

Electricity Generation: Competition, Market Power and Investment

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Summary and Introduction

Over the past twenty years, many countries have introduced competition into their electricity industries, with the goal of greater efficiency and benefits to consumers. This has turned out to be a very complex, multi-dimensional undertaking and the “best practice” is still evolving. Economists around the world are still learning from the experience of electricity markets. In New Zealand, two recent events – against a background of spikes in wholesale electricity market prices (see Figure 2) – have fostered interest in electricity market competition. First, in late 2005, the Commerce Commission launched an investigation “due to complaints and concerns about electricity prices, company profits...and a perceived low level of competitive activity” (New Zealand Herald 2005). Second, the International Energy Agency’s (2006) review of New Zealand claimed “market power abuse is a real threat.”

This paper provides context for these developments by reviewing the international economic literature and building on the discussion of wholesale electricity markets in an earlier issue of the *Policy Perspectives* series (Came and Dupuy 2005). In order to keep the discussion focused, the main consideration here is competition and incentives in the *wholesale* market, in which generators compete to sell into the transmission grid.

The main points are:

- International experience shows that wholesale electricity markets may sometimes be susceptible to bouts of inadequate competition. In particular, transmission constraints can temporarily isolate geographic regions from the larger market, allowing local generators to exercise “market power” by withholding capacity and artificially boosting prices.
- It is very difficult to identify episodes of market power empirically: price spikes will occur even in competitive markets and are not necessarily evidence of market power. This paper summarises several empirical approaches and their strengths and weaknesses. There is little empirical evidence currently available for New Zealand.
- The international literature suggests that several factors can help promote competition in the wholesale market: robust transmission capacity, widespread forward contracting, demand-side responsiveness to price fluctuations, reduction of regulatory uncertainty and removal of barriers to

entry for new generators. In addition, some economists recommend that every country should have an independent, forward looking “market monitor” institution charged with collecting data, providing analysis, and recommending policy changes regarding market power.

- However, market power mitigation should not be pursued at all costs. It is unlikely to be practical or feasible to eliminate *all* scope for market power. For example, additional transmission capacity can help promote competition, but this benefit should be balanced against the cost of construction and maintenance.
- In addition, it is important to avoid introducing new distortions to incentives for investment, for example by treating all price spikes as undesirable. The international literature suggests that, in some markets, prices do not spike *high enough* to support optimal investment. This is sometimes because of price caps and other distortionary policies. However, even in the absence of these policies, the short-run unresponsiveness of demand to prices can lead to inefficient signals for long-term investment.

None of these points argue for a fundamental revamping of New Zealand’s electricity policy or industry structure. Instead, it is important to focus on *details* to “get incentives right” for competition and investment.

Why Competition?

In the late 1980s and early 1990s, several countries began to restructure their electricity industries, on grounds that traditional electricity monopolies were unnecessarily inefficient.

Traditionally, electricity industries around the world were characterized by “vertical integration”: in each country or geographic region, the generation, transmission, distribution and retail segments were typically bound together, operating under direct government ownership or as a regulated monopoly. In the late 1980s and early 1990s, several countries began to restructure their electricity industries, on the advice of economists, policymakers and electricity consumers who argued that the electricity monopolies were unnecessarily inefficient. These advocates pointed to earlier successes with competition in segments of telecommunications and transport. A basic model for electricity restructuring emerged first in the UK, followed by some US regions, New Zealand, Australia and (more gradually) other parts of Europe: split up the vertically integrated electricity organizations and introduce competitive markets in generation and retail, while continuing to regulate the “natural monopoly” transmission and distribution segments.

Of course, competition and unbundling are not ends in themselves. The aspiration of restructuring is to stimulate efficiency – in production, delivery and consumption – and put downward pressure on prices. The idea is to achieve this through three broad mechanisms. First, and most importantly, competition in the generation and retail segments is supposed to provide incentive for profit-seeking firms to improve efficiency in the short-term (through better use of existing plants and inputs such as fuel and labour) and in the longer term (optimised quantity of generation capacity, better choice of technology, fuel source, and plant location). Second, giving consumers greater exposure to market prices for electricity should improve

the allocation of electricity consumption and cut down on waste. Third, economists have pointed toward the potential for productivity gains from introducing “incentive regulation” to improve the performance of firms that own and operate the transmission and distribution networks.

This *Policy Perspectives* focuses primarily on the first of these three broad mechanisms, particularly competition between generators, although we will see that getting this right often depends on getting the other two mechanisms right as well. This paper provides an overview of the international experience with generator competition and draws ‘lessons learned’ that may be useful in the New Zealand context.

Government has to take responsibility for institutions and regulations to support a competitive electricity marketplace.

As Hogan (2003, p. 3) puts it, “successful electricity markets require new institutional infrastructure with a visible hand to support competition...The market cannot solve the problem of market design.” In other words, government needs to set up and maintain the right institutions and regulations to support a competitive electricity marketplace.

