
WHOLESALE MARKET REPORT

TO: TAMARA LINNHOFF, COMMERCE COMMISSION
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TOPIC: PEER REVIEW OF PROFESSOR WOLAK REPORT
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I have been asked by the New Zealand Commerce Commission to peer review the Wholesale Market report by Professor Frank Wolak and provide the Commission with a written report assessing whether:

- (i) the work by Professor Wolak has adopted a mainstream approach or standard methodology, which has been accepted by experts and other competition and/or regulatory authorities to examine issues of market power in electricity wholesale markets;
- (ii) given the approach taken, the conclusions reached by Professor Wolak are reasonable.

I have received a draft of the Wholesale Market report, as well as a Preliminary Report on the Design and Performance of the New Zealand Electricity Market, also written by Professor Wolak. I have also received background information from the Commission on its investigation and Professor Wolak's methodology. My review is based on these documents.

OVERVIEW OF THE REPORT

I first provide a brief overview of the Wholesale Market report, concentrating on the main issues relating to understanding how the four main suppliers of electricity exercise unilateral market power and what impact these actions have on market outcomes in the New Zealand wholesale electricity market.

Chapter 1 contains the introduction to the report, including an overview of the potential for the exercise of market power in electricity markets. Professor Wolak points out that firms serving their fiduciary responsibility to maximize the returns earned by their shareholders can be expected to undertake all unilateral profit-maximizing actions given the actions of their competitors, and that competition law typically does not prohibit firms from exercising all available unilateral market power because there are few goods where the market outcomes that result from all firms serving their fiduciary responsibility to their shareholders are not substantially different from the market outcomes predicted by perfectly competitive behaviour by these firms for sustained periods of time.

He then argues that it is difficult to conceive of an industry more susceptible to the exercise of unilateral market power than electricity; unlike other product markets, coordinated actions among suppliers or the concentration of production capacity in the hands of small number of firms are unnecessary for electricity suppliers to raise prices substantially above competitive levels. The reasons is that electricity possesses virtually all of the product characteristics that enhance the ability of a supplier to exercise unilateral

market power, including that supply must equal demand at every instant in time and at each location in the transmission network; it is very costly to store electricity, and production is subject to extreme capacity constraints in the sense that it is impossible to get more than a pre-specified amount of energy from a given generation unit during a pre-specified time period; delivery of the product consumed must take place through a transmission network with finite transfer capacity; the pricing of wholesale electricity to final consumers makes the wholesale demand extremely inelastic, if not perfectly inelastic; the technology of electricity production historically favoured large generation facilities, and in most wholesale markets the vast majority of these facilities are owned by a relatively small number of firms; and, finally, generation capacity ownership also tends to be concentrated in small geographic areas within these regional wholesale markets.

Professor Wolak claims that evidence from virtually every re-structured electricity market operating around the world is consistent with some or all of the suppliers having the ability and/or incentive to exercise unilateral market power to raise prices significantly above the levels that would be predicted by perfectly competitive behaviour for sustained periods of time, and he refers to the literature where such evidence has been presented. He also argues that the research presented in the present report demonstrates that a significant dependence on hydroelectric generation resources can enhance the ability of suppliers in a wholesale electricity market to exercise unilateral market power for a sustained period of time.

The chapter ends with a presentation of the purpose of the report and an overview of the methods used and the results derived with these methods.

Chapter 2 presents descriptive statistics on several aspects of the New Zealand wholesale electricity market from 2001 to 2007 as well as electricity and market background information, including a description of the characteristics of electricity as a product, a description of the set of generation plants in New Zealand, the workings of the wholesale market – with an explanation of the market interactions between generator-suppliers, retailer-purchasers, and the institutions that clear, and settle, the market – a characterisation of the pattern of load and generation throughout New Zealand, a summary of the behaviour of hourly prices during the sample period, information on water levels and the relationship between water levels and market outcomes, a summary of the behaviour of the retail load obligations and forward contract purchases and sales of each of the four large suppliers, a summary of the behaviour of the electricity production mix by input energy source and fossil fuel prices over the sample period, and a description of the several rounds of advance scheduling, pricing, and dispatch runs that precede the final price-setting process in the wholesale market.

