Vertical integration and consumer benefit in the New Zealand electricity sector

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Executive summary

On the evening of 9 August 2021, the electricity sector failed to 'keep the lights on' as electricity was cut to thousands of households during one of the coldest nights of the year. Several inquiries into this event have been undertaken. Before the results of these investigations were known, several commentators were quick to suggest the cause was due to vertical integration (that is, common ownership) of electricity generation and retail activities. In fact, there has been a pattern of commentators pointing to vertical integration as a contributor to a number of market events since the Authority was formed. To our knowledge, none of the commentators who suggest vertical integration is a problem has published any supporting analysis, either conceptual or empirical. The Authority has not released a study dedicated to the competitive impacts of vertical integration but the recently released Market Monitoring Review raises vertical integration as a potential barrier to entry that may have been restricting entry of independent generators. It notes a number of developments which lead it to the conclusion that:

> VI [Vertical integration] as a barrier to entry may be becoming less of an issue. ((Electricity Authority, 2021) 5.29

Our understanding of the Authority's thinking has been gleaned from what may amount to similar passing comments in consultation papers on rule change proposals.

This report reviews key conclusions and findings from theoretical and empirical studies into the causes and consequences of vertical integration. Virtually all theories of vertical integration turn in one way or another on the presence of market imperfections; that is, on deviations from the long list of explicit and implicit assumptions associated with textbook models of perfect competition. A view of whether vertical integration is beneficial or harmful to consumers therefore must be grounded in an assessment of whether vertical integration is an efficient means of navigating the real-world imperfections of the electricity sector, or a means of exploiting those imperfections.

We reviewed numerous studies into the hazards for ex-ante investment commitment and ex-post performance in the electricity sector. The overwhelming conclusion from this large body of literature is that specific features of electricity markets are both statistically and economically important causal factors influencing the decision of firms to vertically integrate, both in New Zealand and internationally; there may be few other areas in economic research where there is such an abundance of empirical and theoretical work supporting a theory of firm or market structure.

We draw two conclusions:

- vertical integration of electricity generation and retail activities has emerged as an economically efficient organisational form to overcome real-world imperfections in the wholesale and retail electricity markets; if regulatory interventions were to impede efficient vertical integration, the cost of electricity to consumers would increase, potentially substantially
- market reform which reduces market imperfections, including bargaining frictions, will increase competition and lead to a reduction in vertical integration; that is, an increase in competition will reduce the need for firms to vertically integrate (but a decrease in vertical integration imposed through regulation will not increase competition).

1. Introduction

Vertical integration between electricity generators and retailers has become somewhat of a 'lightening rod' for commentators unhappy with the performance of the electricity sector. Government intervention to separate, to varying degrees, generation activities from retail activities would, in the view of some commentators, lead to better outcomes for consumers.[1] To our knowledge, the Electricity Authority (Authority) has not published a paper evaluating vertical integration in the New Zealand electricity sector. However, the Authority does appear to have formed views that are influencing its regulatory actions. An indication of the Authority's thinking is available from a recent consultation paper, *Internal transfer prices and segmented profitability reporting* (Electricity Authority, 8 April 2021) and, more recently, the Market Monitoring Review. (Electricity Authority, 2021).

The Authority views vertical integration of generation and retail electricity businesses as having the potential for economies of scale where fixed costs can be spread over the consolidated business. It also views vertical integration as enabling efficient risk mitigation. However, the Authority considers control by integrated generator-retailers of the bulk of electricity generation raises competition concerns (Electricity Authority, 8 April 2021, para. 2.1). The same possibility was raised in the Market Monitoring Review in the context of the potential for vertical integration to form a barrier to entry for independent generators

In explaining its competition concerns, the Authority had previously referred to comments heard by the Electricity Price Review that generator-retailers may stifle competition by advantaging their own retail arms via preferential pricing of electricity and/or cross subsidisation (Electricity Authority, 8 April 2021, para. 2.2). The Authority considers that it is largely the size of vertically integrated generator-retailers, rather than their vertical integration per se, that is the primary driver of its competition concerns—the Authority states that small integrated firms do not raise competition concerns (Electricity Authority, 8 April 2021, para. 2.3).

While it is difficult to be confident of the Authority's reasoning around vertical integration, given its limited explanation, it seems the Authority accepts there is a trade-off. Vertical integration allows economic efficiencies, which presumably increase with the size of the integrated entity. However, offsetting these benefits are economic inefficiencies due to a belief that integrated entities could raise the costs of their competitors and advantage their own retail arms. In the Market Monitoring Review it states:

> VI can often be efficient because it can reduce transaction costs, lower the cost of capital for building new generation, or facilitate better risk management. However, we are interested in VI because low barriers to entry place pressure on incumbents to display competitive pricing behaviour. (Electricity Authority, 2021) 5.27

[1] See for example, https://www.stuff.co.nz/business/opinion-analysis/300383610/power-blackout-highlights-nzs-electricity-problem; https://www.energynews.co.nz/news/electricity/95733/nz-lacks-basic-power-competition-rules-octopus; https://www.pundit.co.nz/content/has-our-electricity-system-burnt-itself-out

It is not clear whether the Authority perceives their concern as arising when an integrated entity supplies a large share of the market, or when the bulk of the market is supplied by vertically integrated entities, or whether its concern results from some combination of entity size and the proportion of the market supplied by vertically integrated firms.