How Wholesale Electricity Markets Work

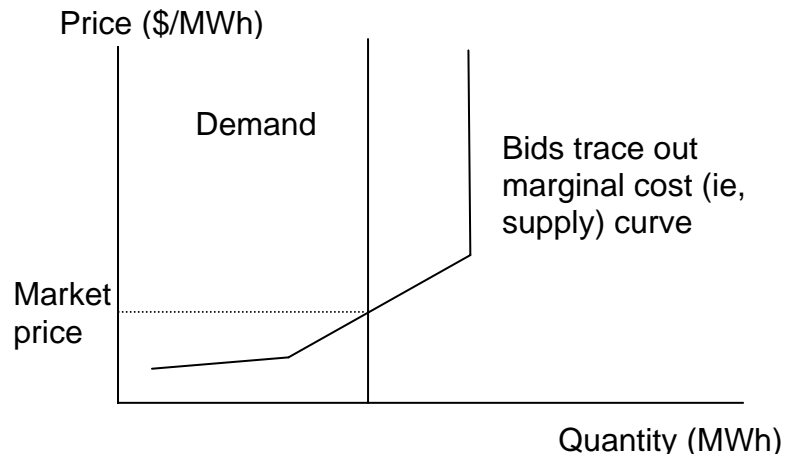
Came and Dupuy (2005) give an overview of the economics of wholesale electricity markets. There are several points worth recapping here:

As a rule, markets work best when the market price is determined by the marginal cost of production.

- As a rule, markets – not just for electricity – allocate resources efficiently because the market price is determined by the marginal cost of production. To understand why, consider a situation where price is higher than marginal cost: this is clearly inefficient because some producer could supply another unit and more than recoup all the costs associated with that unit (ie, the marginal cost). In other words, consumers are needlessly forgoing a unit of output which could feasibly be produced at a price they are willing to pay. Conversely, if price is lower than marginal cost, there is inefficiency because at least one unit is being produced that costs more than the going price.
- A well-functioning, highly competitive market tends to produce a market price that is equal to the industry’s marginal cost of production. That is, the market price equals the cost of bringing the last (marginal) unit of capacity into production in any given hour.¹ In this way, existing generation capacity is managed efficiently on an hour-by-hour basis. If a wholesale market is well-designed and sufficiently competitive, this works well: the available generating units with the lowest costs are called on first. High-cost units run infrequently – typically during periods of high (or “peak”) demand.

¹ As will be discussed below, there is an exception: the market price can deviate from marginal cost in a competitive electricity market when demand is high and industry supply is close to its physical capacity constraint.

Figure 1: Wholesale Market Pricing



- Figure 1 is a stylised representation of a wholesale market during a typical hour (or half-hour) period. In each period, generators “bid” the price at which they would agree to operate various units of capacity.² The market operator ranks these bids and sets the market price at the level of the last bid needed to satisfy demand.³ If the market is highly competitive, the bid ranking traces out an industry marginal cost curve,⁴ and the market price is set by the intersection of demand and marginal cost. The difference between the market price and a given unit’s bid price reflect “scarcity rents” which allow firms to recover capital costs. These scarcity rents thus play an important role in providing incentive for new investment in the long term.
- However, in less competitive markets, individual producers can affect the market price. In this situation, it can be profitable for an individual firm to withhold output and thereby drive up the market price to earn “excess” profits on the remaining output. This is known as the exercise of market power.⁵ It hurts consumers and is bad from an overall efficiency point of view.⁶ International experience has shown that wholesale electricity markets can be susceptible to this problem – for reasons that will be explained below.

In uncompetitive markets, individual producers can exercise market power and raise the market price above marginal cost.

² In New Zealand, the term “offer” is used instead of “bid”. Although the New Zealand terminology is more intuitive – after all, the generators are *offering* supply – the term “bid” is used here in order to keep the discussion closely linked to the international literature on the subject.

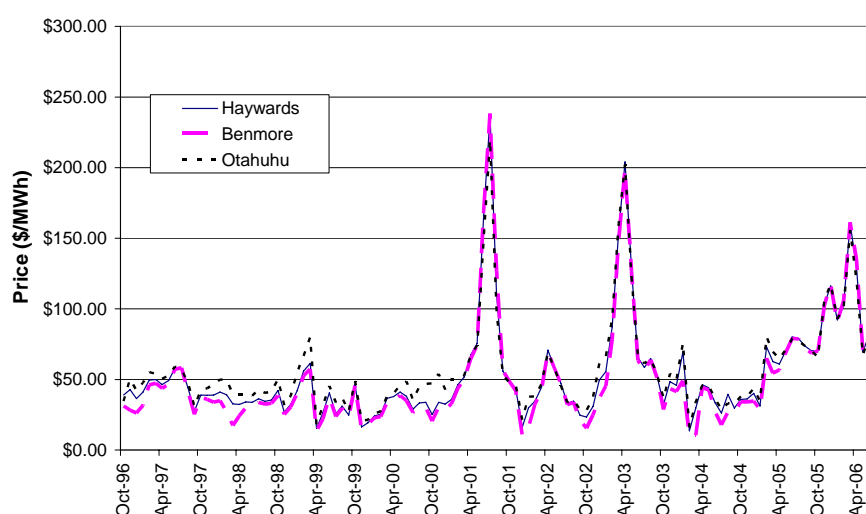
³ In this stylised figure, the demand curve is drawn as vertical or “perfectly inelastic”; in practice, demand may have some elasticity. This issue will be discussed in greater detail, below.

⁴ As explained in Came and Dupuy (2005), this is the case in a “uniform price” system (used in most major wholesale electricity markets around the world) but not in a “pay-as-bid” system.

⁵ There is also the possibility that, even though no single firm is able to *unilaterally* affect market prices, the market is concentrated enough that firms could cooperate in order to affect market prices. However, such cooperation is usually difficult to achieve and much of the literature focuses on unilateral market power in electricity markets.