Professor Wolak points to the high degree of concentration on the generation side – with four firms controlling 85 per cent of total capacity – the high degree of geographical concentration of the capacity of individual firms, the large extent of vertical integration between generation and supply and the high degree of contract coverage (incl. fixed-price retail load obligations). He also presents evidence of the considerable variation in water availability between different years, and the close relationship between water levels and wholesale-market prices.

In his description of the wholesale market, Professor Wolak emphasises that an important feature of the New Zealand electricity market is the number of times that the market Scheduling, Pricing and Dispatch (SPD) software that sets nodal prices for each

half-hour period is run in advance of the actual final nodal price-setting process; since for each advance run of the SPD model market participants submit supply offers and demand bids and receive information of the resulting nodal prices, dispatch and withdrawal levels and operating reserves and operating reserves prices, each market participant obtain feedback about the likely impact its willingness-to-supply offers have on the amount of energy it sells and the nodal prices that it will ultimately pay, without any financial consequences, because dispatch quantities and nodal prices from these advance runs are not financially binding and are for informational purposes only.

Chapter 3 of the report contains a discussion of unilateral market power in wholesale electricity markets, defined as the ability of individual sellers and buyers to profitably influence the market price through the amount of output they are willing to supply or the amount of output they are willing to purchase. As the seller side of the electricity market is much more concentrated than the buyer side, the market power of sellers is likely to be higher than that of buyers, and so the analysis is concentrated on sellers, or producers/suppliers, of electricity.

Professor Wolak points to the distinction between the ability and the incentive to influence price. The ability may be measured by the (inverse) elasticity of residual demand (net demand facing an individual supplier when the supply of all competing suppliers has been accounted for). The more inelastic the demand curve, the larger increase in the market clearing price from a given reduction in supply, implying that the market power of the supplier is large. In order to find the incentive to influence price, one must also take account of the net position of the seller in the wholesale market. Specifically, the more a seller is committed to selling under long-term contracts (fixed-price forward-market obligations), the less he has to gain from an increase in the wholesale-market price; indeed, a supplier who is over-contracted – i.e. who sells more on long-term contracts than he produces – will be a net buyer in the wholesale market and hence will have an incentive to reduce, not increase, price. The incentive to influence market price may be measured by the (inverse) elasticity of net residual demand (residual demand less contracted output).

Professor Wolak points out that the ability of a supplier to influence price is particularly high in cases in which the supplier is pivotal, i.e. when some of its supply is necessary to serve demand regardless of the offer price. However, while a pivotal supplier will be able to drive the price to the absolute maximum, he may not have an incentive to do so, depending on the extent of forward contracting. In the case when net residual demand is positive for all prices, there is effectively no bound on the market power of the supplier.

Professor Wolak discusses how the theoretical concepts of elasticities may be measured in practice, taking account of the stepwise character of residual supply curves, uncertainty about the realisation of demand and supply and the nodal structure of prices (reflecting transmission losses and constraints). He argues that, although these practical issues do complicate the task, they do not fundamentally undermine the possibility of measuring ability and incentive to influence price.

Finally in Chapter 3, Professor Wolak discusses determinants of the duration of market power in wholesale electricity markets, including the ability of generation unit owners to supply more energy from existing generation units, retail consumers to reduce their demand for electricity and new entrants to build new generation capacity. He argues that the duration of market power may be substantial, especially in hydro-dominated

systems, where annual or seasonal variations in water availability that allow the exercise of unilateral market power can persist for a sustained period of time because, different from the case of a fossil fuel-dominated system, the cause of the reduction in available energy cannot be repaired and brought back on line.

Chapter 4 is devoted to empirical evidence on the ability and incentive to exercise unilateral market power. The measurement of the ability to exercise market power is based on the so-called (inverse) semi-elasticity of the residual demand curve, which gives the \$/MWh increase in the market-clearing price associated with a one percent reduction in the amount of output sold by the supplier. To measure this magnitude, Professor Wolak constructs a linear approximation to the residual demand curve from prices (close to) 10 percent above and below the market-clearing price. Professor Wolak calculates and compares semi-elasticities for each half hour and supplier, finding considerable variation both across suppliers and over time. Semi-elasticities are positively related to prices.