In this paper we test the views expressed by the Authority. Our paper unfolds in four sections as follows:

- *This section* introduces our report.
- *Section two* draws out the key conclusions and findings from theoretical and empirical studies into vertical integration.
- *Section three* applies these findings to electricity markets to explain why vertical integration emerged as a feature of existing electricity markets, not just in New Zealand but in competitive electricity markets worldwide.
- *Section four* brings the analysis together to assess whether the views expressed by the Authority in relation to impacts and risks of vertical integration are soundly based, and whether forced vertical disintegration as advocated by some commentators would likely benefit or harm the long-term interests of consumers.

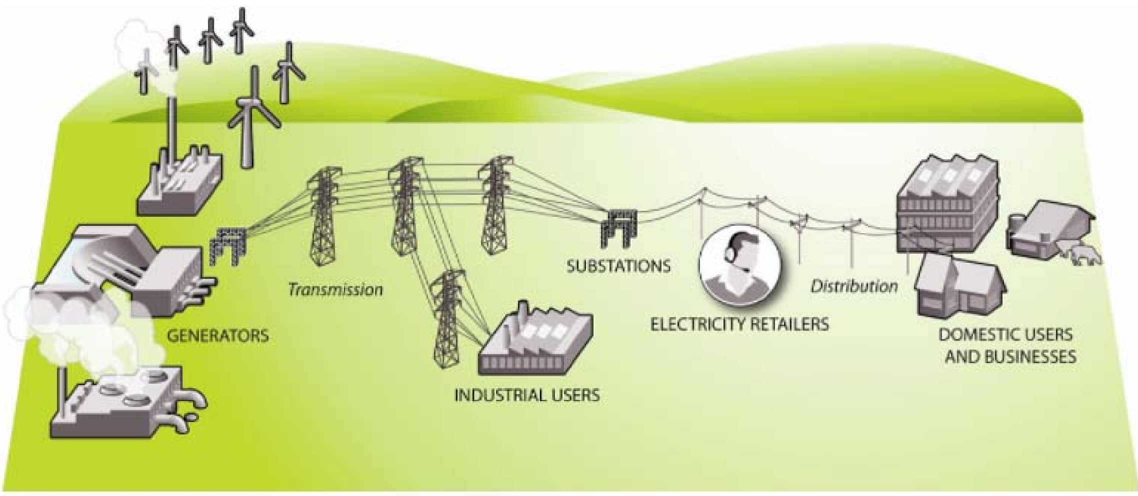
2. Economics of vertical integration

2.1 Vertical integration

Many goods or services involve a series of steps, or functional levels, to produce and supply the product to consumers. The term "vertical integration" refers to a situation where the production or supply of two or more of these functional steps in providing a good or service are owned by the same firm.

The Ministry of Business Innovation and Employment (MBIE) provides the following illustration of the four main components of the New Zealand electricity industry:[2]

Figure 1 The four main components of the New Zealand electricity industry



Source: MBIE

The components of interest in this report are the wholesale electricity market (governing the supply and price of energy and instantaneous reserves) and retail market (where retailers buy from the wholesale market and supply to end consumers). The network components, transmission and distribution, have been required to be owned (with some limited exceptions) and operated separately from the competitive elements of generation and retail for over 20 years.[3]

Oddly, some commentators have suggested the comparatively recent split of Telecom into a network company, Chorus, and a telecommunications and digital service provider, Spark, as providing a model for reform of the electricity sector, seemingly unaware that both industries are subject to similar

[2] https://www.mbie.govt.nz/building-and-energy/energy-and-natural-resources/energy-generation-and-markets/electricity-market/electricity-industry/

[3] Electricity Industry Act 2010.

legislation separating (and revenue regulating) the network component from the content and retailing activities.[4]

Currently, about 89.4 per cent of residential and small-to-medium businesses are served by vertically integrated electricity retailers, when market share is measured by ICP.[5]

2.2 Analysis more complicated than horizontal integration

Vertical integration is inherently more complex to analyse than horizontal integration (Shapiro, 2019, para. 6). When two firms integrate in the same market (horizontal integration), competition is eliminated between the merging parties and the integrated entity would typically have a stronger incentive to raise prices; competition analysis then proceeds by assessing whether pressure from competitors would be sufficient to thwart that incentive (or the integration produces other offsetting benefits) (Slade, 2019, p. 9).

An analysis of vertical integration involves considering two functional markets—in this case the wholesale and the retail electricity markets—and, importantly, the interface between those two markets. The term "market" is a technical term in competition economics to describe a relevant range of activity by reference to economic and commercial realities. A market is the field of exchange (or potential exchange) in which the services being considered are substitutable. It is this possibility of substitution in response to changing prices or output that limits the ability of a firm 'to give less and charge more' (Re Queensland Co-operative Milling Association Ltd, 1976).

Generally, the Commerce Commission (and equivalent competition bodies internationally) identify separate markets at each functional level (Commission, 2019(a), pp. 21-22). It is sometimes possible for firms in different levels of a supply chain to be in the same market if firms could easily, profitably and quickly (the Commission generally uses a period of one year) move from one level to another in response to a small, but significant, non-transitory, price increase.[6]

Firms in the electricity sector are unlikely to move from one level in the chain of supply to another in response to a small change in price. An electricity retailer would need to invest in generation assets to compete in the wholesale market, and a generator is not equipped to compete effectively with retailers for mass-market customers without investing in systems and marketing etc. Firms operating at one level in the supply chain—either generation or retail—are currently not a sufficient threat to constrain pricing in the other level of the supply chain.[7]

As the wholesale and retail markets are separate markets for the purposes of competition analysis, vertical integration in the electricity sector refers to circumstances where activities competing in

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[4] https://www.stuff.co.nz/business/opinion-analysis/300383610/power-blackout-highlights-nzs-electricity-problem; https://www.pundit.co.nz/content/has-our-electricity-system-burnt-itself-out.