⁶ In an infamous incident that colourfully (if not conclusively) illustrates the issue, electricity traders in 2001 were recorded discussing Californian generation capacity under their control. “If you took down the [generation unit], how long would it take to get it back up?” one asks. “Oh, it’s not something you want to just be turning on and off every hour. Let’s put it that way,” another says. “Well, why don’t you just go ahead and shut her down,” the first replies. Traders were also recorded joking about “all the money...[stolen] from poor grandmothers.” (CBS News 2004)

Figure 2: New Zealand Wholesale Market Spot Prices



Source: www.comitfree.co.nz

In practice, wholesale prices can be volatile. (Figure 2 shows average monthly spot prices in the New Zealand wholesale market. This averaging of course masks volatility at the hourly level.) As we will see, price spikes may sometimes be a result of market power, but in competitive markets price spikes provide important signals for investment.

When Competition Is Weak: The Problem of Market Power

Why should policymakers be concerned about market power and lack of sufficient competition in wholesale electricity markets? After all, at least in textbook treatments, economists are often sanguine about the ability of individual firms to exercise market power in product markets: in the absence of barriers to entry, new firms are attracted to industries that exhibit excess profits, in the process “competing away” the profits.

Several unusual economic attributes can leave wholesale electricity markets susceptible to market power.

However, there is now a fairly strong consensus among economists who study electricity that there are unusual economic attributes that make wholesale electricity markets significantly different – and more susceptible to market power – than other product markets (see, among others, Borenstein and Bushnell (2000), Joskow (2002, 2003), Newbery (2002) and Wolak (2003b)). While it is possible to think of other product markets that share *some* of these characteristics, it is the *combination* of these characteristics that makes electricity so unusual from an economic point of view.

In particular, transmission networks are limited in the amount of power they can carry. The degree of network *congestion* varies depending on supply and demand conditions (which typically change over the course of the day, with spikes occurring, for example, when households switch on heat in the evening). Congestion can limit – intermittently and often for only short

periods – the number of generators that can sell to a given demand location, giving some the ability to exercise market power while the period of congestion lasts. The other unusual economic characteristics of wholesale electricity markets can heighten the effect of this market power:

- The very short run (that is, hourly or daily) responsiveness (or “elasticity”) of consumer demand to changes in price tends to be low. This is because most consumers do not have meters and thus cannot see fluctuations in hourly prices; even if they could, elasticity might still be fairly low – once a consumer has purchased a computer, refrigerator or expensive piece of manufacturing equipment, the price of power at any given hour would have to fluctuate significantly in order to influence decisions about usage across the day.
- The short-run elasticity of supply to changes in price can also be very low, particularly when plants are operating near capacity.
- Entry by new generators can be very slow. A new plant can take years to build, particularly in jurisdictions with extensive permit requirements.
- Electricity cannot be stored. (Large-scale batteries are still too expensive to be worth considering from an economic point of view.⁷) As a result, aggregate supply and demand must equal one another on a moment-by-moment basis.⁸

Intermittent transmission constraints can temporarily cut off competition and allow individual generators to enjoy market power.

For an example of the implications of this unusual combination of characteristics, consider a transmission constraint that temporarily frees a generator near a large population centre from the constraints of competition with other, more distant generators. Low demand elasticity means that the generator could withhold a fairly small amount of capacity – perhaps by suddenly deciding to take part of capacity down for maintenance – and be rewarded with a substantial temporary increase in market price (at least in the nearby population centre).⁹ In this case, the high prices earned on the generator’s remaining “online” capacity more than compensate for the lost revenue on the relatively small amount of withheld capacity. In non-electricity product markets, even if producers are temporarily unable to transport goods from distant factories to consumers, inventories help dampen the price impact and limit the scope for market power.

⁷ Newbery (2002) and others point out that water behind dams in hydro systems can be thought of as “stored” electricity. However, the salient point for the present discussion is that, regardless of the nature of the fuel inputs, inventories of the finished product (electricity) cannot be stored in any practical large-scale way. This is very different from other industries where inventories of output can be accumulated.

⁸ More precisely, electricity supply, less losses, must equal demand. In practice, all transmission networks experience losses. Electricity is gradually lost as it travels along transmission lines so that less power is withdrawn (by consumers or distributors) from the grid than injected by generators.

⁹ In wholesale electricity markets in New Zealand and most other countries, electricity prices can vary by location. The market is set up so that demand and supply are calculated separately at each node (a point where electricity can be injected or withdrawn from the grid).

Measuring Market Power in Wholesale Electricity Markets

Price spikes do not necessarily indicate market power. Spikes should be expected even in competitive markets, where they provide crucial incentives for new investment.

In practice, it is difficult to conclusively identify and measure market power in wholesale electricity markets. It is important to recognise that high prices do not necessarily indicate market power. In fact, there is reason to *expect* bouts of high prices in wholesale electricity markets. As we will see below, episodes of high prices, during periods of high demand (or low supply), play a crucial role in providing incentives for long term investment. These episodes may last for hours (for example, due to a particularly cold day) or weeks (for example, due to drought).

Over the last several years, motivated partly by growing recognition of the role of market power in the UK in the 1990s and the California electricity crisis of 2000-01, scholars have accumulated a number of empirical approaches to measuring market power in wholesale electricity markets. Some are simple to construct, while others are highly complex and require data that is difficult to obtain. Each has strengths and weaknesses. In practice, several approaches should be used in conjunction in order to paint a sufficiently comprehensive picture.

Economists have developed a number of approaches to measuring market power. None of them are perfect.

There are three basic empirical approaches to identify market power. (Twomey *et al* (2004) give an excellent overview.) Each approach can be summarised in the form of a question.