In order to investigate the incentive to influence market prices, Professor Wolak calculates the (inverse) semi-elasticities of net (of forward-market obligation) residual demand, which may be done from the corresponding semi-elasticities of residual demand. The calculations demonstrate the mitigating influence of fixed-price forward contracts on the incentive of suppliers to exercise unilateral market power. As ability, the incentive to influence price is positively related to market prices; specifically, during mid-2001, early 2003 and early 2006 the average index of the incentive of the four main suppliers to exercise unilateral market power is high and the quantity-weighted average nodal price is high also; conversely, during 2002, 2004 and 2005, when the average index of the incentives of these suppliers to exercise unilateral market power is close to zero, the quantity-weighted average of the nodal prices is significantly lower than in the other periods.

Professor Wolak then goes on to explore the extent to which the relationships between prices and indices of market power are caused by suppliers exercising unilateral market power by the price offers they submit to the wholesale market. He does this by estimating a relationship between the offer price at the actual level of output and the semi-elasticity of residual demand, controlling for differences between months and half-hours of the day in an individual supplier's opportunity cost of producing electricity from its generation units. The results show that higher values of the index of a supplier's unilateral ability to exercise market power are associated with a higher offer price for the quantity of energy dispatched during that half-hour period by that supplier. A similar statement holds for an analogous index of the supplier's unilateral incentive to exercise market power. There is some variation between different suppliers, with a particularly strong relationship between both ability and incentive to influence market price and its price offers for Mighty River Power.

Professor Wolak also undertakes an analysis of the relationship between a supplier's offer prices and indices of the ability and incentive to exercise market power based on whether the supplier is pivotal or net pivotal. While it regularly occurs that a supplier is pivotal, being net pivotal is a rare event. Linear regressions demonstrate that a higher ability and incentive to exercise unilateral market power as measured by respectively, a pivotal indicator variable and pivotal quantity and net pivotal indicator and net pivotal quantity, predicts higher offer prices for the supplier's dispatched quantity of energy.

Professor Wolak concludes that, taken together, the empirical evidence provides strong indication that there is a causal link between the unilateral ability and incentive of suppliers to exercise market power and the offer prices they submit for the quantity of energy they sell in the short-term market. These higher or lower offer prices produce higher or lower market-clearing prices that are consistent with the unilateral ability and incentive of suppliers to exercise market power.

Finally in Chapter 4, Professor Wolak investigates whether thermal suppliers behave as if they have the ability or incentive to exercise market power, by analysing the extent to which offer prices of thermal units exceed the variable costs of these units. This is done by regressing the offer price for the quantity of energy sold from each fossil fuel generation unit during the half-hour periods when the unit was available to supply energy on a number of (dummy) variables to control for the variable cost of producing electricity from this generation unit at different levels of output and daily level of hydro storage in Terawatt-hours (TWh). The parameter estimates are consistent with the hypothesis that the owners of these generation units have a significant ability to exercise unilateral market power and that this ability increases with the level of system hydro storage (the coefficient on the hydro-storage variable is positive and significantly different from zero).

In Chapter 5, Professor Wolak measures the impact of the exercise of market power, defined as the difference between the actual market price and the counterfactual market price that would result if no supplier had the ability or incentive to exercise unilateral market power, times the actual market demand.

The counterfactual is derived from estimates of underlying marginal costs, under the assumption that the same generation units, with the same input fuel costs, run that actually ran during that half-hour period. Moreover, it is assumed that hydroelectric suppliers do not re-allocate hydroelectric production across half-hours under the no-market-power assumption and that suppliers offer the actual, rather than the nameplate capacity, of each thermal unit. For thermal units, variable costs are measured as the sum of fuel cost (fuel price times heat rate) and an estimate of variable operating cost (taken from international comparisons). For hydro units, costs are calculated using two different methodologies: in the first, it is assumed that a hydroelectric supplier does not re-allocate hydroelectric production across half-hours under the no-market-power assumption, which in effect means that the cost of hydro output at or below what was actually supplied in a given half hour is less than the marginal cost of the marginal thermal unit while the cost of hydro output over and above what was actually supplied in a given half hour is infinitely high; in the second, hydro costs are taken to be the minimum of the actual offer price for that generation unit and the variable cost of the highest variable-cost fossil fuel generation unit in the New Zealand system. Under these assumptions, the only difference between the actual offer curve submitted and the competitive benchmark offer curve is the offer price of the generation unit. Professor Wolak argues that the assumptions tend to an underestimate of actual market-power costs.