[5] This figure includes Trustpower that supplies 11.8 per cent of mass market consumer and has agreed to sell its retail assets to Mercury, subject to regulatory approvals.

[6] Typically abbreviated to SSNIP; the Commission generally uses a SSNIP of 5 per cent, but for some markets, such as frequently purchased, low value products, a lower figure might be adopted (for example, 2 per cent for retail groceries).

[7] Distributed energy resources (for example, small scale solar) are blurring some of these market boundaries, a point we pick up further below.

separate markets are owned by the same entity. A situation where one entity invests in an existing activity in a separate market does not in-of-itself reduce competition in either market—the same number of entities compete in each market with the same market shares. Where an entity enters a separate market by establishing a new entity (e.g., a generator establishes a retail arm), that entry increases competition in the separate market (in this example, retail) without reducing competition in the original market (in this case generation).

An analysis of vertical integration therefore requires an assessment of the interface between activities operating in two separate markets and is inherently more complicated than an analysis of competition within a single market.

2.3 Studies of shipping between integrated entities

2.3.1 Industrial organisation focused on physical integration

Explanations of the cause and consequences of vertical integration that emerged from the study of industrial organisation following World War II tended to assume vertically integrated entities ship goods between their divisions (Carlton & Perloff, 2015). Industrial theorists like Bain (1959) viewed the boundaries of a firm narrowly as encompassing activities that were clearly physically related to one another; an upstream division was assumed to supply inputs to a downstream division, and the downstream division supplied the customer.[8]

This assumption of an upstream entity supplying a downstream entity led to three theories for why firms vertically integrate. Two of these theories—sharing fixed costs and eliminating double marginalization—conclude that vertical integration reduces costs; the third theory 'raising rivals costs' would lead to reduced competition. None of these reasons are likely to hold in the New Zealand electricity market because generators do not ship to retailers in the manner assumed in the industrial organisation literature. We touch on these 'traditional' reasons, as comments by the Authority suggest its thinking may have been influenced by this literature.[9]

2.3.2 Spreading fixed costs

As noted above, the Authority views vertical integration of generation and retail electricity businesses as having the potential for economies of scale where fixed costs can be spread over the consolidated business (Electricity Authority, 8 April 2021, para. 2.1). The explanation by the Authority is limited but

[8] Economics literature tends to refer to entities supplying inputs into a production process as "upstream firms" and the firms producing goods as "downstream". Historically in Europe and the United States, firms used the flow of rivers to ship goods downstream to be processed and on-sold to consumers.

[9] We do not discuss a fourth reason discussed in the industrial organisation literature, third degree price discrimination, as the requirements for this behaviour to be profitable fit neither the Authority's explanation of its concerns nor the characteristics of the electricity sector. Third degree price discrimination would involve charging customers with less elastic derived demand a higher price and customers with more elastic derived demand a higher price, with vertical integration used to prevent the elastic (low price) customer on-selling to the customer charged higher prices.

we think the Authority intended to write 'economies of scope' rather than 'economies of scale'.[10] It is possible there are economies of scope from jointly owning generation and retail. Managing wholesale risk involves developing skills and dedicating resources to forecasting, monitoring the market, updating forecasts and positions, trading and ensuring compliance with risk management policies. A vertically integrated generator-retailer might achieve economies of scope from, for instance, integrating its risk teams, and using the same team to provide risk management to both its generation and retail activities.

While the potential for economies of scope may exist, it is not clear to us why such economies would be vertical-integration specific in the electricity sector; that is, why non-integrated firms might not be able to achieve similar efficiencies, say, through contract. Further, it is not obvious to us that the retail entities that have entered and expanded in the New Zealand market in recent years without investing in generation assets—including national retailers Ecotricity, Electric Kiwi, Flick Electricity and Vocus—have a higher operating cost structure than vertically integrated retailers.[11]

We are aware that our argument conflicts with (Simshauser, 2020, p. 8), who cites several authors as concluding that partitioning generation from retail results in cost efficiency losses of 20 per cent to 40 per cent. However, on our reading, the studies cited by Simshauser in support of this finding reviewed the separation of generation from distribution and transmission, not a separation of retail from generation.

In short, absent further explanation of a theoretical or empirical basis for the Authority's view that vertical integration has the potential for economies of scope (or scale) not available to non-integrated entities, we consider it unlikely that economies of scope or scale are a substantive explanation for the high proportion of the wholesale market served by vertically integrated firms.

2.3.3 Eliminating double marginalization

A classic explanation for vertical integration is that it can eliminate "double marginalization", and hence lower prices for consumers (Slade, 2019, p. 5). The idea that vertical integration creates an incentive to lower prices to consumers was first formalized by Spengler (1950) . An integrated firm will set the downstream price based on the firm's combined upstream and downstream profits. The entity will have an incentive to lower its prices to consumers (relative to what the downstream entity would have charged if not vertically integrated), if a lower price attracts more customers and if those extra customers generate extra profits at the upstream division of the merged firm, as the upstream division increases the volume of inputs supplied to the downstream division to meet the extra demand.

A large body of empirical work shows that vertical integration tends to be efficient and benefits consumers by removing double marginalisation (Lafontaine & Slade, 2007). However, we are sceptical that the benefits identified in many of these studies can be assumed to apply to the New Zealand electricity sector. In the New Zealand electricity market, vertically integrated generators cannot sell

[10] Economies of scope arise when it is cheaper to produce two or more goods using the same infrastructure. Economies of scale arise when it is cheaper to produce more of the same good.