Do any firms have the ability to exercise market power? A number of measures assess each firm's share of the total supply (usually expressed as megawatts of generating capacity) in a given market or country. The idea is straightforward: a market dominated by a few large firms will be more susceptible to market power than a market with numerous relatively small firms. To make sense of this information – and to enable meaningful comparisons across time or perhaps across countries – the shares can be aggregated into a Herfindahl-Hirschman Index (the sum of squares of each firm's share). Higher values of this index indicate greater concentration and scope for market power. Some studies look at a “pivotal supplier” measure which indicates how often a given firm has to run at least some of its capacity – that is, the measure looks at each firm's capacity relative to demand.¹⁰ There are other more complex variations, but the basic idea is the same: evaluate whether any firm is large enough relative to the market to allow it the *ability* to change its own output in a way that will affect the market price.

Unfortunately, concentration measures can give an incomplete picture of the ability of firms to exercise market power. First, these measures generally do not reflect the effect of transmission constraints. As noted above, transmission constraints effectively change the size of the market by limiting the amount of competition at various locations on the network. For

¹⁰ More specifically it looks at whether – in any given period, usually an hour – the capacity of a particular firm is larger than the difference between total (potential) industry supply and demand.

example, a given firm may only have a small fraction of the overall generation capacity in a *country*, but transmission congestion may emerge during certain periods, effectively giving the firm a large share of a *region* that is temporarily cut off from competition. Second, concentration measures don't consider the scope for entry by new firms. For a given level of concentration, a market where new investment is very slow (eg, due to heavy permitting procedures) will be more susceptible to market power compared to a market where entry is relatively easy.

Have any firms actually exercised market power in a given period? To answer this question, researchers look at detailed data on plant characteristics and input prices, and attempt to estimate a marginal cost curve for each generator. These estimates of marginal costs are then compared to each generator's actual bid prices. Deviation of bid prices from estimated marginal cost indicate market power – *if, of course, the estimate is correct*. This approach requires a lot of data and is sometimes controversial because estimates of marginal costs will always carry a degree of imprecision. Getting an accurate estimate of marginal cost can be particularly problematic in the case of hydro generation where the marginal cost of an extra unit of production includes complex considerations about future prices (Evans 2006). (Hydro generators are typically faced with the thorny challenge of choosing *when* to use water from limited reservoirs to generate electricity. Thus, the true marginal cost of generation for each hydro generator includes the “opportunity cost” of not using the water at some other time. Accordingly, estimates of the marginal cost of hydro generation need to take into account the generator's hourly price forecasts.¹¹) A related method evaluates data on unplanned plant outages. If a given firm owns plants that are out of service more frequently than is statistically typical for the relevant plant age and type, then this may be considered evidence of market power (again, depending on the accuracy of the estimate).¹²

Does the performance of the actual wholesale market match the predictions of a simulation model with competitive characteristics? Some economists build complex simulation models that model the characteristics of a given wholesale market. The modellers simulate market prices, bids and other output under the assumption that the market is highly competitive. These modelled outputs can then be compared to actual data from the real-world market. This is a useful approach, although it can be time consuming. The results can be difficult for a non-specialist to assess.

¹¹ Evans also points out that this argument can be extended, in some situations, to gas-fired plants. In some cases, the available storage of gas is limited and pipeline supplies are not readily available, so managers of these plants must make a decision regarding when to use the limited amount of storage. The key idea is that these considerations regarding the opportunity cost of fuel should be reflected in estimates of marginal cost.

¹² This approach will fail to detect a market power strategy called “economic withholding” where a firm simply bids units of capacity it wants to withhold at a very high price, knowing that these will not be “accepted” to run.

What Should Be Done About Market Power?

Policymakers shouldn't wait for bullet-proof evidence of a market power problem. Instead, they should work consistently to promote competition.

As we saw in the previous section, there will always be debates about the size and costs of episodes of market power. At the very least, it can take considerable time after the fact for analysts to come to a reasonable degree of agreement about the empirics of an episode of market power in a particular wholesale market. For this reason, the international literature on the economics of electricity suggests that policymakers should think carefully about appropriate institutions to promote competition and mitigate the scope for market power – even if the measurement of market power is not conclusive. At the same time, it is important to remember that it is impossible to *completely* eliminate market power and efforts to ameliorate market power should be balanced against the costs of doing so (Twomey *et al* 2004). For example, society could spend additional money on expanding transmission capacity. However, there is a point where the cost of additional transmission capacity outweighs the benefit of the reduced congestion.

Special caution should be taken to avoid introducing any new distortions: market power mitigation should not be a witch hunt. Regulators are faced with the difficult task of identifying and mitigating market power without distorting incentives for investment. Another lesson is that legal anti-trust systems are not adequately forward-looking and should not be relied upon to deal with market power – although they can play an important part.

As mentioned in Came and Dupuy (2005), there are several broad features of market design that can help to mitigate market power:

Ample transmission capacity is essential: it forces distant generators to constantly compete.

Transmission capacity and transmission regulation: As noted above, transmission congestion can limit competition. For this reason, adequate transmission capacity is very important for well-functioning competitive wholesale markets.¹³ In other words, a competitive electricity market requires a robust “economically reliable” network (Wolak 2003a).

Many countries have had trouble getting transmission regulation “right”.

Transmission regulation is a complex subject and deserves an extended discussion that is beyond the scope of this paper. However it is worth noting several points. Almost all countries with restructured electricity industries have had particular trouble with transmission regulation and, in practice, incentive regulation has been difficult to “get right”. There are many lessons to be learned from the experience in England and Wales, where policymakers have evolved a relatively comprehensive regulatory framework for transmission.