Professor Wolak also considers two alternative methods with respect to the locational pricing mechanism. The first method uses a single pricing zone for the entire New Zealand market. The second method replicates the nodal-pricing algorithm used to compute actual nodal prices. While the second method is more realistic, it is also substantially more computationally intensive; however, it would seem that the two

methods produce essentially the same results, something which is not surprising given that transmission congestion in the New Zealand market is relatively rare.

Professor Wolak draws three major conclusions from his empirical results derived in Chapter 5. First, substantial market power rents are earned during several years; the two time periods with the highest rents occurred during the winter of 2001 and the autumn of 2003, and during these calendar years market-power rents are estimated to exceed 45 percent of total annual wholesale energy revenues. The second conclusion is that in several years there were virtually no market-power rents earned by suppliers; for example, during the calendar years 2002 and 2004, the annual cost of the exercise of unilateral market power is not significantly different from zero. Thirdly, the two remaining years of the sample have intermediate levels of market power rents. The results also show that the large market-power rents typically come during only a portion of the year, usually during high-demand periods and low-water periods.

Chapter 6 links the analysis of the half-hourly relationship between the incentive and ability of the four large suppliers to exercise unilateral market power and the offer prices that they submit to the wholesale market presented in Chapter 4 to the magnitude of the half-hourly values of various measures of market power rents computed using the competitive benchmark pricing results from Chapter 5.

The three measures of market power rents are (i) gross rents, defined as the difference between actual price and the competitive benchmark price times total system generation, (ii) net rents, defined as the difference between actual price and the competitive benchmark price times the difference between total system generation and total contracted quantities (fixed-price forward market obligations), and (iii) positive net rents, defined as the minimum of net rents and zero. For the competitive benchmark, the single-zone measure is used (i.e. transmission constraints are not taken into account).

Professor Wolak relates the three measures of market power rents to the measures of ability and incentive of generators to exercise market power estimated in Chapter 3. For each measure of rents, he considers different variants of the same econometric model. The variants differ in three dimensions: (i) whether an index of ability or incentive to exercise market power is included, (ii) whether there are separate indices for each individual generator or an average index for all generators, and (iii) the structure of fixed effects to account for daily and hourly variations in underlying cost terms such as fuel prices and water values. In all variants, a second-order polynomial in total generation is included, to account for the level of system demand.

Professor Wolak finds that, for the three generators Contact, Meridian and Mighty River Power, market power rents are positively related to their respective measures of ability to exercise market power; for the fourth generator, Genesis, the corresponding coefficient is negative but insignificant. For all four generators, market power rents are positively related to the measures of their incentive to exercise market power. The results are consistent across the different measures of market power rents, as well as for the different econometric specifications considered. In the words of Professor Wolak, *“These results are consistent with the statement that half-hours when each supplier has a greater incentive to exercise market power, the market power rents as measured by gross rents, net rents and positive net rents are substantially higher.”*

The report contains two appendices. Appendix 1 provides observations on market-power mitigation mechanisms used, or discussed, elsewhere in the world to improve the performance of short-term wholesale markets, specifically to adapt the market structure,

market rules and regulatory process to alter the ability and incentive of market participants to exercise unilateral market power. Based on this discussion and the results of the empirical analysis, Professor Wolak concludes as follows: *“Considered from the perspective of balancing benefits into the distant future against current implementation costs, it is difficult to see how taking action now to fix these market performance problems does not have positive expected net benefits to New Zealand consumers and the New Zealand economy.”*

Appendix 2 contains the report received by the Commission in December 2006, which contains an overview of the New Zealand electricity supply industry, including its history, the structure of the wholesale market and regulatory oversight.