[11] In a recent submission to the Commerce Commission, Electric Kiwi stated "we believe we are among the most efficient retailers in the market" (Electric Kiwi , 31 August 2021).

electricity directly to their retail arms. Under the gross pool design, all vertically integrated firms are obliged to sell electricity into the wholesale market pool as generators and buy it back as retailers to serve their customers. As no vertical shipments occur, eliminating double marginalization is lessened as a motive for vertical integration (we turn to the effects of financial contracts and derivatives, including retail as a physical hedge, below).

2.3.4 Raising rivals' costs

Similarly, when no vertical shipments occur the primary mechanism by which vertical integration can lessen downstream competition is also weakened. Vertical integration can harm competition when an integrated entity can use its control over an upstream input to weaken its downstream rivals, either by denying them access to that input – "total foreclosure" – or by raising the price charged for that input – "partial foreclosure" (Shapiro, 2019, para. 7). From an economic perspective, total foreclosure is just a special (and extreme) case of partial foreclosure. For simplicity, we refer to both effects as "raising rivals' costs".

Vertical shipments can raise the economic cost to the integrated firm of selling inputs to its rivals, because access to the input, or a lower price for that input, may make those rivals stronger competitors. Integrated suppliers could try to use key inputs strategically to advantage their downstream operations. Economists and regulators refer to these key inputs as "bottlenecks"—inputs that must be obtained to compete in a downstream market but which are controlled (typically) by a single entity. Ensuring access to a 'bottleneck' facility is the reasoning that led the government to separate Chorus (network) from Spark in the telecommunications sector, and Transpower (network) from ECNZ in electricity sector.[12]

As a general rule, the potential for vertical practices to harm competition occurs only under specific assumptions, with seemingly "only minor perturbations to these assumptions" reversing the predicted welfare effects (Cooper, Froeb, O'Brien, & Vita, 2005, p. 3). In the New Zealand electricity sector, the mechanism for raising rivals' costs via vertical integration is not available to generators trading through the wholesale electricity spot market. A generator does not sell into the wholesale spot market at different prices to different customers, and a generator cannot prevent a retailer becoming a purchaser from the wholesale pool.

A generator may, or may not, have market power in the wholesale market, but owning a retailer does not provide the generator with an additional means to raise the costs to its rivals of purchasing electricity in the gross pool. Indeed a generator owning a retailer is generally considered to have a reduced incentive to raise prices in the wholesale market (relative to a generator in a similar position but without a retail position), because the generator-retailer is also a purchaser in the same market (Australian Competition & Consumer Commission, 2018); we discuss further below how retail and forward contract positions alter incentives for generators to offer capacity into the wholesale market.

[12] The separation of Telecom into Chorus and Spark was proposed by the Telecom Board as a condition for the Government to accept its proposal to build the majority of the Ultra Fast Broadband network: https://company.chorus.co.nz/file-download/download/public/1467

In a variant on this argument, the Authority suggests, in its *Internal transfer pricing* consultation paper, the possibility generator-retailers may sell at prices below what is economic with the intent of forcing competitors to exit (Electricity Authority, 8 April 2021, p. 4). Such a strategy would involve generator-retailers choosing to transfer shareholder funds to consumers, which is the effect of pricing below cost, in the hope of squeezing competitors out of the market. Economic theory sets out the conditions necessary for such behaviour to be rational (Carlton & Perloff, 2015, pp. 352-353). The generator-retailer would need to be confident that:

- competitors would exit the market or reduce market share until they were ineffective as competitors
- the generator-retailer could subsequently raise retail prices above competitive levels to recoup the losses
- competitors would not re-enter or expand (including other generator-retailers) when the generator-retailer attempted to raise prices above competitive levels to recoup its losses.

The Authority offers no analysis or explanation of how an integrated generator-retailer could be confident of these outcomes. Taking just the last point, no generator-retailer can deny access to the 'gross pool' for retailers seeking to re-enter, nor deny those retailers access to exchange traded futures.

In the more recent MMR the Authority raises the issue of whether VI provides barriers to entry in generation, and the effect such barriers can have on wholesale prices. Low barriers to entry place pressure on incumbents to display competitive pricing behaviour. The Authority notes the possibility that

> VI may increase costs for new entrants by reducing liquidity in the forward market and reducing the demand for PPAs that can support new-entrant generation. This is because it can be hard for non-VI generators to obtain PPAs from generator–retailers or obtain hedges elsewhere. Vertically integrated firms may be incentivised to grow their supply and retail shares in parallel, thereby constraining PPAs with independent generators by the rate at which they grow their retail books. (Electricity Authority, 2021) 5.28

The Authority notes a number of developments in the market in recent years which lead it to the conclusion that:

> VI as a barrier to entry may be becoming less of an issue. (Electricity Authority, 2021) 5.29

The Authority reports the percent of new generation built by new entrants versus incumbent vertically integrated firms in recent years and repeats the conclusion above:

> Over three-quarters of committed projects and projects that are likely to be committed soon are owned by generator–retailers. This suggests there may be barriers to entry for smaller, independent firms, although there are encouraging signs (the possibly committed solar projects are all from independent companies) that this may be changing. (Electricity Authority, 2021) 5.34

2.4 Vertical integration as a means of navigating market imperfections

A limitation in the theories outlined above is that, in the real world, the motivation for vertical integration does not require product flows. In a study of vertical integration in United States manufacturing sector, Atalay, Hortacsu, & Syverson (2014), found that one half of upstream establishments do not ship to their downstream divisions. In electricity markets with gross pools, there is of course no physical supply between generators and retailers. Instead, the motivation for vertical integration involves intangibles.