Hedging and forward contracts: Having a significant fraction of electricity production committed in forward contracts significantly reduces the scope for market power. This is because firms that have pre-contracted at a certain

¹³ “Capacity” should be defined broadly in this context: expansion of transmission capacity can take the form of new lines – but it can also take the form of investment in new software or computer systems that improve the management of existing lines. Better system operation and control procedures and technology can also effectively expand capacity.

price have less capacity with which to try to unilaterally influence spot market prices. Hedging can take several forms – there can be a formal hedge market with a range of pre-sized types of contracts. There can also be various bilateral agreements tailored to the particular situation that are not traded on a market. In addition, vertical integration – the existence of a generator and retailer together in one firm – can be thought of as a form of hedging (see Hunt 2002, for example). Hedge markets themselves can sometimes suffer from market power and policymakers concerned about wholesale market power should be on guard against distortions in hedging arrangements.

Demand side responsiveness: An increase in the elasticity of demand – that is, the degree to which consumers reduce their demand when the price increases in the wholesale market – will tend to reduce the severity of market power. A given generator may still be able to unilaterally increase prices by withholding capacity, but heightened demand elasticity will mean that the resulting price increase – and thus the payoff to the firm – will be small. If the potential payoff is small, so will be the incentive to exercise market power.

Low barriers to entry for new generators: The speed of entry of new generators in response to the incentive of excess profits in the wholesale market tends to be slow. Many countries have extensive permitting and public review processes. These often serve very useful purposes and have substantial benefits (eg, in terms of environmental protection), but it is important to keep a careful eye on the associated costs (such as distortion of generator investment decisions). Unfortunately, these opposing benefits and costs are difficult to quantify and are rarely comprehensively measured.

A regulatory body charged with monitoring market power: Several economists (Wolak 2004 and Twomey *et al* 2004) make the case that every wholesale electricity market needs a regulatory body charged with promoting competition and limiting the scope for market power. Broadly speaking, these authors share a view of the emerging “best practice” design for such a “market monitoring” agency:

- The market monitor should be “prospective” – that is, the major task should be to watch for the *potential* for market power. Identifying, measuring, documenting and responding to *past* episodes of market power can be important, but, because of the measurement problems described in the previous section, the market monitor should also be encouraged to look forward and monitor the ongoing state of competition.
- The market monitor should collect and regularly publish data on a consistent basis. This can act as “sunshine regulation” which can help restrict market power.
- As discussed in the previous section, the market monitor should use a range of approaches to measuring and identifying market power.
- The government should support these principles and allow the market monitor operational independence.

- The market monitor should have oversight concerning wholesale market rules and the capacity to make recommendations about system operator (SO) functions.¹⁴

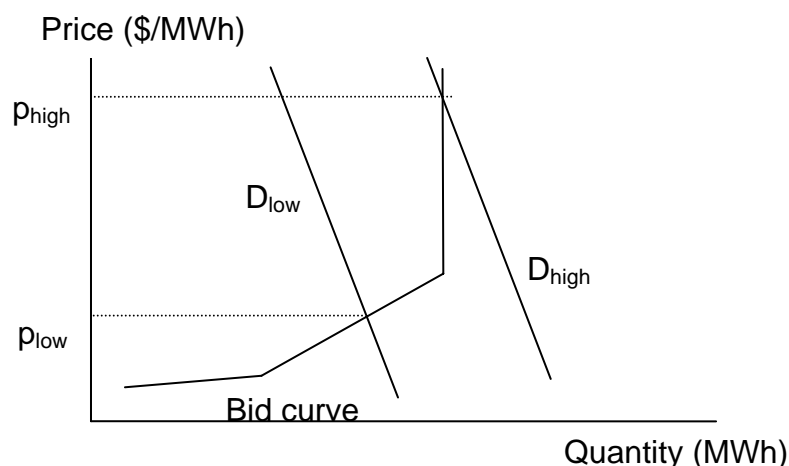
Twomey *et al* caution that there is no clear single model. Wolak points to Australian success and says “market monitoring is a process of continuous improvement” (p. 19).

Generation Investment and Security of Supply

So far, this paper has focused on competition and market power. As noted in the introduction, these considerations are subtly related to the issue of generation investment and security of supply.¹⁵

Security of supply is somewhat difficult to define when looked at from an economic point of view. What does it really mean? After all, people don’t often find reason to worry (at least in industrialised countries) about security of supply in other areas of the market economy – even areas that, like electricity, are “crucial” to daily life, such as food. For example, there’s little discussion or concern about security of supply of apples. We take it for granted that, in the apple market, supply and demand interact, prices fluctuate and there are (almost) always apples available to those willing to pay the market price. That is, the market for apples always “clears”: the price fluctuates so that supply equals demand.

Figure 3: A Wholesale Electricity Market with Elastic Demand



¹⁴ Electricity transmission networks require a system operator that monitors and maintains a stable transmission system. In New Zealand, the system operator is part of Transpower, the state-owned enterprise that owns the grid. In some countries, the two functions are split into separate entities.

¹⁵ The stability, reliability and management of the transmission and distribution networks is the other major aspect of security of supply, but is beyond the scope of this paper.