DISCUSSION

Professor Wolak’s analysis is founded on well-established economic theory, statistical methods and empirical practice. In addition, the analysis utilises a number of new and sophisticated methods, mostly developed by Professor Wolak himself for the study of wholesale electricity markets around the world. My comments do not represent so much a critique as an elaboration on some of the issues raised in the Wholesale Market report as well as some potential caveats to the results and their interpretation.

Professor Wolak starts out by making the highly relevant point that electricity has certain features that leave electricity markets particularly susceptible to unilateral exercise of market power. He also refers to evidence from around the world that demonstrates that this is not just a theoretical issue, but a real phenomenon in actual electricity markets. While these points are certainly well taken, one should not draw the conclusion that significant market power is unavoidable in electricity markets; with the right design and structure, electricity markets may work quite well. Also, one should be careful not to make the standard of comparison too strict – no real market is fully competitive in the sense of textbook economic theory; if other markets were scrutinised with the same rigour as electricity markets, many would be found deficient.

Nevertheless, the exercise of market power in electricity markets raises a number of issues that are not relevant in most other markets. One such issue is the spatial nature of the market, due to the geographical distance between generation sites and load centres and the costs of, and constraints on, bringing electricity between them. Professor Wolak devotes a considerable portion of his report to discussing this issue, which represent a considerable challenge to the analysis of market performance in general and market power in particular. Fortunately (for the present study), it would seem that there is sufficient transmission capacity in the New Zealand system and hence that this issue, while of considerable theoretical interest, may be of limited practical importance here.

Another important issue that characterises (some) electricity markets are differences between generation technologies, in combination with the necessity to balance the market at all times. For thermal technologies, we may (to a first approximation) view each period in which the market is open in isolation. In particular, the extent of market power (of a seller) may be measured by the ability to raise price over (variable) costs, measured by the sum of fuel and operating costs. The theory presented by Professor Wolak is directly relevant to this case.

For hydro technologies, matters are somewhat different. Firstly, for hydro plants with limited or no storage capability (“run-of-river” plants) market power is essentially not an issue; when water runs, cost of output is practically nil and it will typically be optimal to

operate at maximum capacity. Secondly, for hydro plants with larger storage capacity market power is exercised by moving output between periods; in particular, and compared to a supplier with no market power, a supplier with market power will aim to move output away from periods in which market price is sensitive to supply towards periods in which this is not so. It follows that while market power of thermal suppliers is related to the sensitivity of price in any given period, the market power of hydro suppliers is related to the difference in price sensitivities across periods. One implication of this insight is that the market power of hydro suppliers will be limited over sustained periods of similar market conditions, unless they have sufficient storage capacity to shift supply into or out of such periods.

Professor Wolak is clearly aware of these issues and devotes considerable attention to discussing the particular characteristics of hydro technologies and their importance. Specifically, he discusses the practical challenges associated with analysing market power of hydro suppliers. Nevertheless, since he takes hydro output as given, his empirical analysis is not able to shed light on the use of hydro plants in the exercise of market power (although, as he points out, his treatment of hydro technologies are likely to underestimate the overall cost of market power in the New Zealand market). In particular, it cannot shed light on the extent to which suppliers shift hydro output in such a way as to increase the total cost of thermal output.

A third issue related to the specificities of electricity markets concerns the type and origin of market power. The Wholesale Market report is about unilateral market power. However, as is well known, electricity markets have a number of characteristics that may make them susceptible to the exercise of multilateral or coordinated market power, or (open or tacit) collusion. These characteristics include very frequent interaction between market participants, a stable market structure and a high degree of transparency (eg. with respect to availability, output and storage levels). Given the fact that the supply side of the New Zealand market is highly concentrated, it would not be surprising if coordinated market power would be an issue also. One could argue that for Professor Wolak's analysis this issue is just a matter of interpretation; what is of interest is the extent to which prices are manipulated, not the underlying cause. However, from a policy or remedy perspective underlying causes clearly matter. One reason for assuming that the distortion of prices do indeed follow from unilateral, as opposed to coordinated, market power is the fact that distortions vary over time, and, indeed, that for long periods of time there is no sign of such distortion (the latter impression may be misleading however, given the potential over-estimate of competitive prices).