Transaction cost theories pioneered by Nobel Laureate, Oliver Williamson (1975), and the work of those who built on his insights both theoretically and empirically, have changed the way economists think about vertical integration. An important conceptual lesson from Williamson's work is that it is not particularly useful to think about a sharp dichotomy between vertical integration and market transactions; rather, there is a continuum of governance arrangements between spot transactions (anonymous sales and purchases) through to bringing activities in-house. These hybrid forms include various types of long-term contracts, non-linear pricing arrangements, joint ventures, and so on.

The foundation of transaction cost theories is the recognition that contracts are incomplete (it may be impractical or prohibitively costly to write a contract that covers every possible contingency and to stipulate appropriate responses). Because contracts are incomplete, contractual hazards arise—one or other party might undertake actions that do not suit the other party after the contract has been agreed.

Modern theories of vertical integration turn in one way or another on the presence of these market imperfections; that is, on deviations from the long list of explicit and implicit assumptions associated with textbook models of perfect competition. Vertical integration provides a means of navigating these real-world imperfections. Internal organisation mechanisms provide the potential to better harmonize conflicting interests and can provide for a smoother and less costly adaptation process, thereby facilitating more efficient ex-ante investment and more efficient adaptation to changing supply and demand conditions over time (Joskow P. L., April, 2010, p. 23). As Williamson observed (Williamson O. E., 1971, p. 61) :

> The advantages of integration thus are not that technological (flow process) economies are unavailable to non-integrated firms, but that integration harmonizes interests (or reconciles differences, often by fiat) and permits an efficient (adaptive, sequential) decision process to be utilized...

Against these benefits, vertical integration risks costs of increased bureaucracy and dulled incentives of in-house production. A view of whether vertical integration is beneficial or harmful to consumers therefore must be grounded in an assessment of whether vertical integration is an efficient means of navigating the real-world imperfections of the sector under study, in this case the electricity sector; that is, whether the gains from over-coming real-world imperfections exceed the costs of dulled incentives and increased bureaucracy.

The theoretical literature has identified numerous ways through which organizational design through vertical integration affects firm performance. We briefly introduce several forms of contract hazards below. In the following section, we consider whether some these hazards are likely to be material when evaluating vertical integration in the New Zealand electricity markets.

Relationship-specific investments can be especially problematic in making bilateral trading relationships susceptible to ex-post bargaining and contractual performance problems (Williamson, O. E.,1975, 1985; Klein, Crawford, & Alchian, 1978; Joskow, 1987). A relationship-specific investment may have little value outside of its use in a specific trading relationship. Once the investment is made, a risk of 'hold-up', a form of opportunistic behaviour, occurs. The investing party's bargaining power is reduced once they have made an investment, because the value of the investment becomes dependent on another party for either sale of their output or a source of inputs. This exposure reduces the incentive to undertake an otherwise efficient investment. An example of this outcome is where an investment in long-term assets is required, but only short-term sales commitments are available in the market.

Where recurrent bargaining is required as market circumstances change, internal organisation has an advantage over market exchange in that it permits adaptation and forecloses future haggling. In contrast, recurrent contracting can be impaired as each party seeks to adjust the terms to their advantage as market conditions change.

Contracting for an item whose final cost or quality is subject to uncertainty raises issues about incentives. The supplier could bear the uncertainty but would charge a risk premium. If the buyer regards the premium as excessive and prefers to bear the risk, they may seek a cost-plus contract. Under this type of contract, the supplier has less incentive to achieve least cost performance, so the buyer may therefore wish to monitor the supplier and, where external monitoring is difficult, integration may become the most effective option. Typically, incentives to behave opportunistically are reduced and monitoring costs are lower where firms are vertically integrated.

Property rights theories identify alignment of investment incentives with better performance (Grossman and Hart, 1986; Hart and Moore, 1990). Hart (2017) argues that integration will occur between firms in response to incomplete contracts if it is more efficient for one of the firms to hold the residual control rights than for these to be shared between the firms. The firm with residual control rights has the power to make decisions about things that are left out of the contract. Offsetting these benefits, divisions within an integrated firm lose control rights and may have less incentive to innovate or invest, because they are unable to capture all the benefits of innovation. Whether integration is efficient depends on which distortion is more important (Hart, 2017, p. 1734). Commercial entities have strong incentives to strive for the optimum balance between these incentives.

Vertical integration can also incentivize multi-tasking (Holmstrom and Milgrom, 1991), and improve coordination (Hart and Holmstrom, 2010), by reducing transaction costs. Moral hazard models highlight productivity gains due to alignment of incentives to exert effort and the rewards of those efforts (Lafontaine & Slade, 2007).

In the following section, we consider some of the contracting hazards arising in electricity markets and whether vertical integration is likely to be an efficient response to those market imperfections.

3. Vertical integration in electricity markets

3.1 Vertical integration a feature of electricity markets

Vertical integration of electricity generation and retail activities has emerged as the prevailing organisational form in most electricity markets in which the wholesale and retail sectors have been opened to competition. For example, in Singapore the largest 6 vertically integrated generator retailers supply 90 per cent of the retail market.[13] In Australia, the four largest vertically integrated participants in each region accounted for the majority of generation output and at least half of all retail load (AER, 2021, p. 249). These four vertically integrated firms account for:

- 79% of generation output and 65% of load in NSW
- 83% of generation output and 50% of load in Victoria
- 69% of generation output and 63% of load in South Australia.