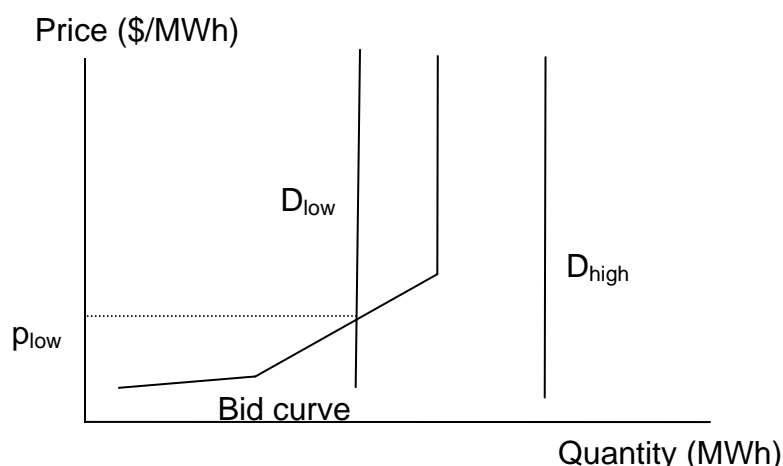
In an ideal wholesale market, price spikes indicate scarcity and offer incentive for new investment.

Indeed, this is what should happen in an electricity wholesale market if demand were sufficiently elastic. Consider Figure 3, which depicts an ideal wholesale market with fairly elastic demand (not typically seen in real world electricity markets). The demand curve is drawn with a downward slope to indicate the responsiveness of consumers to hourly price changes. The demand curve D_{low} represents low (or normal) demand and the demand curve labelled D_{high} represents high (or “peak”) demand (for example, a cold winter evening when a large fraction of consumers turn on electric heaters). In this ideal market, prices rise during periods of high demand and consumers cut back consumption to the point where supply equals demand – that is, the market price “clears” the market. The high market price acts as a signal to investors, sending information about the optimal amount of long-term investment. New firms will enter the market if they believe that the market price will cover investment costs.

In practice, investment decisions are very sensitive to the prices received in rare high-demand periods.

Some analysts (California Public Utilities Commission 2005, Cramton and Stoft 2006 and Joskow 2006) have recently argued that – in many wholesale markets around the world – there are not adequate incentives to underpin enough long term investment. In some wholesale markets, it appears that prices are not spiking to *high enough* levels to support long term investment. In particular, “peaking” capacity runs only a few hours per year and so capital costs must be recovered in those few hours. That is, price must rise above the marginal cost of running these units and they must earn significant scarcity rents in a small number of hours. As a result, investment decisions are very sensitive to price conditions in rare high-demand hours. Cramton and Stoft call these inadequate scarcity rents the “missing money” problem.

Figure 4: A Wholesale Electricity Market with Inelastic Demand



Why might wholesale prices not rise high enough to provide adequate scarcity rents for optimal investment? One reason is that many countries have implemented price caps – partly in response to concerns about market power. These may be straightforward administrative measures (i.e., no bids are accepted above a pre-announced price level) or may involve certain interventions (such as operation of a designated government-owned generation plant at a pre-announced level).

However, Cramton and Stoft (2006) and Joskow (2006) – looking primarily at the US experience – argue that another set of issues would lead to a “missing money” problem and inadequate generation investment, even in the absence of price caps. The combination of inelastic demand and inelastic supply (when capacity is near its limit) produces situations when the market is not able to clear. A stylised representation of this type of situation is presented in Figure 4. Here, the demand curve is shown as vertical (or perfectly inelastic).¹⁶ What happens when demand jumps – eg, only for a number of hours in a single evening – from D_{low} to D_{high} ? In the case depicted in Figure 4, most consumers aren’t aware of what is happening to prices on an hourly basis – so they do not respond to the rising prices on this particular evening. In order to keep demand from outstripping supply and destabilising the transmission network, the system operator (SO) typically intervenes, administratively setting prices and rationing electricity. In extreme situations (as shown in the “high” case in Figure 4) this intervention takes the form of managed “rolling” blackouts. However, in practice, the SO’s intervention usually begins when some pre-determined “reserve margin” line has been crossed. Joskow (2006) offers some examples of how the SO’s actions can artificially depress prices in these cases, but for the purposes here it is enough to keep the “blackout” situation depicted in Figure 4 in mind.

Some economists contend that crucial peak-period investment signals are often distorted: the inelasticity of supply and demand forces the system operator to intervene in the wholesale market.

Cramton and Stoft put it this way: the market is simply unable to “choose” the efficient level of long-term capacity in the decentralised way that other markets do. Again think of the apple example. In the absence of any distorting government intervention, the market price (determined by supply and demand) sends signals to investors about the “right” amount of long-run investment. However, inelastic demand effectively requires the SO to set prices during occasional “crisis” periods when demand is high (or supply is temporarily low). Cramton and Stoft argue that it is thus the SO (or the SO’s procedural rules) that effectively sets a target for long-run investment. They lament the fact that this is not recognised by policymakers and the SO, who thus make the implicit decisions about investment “with eyes closed”.¹⁷ This is *not* to say that the SO should be disparaged for intervening. After all, it is the SO’s primary responsibility to maintain the grid’s physical stability. Instead, the *economic* distortions may be better described as an unintended consequence of the SO’s *technical* responsibilities.

It might be tempting to conclude that – if prices are not spiking high enough to support investment – policymakers should err on the side of *ignoring* market power. This is not justified. Instead, policy should promote wholesale market institutions that encourage competition and “good” price fluctuation (ie, driven by legitimate scarcity rents, not market manipulation).

¹⁶ This is of course a stylised representation of the spot market. In reality, the demand curve may effectively have an elastic *segment*: some large commercial consumers have meters that allow them to respond to hourly price changes.

¹⁷ Cramton and Stoft also emphasise another “demand-side imperfection”: the typical inability of the SO to cut off *individual* consumers. This prevents the establishment of a “market for reliability.”