The measurement of market power raises a number of principle and practical issues. The most direct test of market power would be to consider price-cost mark ups. Professor Wolak does perform such an analysis, in Chapter 4.4, where he relates offer prices on thermal units to estimates of variable costs as well as other variables, notably availability of hydro power. The fact that offer prices cannot be fully explained by costs, and that they are positively related to availability of hydro resources, is an indication that suppliers do not price thermal units competitively.

However, given the availability of high-quality data on both costs and offer prices, one might be able to get further in the analysis of supplier price setting. In particular, by matching offer prices and costs, and calculating price-cost margins, one should be able to get a very detailed picture of supplier pricing strategies. In particular, evidence that suppliers vary offer prices between periods in which underlying costs are the same – especially between periods of different market conditions, such as times of day, days of

week or seasons – would give a more complete picture of the extent of market power. Such analysis may lead to a richer, more detailed, insight into the behaviour of the generators.

A similar comparison between offer prices and costs would clearly be much more difficult for hydro plants. As explained by Professor Wolak, establishing the (opportunity) cost of water requires solving a stochastic, dynamic problem of optimal disposal of water into the future. Nevertheless, one might be able to cast some light on pricing behaviour by just analysing offer prices as such, to uncover changes in offer prices that would seem not to be related to underlying supply conditions.

For measuring incentive to influence price, Professor Wolak takes as his starting point a (simple) model of profit maximising behaviour, which leads to the following relationship:

$$\frac{P - C}{P} = -\frac{1}{\epsilon}$$

where P is offer price, C is cost of the marginal unit and $-\frac{1}{\epsilon}$ is the inverse elasticity of the residual demand curve (net of forward contracts, if such are relevant; cf. Equations (1) and (8) in Chapter 4). The left-hand side of the equation – the percentage mark up of price over cost – is often termed the Lerner index and is commonly viewed as a measure of market power. This approach suggests that market power could be measured (indirectly) by the elasticity of residual demand at the realised marginal offer price.

Note that for measuring ability, as opposed to incentive, to influence price, one could argue that the starting point should be costs rather than offer price, since the question would then be the extent to which suppliers have the ability to raise price over costs. There are practical problems associated with such measurement – particularly with measuring costs – which would make this approach difficult. Unless pricing was actually competitive – in which case realised offer price and costs would be equal – results might differ depending on the starting point; in particular, Professor Wolak’s approach might well underestimate the ability of firms to raise prices over costs.

Even with realised marginal offer price as the starting point, a number of practical difficulties remains. Professor Wolak explains very carefully what these are and how he has dealt with them. It is comforting that his robustness tests seem to indicate that results do not depend to any great extent on particular modelling choices; for example, Table 4.1 indicates that the size of the price window used to estimate the slope of the residual demand function is of little importance (admittedly, these are average numbers and do not provide information about deviations in any given period).

Professor Wolak relates offer prices to his measures of ability and incentive to influence price, finding a strong positive relationship, even controlling for underlying costs. Note that this finding does not necessarily imply that the extent of market power varies over time. In particular, from the relationship above, we find

$$P = C - \frac{1}{\epsilon}P = C + 100\eta,$$

where $100\eta = -\frac{1}{\epsilon}P$ is the semi-elasticity, measuring the \$/MWh increase in the market-clearing price associated with a one percent reduction in the (net) position of the supplier. Therefore, since η is a function of P , if we relate P to η we would find a positive relationship even if the (inverse) elasticity was constant. Therefore, if we take the

standard approach and measure market power by the Lerner index – which in this model equal the (inverse) elasticity of residual demand – we could not necessarily take the results of the Wholesale Market report as an indication that market power varies over time. It might be interesting to complement the results presented in the report by an analysis of (systematic) variations in the Lerner index (and its relation to offer prices).

