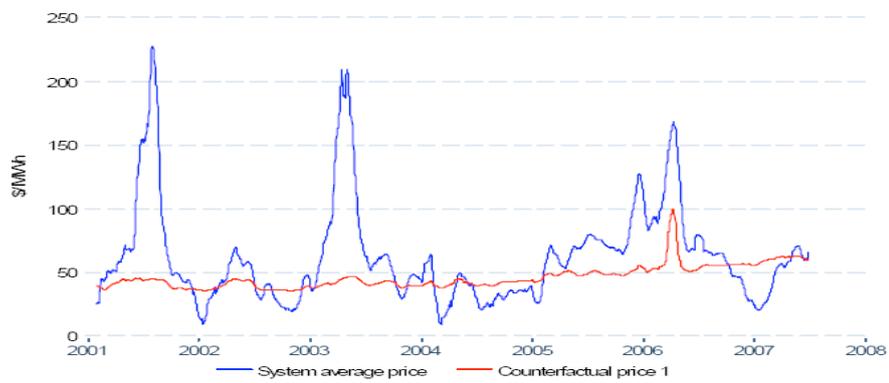
***The competitive counterfactual***

- *finds the generation portfolio that minimises the cost of historical electricity consumption*
- *assumes short run marginal cost is the marginal cost of gas generation based upon (s.98) reported gas prices and where there are no gas plant availability issues*

***In sum, the competitive counterfactual assumes that electricity demand is completely unaffected by prices maintained over periods of time***

# ***Wolak Factual and Competitive Counterfactual (1):***

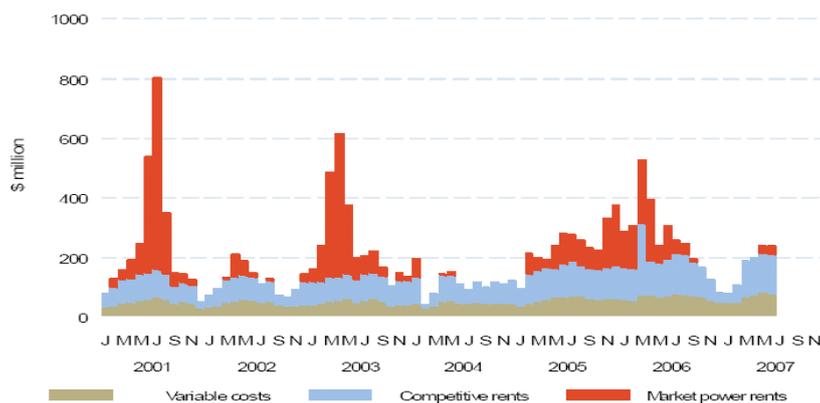
## **Prices**



Source Wolak 2009 (Figure 5.13)

## ***Wolak Factual and Competitive Counterfactual (1):***

### **Rents**



Source: Wolak 2009 (Figure 5.11)

If spot prices affect demand at all, Wolak's calculated market power rents

- arise from un-costed involuntary reductions in demand, or
- disequilibrium in which case they are not estimates of rents.

## **Summary: Frank Wolak's NZEM study**

- **is in accord with his general approach to analysis of other markets;**
- **maintains the hypothesis of unilateral market power and does not test it;**
- **does not**
  - **sensibly estimate market power rents;**
  - **properly account for the critical role of uncertainty and generation (fuel) availability in his analysis (as in previous work);**
- **contains**
  - **inexplicable statistical and empirical analysis;**
  - **no check against the context of, or other work on, the New Zealand electricity market; and**
- **provides no basis for changing elements of the New Zealand electricity market.**