Policy should focus on improving incentives for investment.

There are different approaches to improving the performance of wholesale markets in stimulating optimal long term investment. First, policymakers could focus on ‘fixing imperfections’ – by removing price caps (and instead mitigating the scope for market power through other measures described above), improving demand responsiveness, reducing regulatory uncertainty and carefully evaluating SO procedures. Improving demand responsiveness is particularly important, although there may not be much that can be done beyond waiting for technological advances that allow consumers to affordably monitor prices.¹⁸ Second, Cramton and Stoft and Joskow recommend that policymakers explicitly recognise the need for a long-term investment (or “resource adequacy”) program. Such a program might involve establishment of a parallel “capacity market” that would offer payments to generators to replace “missing” scarcity rents and improve incentives for long-term investment. Of course, like other areas of electricity policy, the devil is in the details. Implementing a resource adequacy program that avoids creating new distortions is a challenge. Finally, policymakers should be mindful of producing a stable, credible regulatory regime that reassures investors that any justified scarcity rents won’t be removed by regulatory changes in the future. Generation investments last for a large number of years – so investors have good reason to be sensitive to the *possibility* of future regulatory changes.

Implications for New Zealand

The preceding discussion about the international literature on electricity market policy raises three questions regarding New Zealand.

Little empirical research exists regarding market power in the New Zealand context.

What evidence is available from empirical measures of market power in New Zealand? The short answer is that very little work has been done to apply the empirical measures described above to New Zealand. As a result, it is very difficult to assess whether or not market power is a problem for New Zealand’s wholesale market. Murray and Stevenson (2004) look at market shares of generating firms. According to their analysis, the top five firms (Meridian, Contact, Genesis and Mighty River) accounted for 86% of New Zealand generation capacity in 2003 (p. 14). Overall, they calculate a Herfindahl-Hirschman Index of 2031. According to Twomey *et al* (2004), markets with HHI above 1800 can be “broadly classified” as “highly concentrated” (p. 17). At any rate, as the preceding pages should have made clear, concentration indices alone mean little. A comprehensive assessment would consider several of the other measures discussed earlier. One other piece of research on market power in New Zealand (Videbeck 2004) argues that (for the 1997-2002 period) generators were unlikely to have exercised substantial *regional* market power because regional prices were highly correlated.

¹⁸ In the future, technology may become widespread that allows consumers to program equipment and appliances to shut down automatically at given price levels.

How does NZ do in terms of getting market design and institutions right to mitigate the scope for market power? The above discussion mentions several factors that should help mitigate the scope for market power. Several of these could be particularly important in the New Zealand context.

The transmission regulation experience of England and Wales holds lessons for New Zealand.

- *Transmission capacity and transmission regulation:* A full discussion of this complex subject is beyond the scope of this paper. However, one instructive exercise is to draw some broad comparisons between New Zealand and the regulatory regime in England and Wales, which is regarded as a benchmark in the imperfect world of transmission regulation.¹⁹ At a broad level, both regimes share some characteristics. They both feature some form of incentive regulation: that is, a profit-seeking firm (Transpower in New Zealand and National Grid in England and Wales) is subject to incentive mechanisms to promote efficient network operation and investment. These incentives augment grid investment regulatory procedures in which regulators are responsible for monitoring and approving investment. However, there are some important differences between New Zealand and England and Wales. First, the England and Wales incentive regime is more comprehensive – in particular, there is an incentive mechanism that offers the transmission company financial bonuses and penalties to minimize congestion on the grid. Second, the transmission investment approval process is arguably less contentious in England and Wales, thus underpinning a more stable environment for generation investment (and electricity consuming industrial projects).
- *Demand side responsiveness:* New Zealand's wholesale market, like others around the world, has highly inelastic short-run demand, even though some large electricity consumers have meters that allow them to see and respond to hourly price changes. As in other countries, boosting elasticity of demand is partly a matter of waiting for technological improvements, such as less expensive consumer meters. The Treasury's (2005) report on electricity "demand-side management" discusses various options including "smart meters" and existing "ripple control" technology (which could allow widespread contracting for shut-off of hot-water heating during periods of high wholesale market prices).
- *Market monitoring:* The Electricity Commission (EC) was created in 2003 and is charged "to ensure that electricity is produced and delivered to all classes of consumers in an efficient, fair, reliable and environmentally sustainable manner."²⁰ The preceding discussion of market monitors suggests a few comments regarding the EC. First, the EC could usefully build on efforts to examine various empirical measures and publish them regularly along with analytical discussion. Second, the overlap in mission with the Commerce Commission need not be a problem. The Commerce Commission is charged with investigating "anti-competitive" practices under the Commerce Act of 1986. But these

¹⁹ According to Joskow (2005), "The regulatory framework that has evolved in the UK over the last 15 years is the international gold standard for electricity...network regulation within a liberalized sector context."

²⁰ See <http://www.electricitycommission.govt.nz>

investigations are necessarily *backward looking* with a focus on evidence that will survive legal tests of criminal wrongdoing; as we have seen, detecting market power is an inexact science. The EC should focus on a *prospective* approach to mitigating the *scope* for market power. Third, independence from political decision-makers helps bolster a consistent, impartial approach to market monitoring.

Do New Zealand wholesale electricity prices give adequate incentive for long-term investment in generation?