In the estimated relationships between offer prices and ability and incentive to influence price (cf. Equation 13 in Chapter 4.3), costs are accounted for through fixed controls for half-hour of the day and month. Professor Wolak argues – quite convincingly – that the number and structure of fixed effects should allow for sufficient flexibility to cover variations in the opportunity cost of producing electricity from the highest variable cost generation unit operating in any given period. Nevertheless, if there are variations in this opportunity cost that are not systematic across times of day, or across months, they would likely affect the estimate of the coefficient of the ability/incentive variable η ; for example, a positive shock to demand that result in a movement up the supply curve might increase both price and the steepness of the residual demand curve of any given firm, without necessarily affecting any change in ability or incentive to raise price. It is not obvious how one could improve the control for variations in opportunity costs, and it is difficult to say to what extent such improvements might affect results, but there does seem to remain a question about exactly how well the current controls are performing.

The estimated parameters on the ability/incentive semi-elasticities variables are large and significant (cf. Table 4.2 and Table 4.3). However, it is not entirely obvious how these coefficients should be interpreted. From the model reproduced above one would expect that the coefficients on the incentive variable (δ) equal 1. Admittedly, and as explained very carefully by Professor Wolak, this model is likely much too simple to accurately reflect behaviour in the New Zealand wholesale electricity market. Nevertheless, the question remains why these variables take the values they do and, in particular, why they differ between firms.

The problem of interpretation also concerns causality. Strictly speaking, these regression analyses do not say anything about the causality between ability and incentive to influence price and actual offer prices (a similar comment applies to the other regression analyses). One could argue that, based on economic theory and other evidence, it would nevertheless seem natural to interpret the estimated relations to run from market power to price setting.

The analysis of impact of the exercise of market power concentrates on the difference between actual and competitive prices, multiplied by total demand. One interpretation of this measure is that it reflects the additional revenue due market power that suppliers earn from the spot wholesale market (if all transactions went through this market); an alternative interpretation is that it measures the extra costs due to market power that customers have to pay for electricity (if all transactions went through this market). Essentially, this is a measure of (the upper limit of) the transfer of surplus between buyers and sellers of electricity in the wholesale market resulting from the exercising of market power.

It is a matter of preference what is considered the cost of market power. In mainstream economic literature, as well as in some national jurisdictions, transfers are not considered as inefficiency *per se*, since the cost to some group is fully reflected in the gain to some other group; to count as a cost, one would have to weight gains and losses

differently across market participants. Admittedly, in some national jurisdictions price is indeed considered a (sufficient) measure of inefficiency. Since much of the transfer in the wholesale market is internal (between generation and supply arms of the same company), it would probably not be considered a cost in any case; it is only when changes in wholesale prices are transmitted to retail prices that consumers would be affected by the exercise of market power in the wholesale market.

Nevertheless, market power potentially involves inefficiencies distinct from transfers between buyers and sellers. In particular, distortion of prices may affect dispatch and hence overall generation costs (specifically, the total cost of thermal output), as well as impact on investments (specifically, higher average prices may result in over-investment). In order to measure such inefficiencies, one would have to analyse how market power affects availability and use of individual plants. This is not an easy task, as explained by Professor Wolak; nevertheless, by taking dispatch as given, his analysis essentially ignores such economic inefficiencies resulting from the exercise of market power in the New Zealand electricity wholesale market.

It may be remarked that although a number of the assumptions underlying the calculation of the (hypothetical) competitive benchmark tend to overestimate the associated prices, the treatment of start-up costs may work in the opposite direction. Such costs may constitute a significant part of total (semi)variable costs when plants are in operation for only a small period of time, say one or a few half-hours, which may be the case for plants at the margin. Since the marginal plant in any given half hour sets the market price in that hour calculations of market prices are particularly sensitive to the costs of these plants. The importance of this factor depends on the size of start-up costs as well as the operation of marginal plants.

These issues are relevant also for the analysis of the benefits of generators from exercising market power. Furthermore, it is not obvious whether these benefits should be calculated based on spot transactions or whether contracted volumes should be taken into account also. In the short run (i.e. for given contract positions), the gain from raising market prices only accrues on net suppliers to the spot market (i.e. total generation less fixed-price forward market obligations). However, it is likely that forward prices will be influenced by expectations of future spot prices, which again may be affected by the exercising of market power; if so, benefits from exercising market power may be earned on contracted volumes also.