NERA report consolidation and vertical integration as a common experience of deregulated electricity markets in Great Britain, Ireland, the Netherlands, and PJM) (NERA Economic Consulting, 2019). The structure of the market in Great Britain has recently become less vertically integrated. Some analysts suggest a primary motivation for reduced vertical integration has been the regulator shifting the risk of new investment from generators to consumers (via-feed in tariffs and capacity payments) reducing the need for vertical integration as a means for managing investment risk (Helm). NERA observe that the regulator also raised the cost of vertical integration by imposing the cost of market-making obligations on integrated firms and withdrawing those obligations upon divestment.

As outlined above, vertical integration can be an efficient response to market imperfections. In this section we discuss four reasons why vertical integration emerged as the predominant organisational form in competitive electricity markets. In the following section, we consider whether further market evolution may lead to a greater diversity of organisational forms becoming economically efficient, and therefore consistent with the long-term interest of consumers.

3.2 Incentives to invest

In the wholesale market, generators make investments in large, long-lived assets. Prior to committing, the generator needs to be confident that it will be able to sell the output of the plant at a price that makes the investment profitable. In concept, spot price fluctuations have opposite effects on retailer and generator profits; an increase in the spot price affects positively the revenue of the generator to the detriment of the retailer, and a decrease in spot price benefits the retailer to the detriment of the generator.[14] As the price risk profile of a retailer and generator are negatively correlated, long-term fixed price forward contracts should, in principle, align the hedging needs of both parties.

[13] Energy Market Authority, Singapore Energy Statistics 2020.

[14] In New Zealand, the vast majority of mass-market customers are on contracts that allow the consumer to vary the volume of electricity they consume at a fixed monthly price.

However, when contract prices are fixed, the ex-post distribution of risks across the parties depends on the duration and magnitude of the periods during which the spot price will be above or below the contractual fixed price. In the electricity sector, the duration and magnitude of these periods is not foreseeable, especially in the New Zealand electricity sector with its reliance on hydro-electricity generation and electrical isolation from other markets (unlike, for example, Europe).

As entry costs into the retail sector are comparatively low,[15] any period of sustained spot prices below the contract fixed price may induce profitable new entries into the retail market. Retail firms sell electricity on short-term fixed price contracts with their customers. Retailers with a significant level of sourcing through long-term fixed-price contracts would be exposed to a risk of price-squeeze from the new entrant retailers; retailers on long-term fixed-price contracts and exposed to a risk of price-squeeze would, in turn, expose generator counterparties to the risk of default by thinly capitalised retail entities. Anticipating this risk of opportunism, generators would require a higher contractual premium, making long-term contracts more expensive, and therefore less attractive, for retailers. Absent long-term alignment of parties' interests, long-term contracts between generators and retailers that would support investment in new generation are not ''self- enforcing'' (Klein, 2000).

By contrast, vertically integrated generators rely on the internalised incentive to maintain their retail base, eliminating hold-up risk and enabling investment in generation. It is not a coincidence that since the inception of the wholesale electricity market 25 years ago, almost all new investment in new generation of scale has been under-taken by vertically integrated generator-retailers.[16] The notable exceptions are Whirinaki (which was commissioned by the government and paid for by a regulated levy on consumers), several geo-thermal plant built by lines companies, and most recently the Waipipi windfarm, built by Tilt.[17] (We discuss further below how distributed energy resources alter the risk profile and may impact on the efficient organisational form for new investment).

To date, vertical integration has lowered the total risk, and hence the cost, of financing investment in generation relative to what could be achieved via contracting. Consumers have benefited from a lower cost of capital for investment in electricity generation through lower wholesale prices and higher reliability than would otherwise have been experienced. Appendix A explains why the bulk of cost reduction due to a lower cost of capital can be expected to have been passed through to consumers.

As we mention earlier, the Authority tested the whether the degree to which new entrants and vertically integrated firms are investing in generation from the perspective of the impact on competitive pricing behaviour. They confirm that non vertically integrated generators are entering the market even though the majority of upcoming projects are still being initiated by vertically integrated

[15] In comparison to the cost of building new generation plant. In addition to systems and marketing costs, retailers must also fund prudential requirements in the wholesale market, lodge deposits with the network companies, and potentially fund prudential requirements in the futures market.

[16] Ecotricity, (2020, p. 1) argue that "gentailers" have controlled the development of new generation capacity into the market with the gentailer's retail base providing an internal hedge for the new generation volumes. The better view is that vertical integration improves incentives to invest by reducing hold-up risk and improving access to capital; this is a benefit of vertical integration.

[17] Energy News reports (18 November 2020) the Tilt Waipipi output is all sold through a PPA to Genesis, that is, a vertically integrated portfolio generator: "Under the PPA, Tilt Renewables owns and operates the wind farm and Genesis purchases the electricity generated".

firms. In the MMR section on dynamic efficiency, the Authority states that uncertainties and incentives on existing players may have impeded timely investment but the investment environment is improving. It describes the current state of investment as "encouraging".

3.3 Reduced credit and re-contracting risk

A standalone generator could be expected to enter into a series of wholesale finite term financial contracts with independent retailers. A vertically integrated generator substitutes these contract arrangements with a large, diverse, group of contracts directly with retail consumers. The bundle of retail customer contracts reduces both credit and re-contracting risk exposure.

In terms of credit risk, retail customers are more diverse than wholesale customers and their default risk is more easily and cheaply managed (for example via credit checks, bonds, and prepayment meters). In contrast, a non-integrated generator may have limited ability to assess the creditworthiness of the retailer (or other wholesale customer) and little ability to monitor the impact of their behaviour on their credit risk. Counterparty risk on a bilateral contract is managed by the parties themselves and by the exchange in exchange traded contracts. The generator or the exchange may impose some prudential requirement on the wholesale customer to reduce the generator's risk exposure. Ultimately prudential requirements increase cost to the consumer, by increasing the cost of hedging to retailers.