There are two reasons to be concerned about the incentives for investment in New Zealand. First, the Government's Whirinaki generation capacity agreement may act as a "soft" price cap.²¹ In 2005, the plant was operated for only 69 hours for reasons other than testing (International Energy Agency 2006). However, as discussed earlier, investment incentives are sensitive to the prices obtained in rare "high demand" hours. Without careful empirical analysis, it is difficult to know whether the Whirinaki scheme causes a "missing money" problem and dampens investment incentives, although this should be a concern. Second, policymakers in New Zealand should be aware of the concerns outlined in the preceding section: the wholesale market may not work well during crucial high-demand hours and thus prices may not provide optimal signals for investment. It is worth examining the possibilities for a "resource adequacy program", possibly including capacity markets, to address any "missing money" problem (see Cramton and Stoft 2006 and Joskow 2006). However, as noted above, it is crucial to make sure this is designed carefully – drawing on the existing international evidence – in order to avoid introducing new distortions. Policymakers should strenuously avoid simply throwing money at new generation. Indeed, this leads to the third, and perhaps most important, concern about incentives for investment in New Zealand: investors may be leery about committing money to generation in an environment where policy and regulatory changes may allow the Government to effectively "hold up" generators and appropriate scarcity rents at some point during the life of a prospective plant. In other words, even if wholesale prices were sending efficient signals for optimal investment *today*, investors might justifiably balk at the prospect that regulatory changes might change the picture after a few years.

²¹ According to the agreement, the Whirinaki plant offers capacity into the wholesale market whenever wholesale prices reach \$1000/MWh or reach \$200/MWh for four hours (International Energy Agency 2006).

Conclusions

The international literature on electricity markets is still evolving. Competition and market power in electricity markets have been the subject of a substantial discussion in the international economics literature in recent years. One important conclusion is that market power in wholesale markets should be addressed in a forward-looking manner, focusing on measures such as robust transmission capacity to bolster competition. This paper also explained why achieving a market that sends efficient signals to prospective investors – so that the market achieves optimal levels of generation capacity – is cause for concern. None of these points argue for a fundamental revamping of New Zealand's electricity policy or industry structure. This paper has pointed toward ways to “get incentives right” for competition and investment, within the broader context of the existing system.

References

- Borenstein, Severin and James Bushnell (2000) "Electricity restructuring: Deregulation or reregulation?" University of California Energy Institute Program on Workable Energy Regulation Working Paper(PWP-074).
- California Public Utilities Commission (2005) "Capacity markets white paper." 25 August.
- Came, Sharon and Max Dupuy (2005) "Pricing in wholesale electricity markets." New Zealand Treasury Policy Perspectives.
<<http://www.treasury.govt.nz/workingpapers/2005/pp05-03.asp>>
- CBS News (2004) "Enron traders caught on tape." 1 June.
<<http://www.cbsnews.com/stories/2004/06/01/eveningnews/main620626.shtml>>
- Cramton, Peter and Steven Stoft (2006) "The convergence of market designs for adequate generating capacity, with special attention to the CAISO's resource adequacy problem: White paper for the electricity oversight board." 17 March.
- Evans, Lewis (2006) "Alternating currents or counter-revolution?" (Seminar slides, Wellington, April)
- Hogan, William W. (2003) "Transmission market design."
<<http://ksghome.harvard.edu/~whogan/>>
- Hunt, Sally (2002) Making competition work in electricity. (New York: John Wiley & Sons, Inc.).
- International Energy Agency (2006) "Energy policies of IEA countries: New Zealand." Paris, OECD.
- Joskow, Paul L. (2002) "Electricity sector restructuring and competition: A transactions-cost perspective." in Eric Brousseau and Jean-Michel Glachant ed The economics of contracts: Theories and applications (Cambridge: Cambridge University Press): 503-530.
- Joskow, Paul L. (2003) "Electricity sector restructuring and competition: Lessons learned." Cuadernos de Economia: Latin American Journal of Economics 40(121): 548-558.
- Joskow, Paul L. (2005) "Supply security in competitive electricity and natural gas markets." Prepared for the Beesley Lecture in London, October 2005. <http://econ-www.mit.edu/faculty/download_pdf.php?id=1270>

- Joskow, Paul L. (2006) "Competitive electricity markets and investment in new generating capacity." <http://econ-www.mit.edu/faculty/download_pdf.php?id=1348>
- Murray, Kieran and Toby Stevenson (2004) "Report prepared for the Electricity Commission: Analysis of the state of competition and investment and entry barriers to New Zealand's wholesale and retail electricity markets."
- New Zealand Herald (2005) "Power firms come under scrutiny." 17 November.
- Newbery, David M. (2002) "Mitigating market power in electricity networks." <<http://www.econ.cam.ac.uk/faculty/newbery/output-download.htm>>
- The Treasury (2005) "Electricity demand-side management." Wellington, New Zealand Treasury.
<<http://www.treasury.govt.nz/electricity/edm/edm-oct05.pdf>>
- Twomey, Paul, Richard Green, Karsten Neuhoff and David Newbery (2004) "A review of the monitoring of market power." Cambridge Working Papers in Economics(0504).
- Videbeck, Steen (2004) "Economic market segmentation of an electricity pool." Wellington, New Zealand Institute for the Study of Competition and Regulation.
- Wolak, Frank A. (2003a) "The benefits of an electron superhighway." Stanford Institute for Economic Policy Research: Policy Brief November 2003.
- Wolak, Frank A. (2003b) "Debating California: Diagnosing the California electricity crisis." The Electricity Journal August/September 2003: 11-37.
- Wolak, Frank A. (2004) "Lessons from international experience with electricity market monitoring." University of California Energy Institute, Centre for the Study of Energy Markets Working Paper(134).