Professor Wolak does analyse market rents both gross and net of long-term contracts, and his results suggest that not only net rents but also gross rents are positively related to the ability and incentive of generators to exercise market power. It should be noted, however, that the analysis undertaken in Chapter 6 relates rents and market power half-hour by half-hour; it therefore does not really consider likely gains to suppliers, with excess generation above their retail needs, from increases in prices for forward contracts sold, where the general increases in the spot market price arising due to the exercise of market power causes a knock on effect on contract pricing.

A final comment on the empirical analysis concerns the quality of the data on which the analysis is based. Since I have not had access to the data, nor have had an opportunity to consider the process by which the information has been obtained and the data base has been constructed, I am not in a position to judge the quality of the data directly. However, based on the description given in the report and on the various tests employed to check the reasonableness of the results, I have no reason to doubt that the

quality of the data is sufficiently good not to undermine the general validity of the results and the conclusions drawn from these results.

In Appendix 1, Professor Wolak presents some observations on ways to mitigate market power. He emphasises – quite rightly in my view – that mitigation measures must first and foremost address the ability and incentive of market participants to exercise market power. It is generally not helpful – and, one could argue, directly in conflict with the legal rights and obligations of New Zealand electricity supply firms – to simply ask or request firms not to exercise market power or to expose them to political pressure or popular scorn for doing so.

The Nordic countries – where bids into the wholesale market are considered and treated as private information – would seem to provide an example that public access to detailed data on the operations of individual market participants is not a prerequisite for a well-functioning electricity market. Indeed, the Nordic market works well even though it does not have in place commonly discussed market-power mitigation mechanisms such as vertical separation between generation and supply, caps on prices offered into the wholesale market, retail-price controls and public release of information on wholesale market behaviour. It may be noted that the Nordic market, as the New Zealand market, is highly dependent on hydro resources that vary considerably between wet and dry years.

The reason the Nordic market works so well seems to be because the market structure is conducive to competition; there is a large number of wholesale suppliers, many of these have their units geographically dispersed and transmission capacity is sufficient to avoid market segmentation (the latter with some notable exceptions). There appears to be a more general lesson here, also for the New Zealand market: ultimately, effective competition requires a low degree of market concentration, especially in electricity markets.

While 3 of the 4 largest suppliers are corporatised, and are expected to maximize returns to shareholders as would a privately owned business, they are State Owned Enterprises owned by the New Zealand Government, and it would therefore be easier for the Government to mandate structural changes than if they were privately owned. In any case, as Professor Wolak points out, there are good reasons to contemplate restrictions on the expansion of major generators and instead encourage the expansion of their smaller competitors or new entrants. Given the high degree of geographical concentration of existing firms, it would seem particularly important to encourage new competition in areas of high concentration. Maintaining and expanding transmission capacity beyond levels that would be deemed necessary from purely operational reasons may be required to counteract the tendency to geographical concentration.

Given the high levels of concentration of the New Zealand market, Professor Wolak is quite right in pointing to alternative, regulatory measures to mitigate market power. It is important to be aware that some of the measures discussed would take the New Zealand market quite far from the philosophy underlying the current regulatory regime. For example, an average wholesale price cap, or retail price controls, could easily bring price formation in the wholesale market to become more or less a direct regulatory responsibility.

While the ideas put forward by Professor Wolak may be well worth considering, careful analysis and discussion would seem to be warranted before the ideas are put into practice.

CONCLUSION

To sum up, I conclude from my review of the Wholesale Market report that Professor Wolak's approach is fundamentally sound, well founded on accepted economic methods and practices. As such, the conclusions of the report are reasonable. In particular, Professor Wolak's investigation has identified that

- generators in the New Zealand electricity industry have periodic market power;
- generators with market power have exercised this market power to raise prices above underlying costs; and that
- generators have obtained significant rents, at the cost of customers purchasing from the wholesale market, by exercising market power.