Re-contracting risk is also reduced by vertical integration. A non-integrated generator is exposed when contracts expire (or if a purchaser fails). This re-contracting risk is relatively more significant, although less frequent, than the equivalent risk associated with retail contracts and switching rates. Re-contracting risk is likely to be a significant concern for generators with long-term investments. Diversifying across a range of sales methods, including vertical integration with a retailer, may mitigate this risk, reducing capital costs.[18]

3.4 Incentive to offer competitively to ensure dispatch

As noted earlier, New Zealand's wholesale gross pool market means vertically integrated generators sell their electricity through the spot market: they cannot sell it directly in an internal transaction to their affiliated retailer. This market structure differs from other some markets such as the United Kingdom.[19] In a gross pool, the generator wants to ensure its generation is dispatched so that they earn revenue from generation to offset the cost of their retail purchases. This incentive is likely to be at least as strong as the incentive created by a hedge contract between a generator and non-affiliated retailer since the internal hedge position (i.e., the proportion of generation committed to its retail base) is likely to be at least as great as that which would be committed to an external hedge position.

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[18] An alternative strategy is for the output to be sold through a power purchase agreement (PPA). In this case the entire volume is sold, usually on a long-term basis, to a single party. In reality the single buyer is often a portfolio generator and, oftentimes, a vertically integrated portfolio generator. The price for PPAs reflects the fact that the buyer takes the risk on the variability of the generator's output.

[19] The National Electricity Market (NEM) of Australia, Singapore and the Philippines also operate gross pool markets.

Thus, vertical integration is likely to be at least as effective as hedge contracts in limiting the exercise of market power in the wholesale market (Australian Competition & Consumer Commission, 2018).

Vertically integrated generator retailers have the same, additional incentive, as stand-alone generators to offer generation capacity so if demand is higher than expected and prices commensurately higher they can capitalise on those opportunities.[20] However, a vertically integrated generator is likely to act in a more conservative way—offer additional generation at dispatchable prices—because they have to cover an unknown retail volume. In contrast, the stand-alone generator knows their contract position.[21]

Because a vertically integrated generator faces greater demand uncertainty than a non-integrated generator, the integrated generator is more likely to offer at prices closer to marginal cost than a stand-alone generator. This result arises because competition in the wholesale electricity market most closely corresponds to Cournot quantity competition (Hogan, 2011). Cournot, or quantity competition, is one of the two key models applied in competition economics to understand how firms interact and compete for market share in markets that are not perfectly competitive (that is, almost all real-world markets); the other model is "Bertrand" or price competition. Under Cournot quantity competition, firms behave as though they set quantities based on their knowledge of demand and the quantities they expect other firms to set.

Where a market exhibits Cournot-like competition, an increase in capacity will typically lead to increased competitive pressure, and hence lower prices and increased trade. However, a generator faces many different possible demand levels even when it has a good level of knowledge about its competitors' production levels. Uncertain demand means that the market outcome will move away from the Cournot equilibrium to an outcome that has smaller price-cost margins (Borenstein, Bushnell, Kahn, & Stoft, 1995). Demand uncertainty means that wholesale prices are expected to be closer to the perfectly competitive outcome than in a market with more certain demand.

Consistent with the prediction from economic theory, empirical analysis of the Australian NEM shows that vertical integration increases the amount of capacity offered into the market at competitive prices. Frontier Economics (2017, paragraph 12) explained:

> We found that vertically integrated generators in fact behave more competitively on average than when they were operating as stand-alone generators.... This statistically significant, robust and striking result is contrary to claims that vertically integrated generators will bid at higher prices than stand-alone generators.[22]

[20] There are nuances around this incentive including where a generator may not want to face the warm-up cost and some 8-10 hours warm up period for a thermal unit. Another case is where hydro capacity may be offered from storage reservoirs but priced at the opportunity cost of releasing today compared with the value of being available to manage risk in the future. In the latter case the capacity is offered but the price might be more associated with scarcity value.

[21] To date, this has been a hypothetical construct as all generators of scale have been vertically integrated. We understand that the sale by Trustpower of its retail base will be accompanied by relatively long-term hedge contracts to the purchaser of the retail base.

[22] In the NEM, generators are said to 'bid' into the market, whereas the NZEM uses the term 'offer' (to sell and bid to buy) consistent with commodity and other exchange traded markets.

Frontier's conclusions are consistent with our expectations: generation only provides a hedge if it is dispatched and the risk of not being dispatched constrains offer behaviour.

3.5 Managing residual volume risk

Retailers generally sell electricity to their customers on a fixed price variable volume contract. This form of contract means that there is uncertainty about both the volume of electricity the retailer will require and the intraday shape of the load. Some of this uncertainty resolves as the time gets closer (for example the weather becomes more predictable), but it is not fully resolved until real time (or once meters are read).

Due to the correlation of retail quantities and spot prices, electricity retailer price and quantity risks have been described as having ''flat hills and deep valleys'' (Boroumand & Zachmann, 2012). In periods of high wholesale prices their customers are likely to demand more electricity than the retailer expects and has provided for; this higher-than-expected demand is one of the reasons prices may be high—this was well illustrated by peak demand during cold weather in August 2021. Thus, in the absence of vertical integration or contracts, a retailer's losses in periods where wholesale prices are above retail prices are over proportional. In periods of low wholesale prices (say, a summer holiday evening) retail customers demand less electricity so that a retailer's gain from the positive retail-wholesale price differential is under proportional. This payoff-structure of retail contracts is almost perfectly mirrored by call options and peak generation assets. Thus, those assets are essential for hedging a retailer's joint price and volume risk. This 'residual volume risk' explains why forward contracts alone are not sufficient for hedging a retail commitment.

A vertically integrated generator may mitigate this risk by offering a larger quantity into the spot market at a more competitive price to cover short-term retailer volume risk, as discussed above. Volume risk could, in theory, be managed by an option contract, but it is likely to be costly to find a form of option that suits more than one party, particularly compared to the cost of managing uncertain outputs through vertical integration.

3.6 A simulation model

To test formally our conclusion that vertical integration is an efficient means for mitigating residual risk in the New Zealand electricity market we adapted a simulation model published by Boroumand & Zachmann (2012). Whereas the Boroumand & Zachmann study simulates the outcomes for an electricity retailer holding 1 MW of *retail* contracts, we simulate the outcomes of a *generator* holding 1 MW of generation assets. Our adaptation of the work of Boroumand & Zachmann (2012) for this analysis is described in detail in Appendix B.

Our simulation model estimates the benefits of different risk management portfolios (potentially) available in the New Zealand electricity market. It compares the risk for a North Island and a South Island generator under 7 separate strategies choosing between full market exposure, entering into retail contracts and/or forward contracts and/or call options and/or put options.

The results show that the least risk strategies include the use of options. The results show that a combination or retail and forward contracts are more risky than using options, but not as risky as spot exposure. For generators with access to only retail and forward contracts—as is effectively the case in the New Zealand market as option contracts are limited—a combination of the two is the least risky strategy. That is, a combination of vertical integration and trading in forward markets, is the least risk strategy available to generators in the New Zealand market.

4. Recent commentary on vertical integration

4.1 Drawing from the theory and empirical research

In section 2, we reviewed key conclusions and findings from theoretical and empirical studies into the causes and consequences of vertical integration. Virtually all theories of vertical integration turn in one way or another on the presence of market imperfections. In section 2, we discuss four reasons why vertical integration emerged as an efficient organisational response to the hazards for ex-ante investment commitment and ex-post performance in the electricity sector. In this section we draw from the preceding analysis to assess the views expressed by the Authority in relation to impacts and risks of vertical integration, and whether forced vertical disintegration as advocated by some commentators would likely benefit or harm the long-term interests of consumers.

4.2 A comment on the Authority's perspective

4.2.1 Economies of scale and efficient risk mitigation

As noted in the introduction, the Authority views vertical integration of generation and retail electricity businesses as having the potential for economies of scale where fixed costs can be spread over the consolidated business. It also views integration as enabling efficient risk mitigation.

As discussed in section 2.4 above, we are sceptical that vertical integration provides significant economies of scope or scale in operating costs not available to non-integrated entities. We therefore consider it unlikely that these economies are a substantive explanation for the high proportion of the wholesale market served by vertically integrated firms.

The Authority's comment that vertical integration enables efficient risk mitigation, while correct, grossly understates the importance of choosing the most efficient organisational form for the long-term benefit of consumers. In the current market, vertical integration:

- has underpinned almost all new investment of scale in generation plant in New Zealand over the past 25 years (see section 3.2)
- reduces both credit and re-contracting risk, leading to lower costs to serve consumers (see section 3.3)
- increases the amount of capacity offered into the market and at lower prices than would be expected from stand-alone generators (see section 3.4)
- lowers residual volume risk relative to a standalone generator with forward contracts (see section 3.5).

Given the scale of investment in the sector and the significance of the risks being managed, vertical integration can be expected to have resulted in substantial long-term benefits to consumers through lower prices and increased reliability—relative to what would have occurred, had generation been separated from retail.

4.2.2 Competition concerns

The Authority considers control by integrated generator-retailers of the bulk of electricity generation raises competition concerns in the retail market (Electricity Authority, 8 April 2021, para. 2.1). As we noted in our introduction, it is not clear whether the Authority perceives this concern as arising when an integrated entity supplies a large share of the market, or when the bulk of the market is supplied by vertically integrated entities, or whether its concern results from some combination of entity size and the proportion of the market supplied by vertically integrated firms. The MMR focusses on barriers to entry in generation and the effect such barriers can have on wholesale prices, thought the MMR sees the basis for any concerns as improving and "becoming less of an issue".

Although we cannot be confident that we understand the Authority's thinking on vertical integration, given its limited explanation, the concerns as expressed by the Authority are not supported either in theoretical literature or the applied experience of competitive electricity markets. We respond briefly to each aspect of the Authority's comments below.

4.2.3 Market structure is not determinative of competitive behaviour

An entity with either a large share of the wholesale market, or a large share of the retail market, may or may not give rise to competition concerns in the market in which it holds a large share; however, vertical integration does not add to those competition concerns; the gross wholesale pool structure is not conducive for an entity to leverage market power from one market into the other market. The MMR considers VI from the perspective of whether it imposes barriers to entry for non-vertically integrated firms. It posits the view that barriers to entry in new generation may limit price competition. The literature and applied experience of competitive electricity markets does not support the Authority's concern that integration combined with significant market concentration confers the ability for the largest firm or firms to act without competitive constraint in either the generation or retail markets. The Australian Competition Tribunal, in its decision to authorise AGL Energy to acquire Macquarie Generation addresses this point at some length (Application for Authorisation of Macquarie Generation by AGL Energy Limited, 2014); it makes a number of comments that reinforce points that we have already made:

- Market structure is not determinative of competitive behaviour (paragraph 369).
- Integrated companies have an incentive to ensure that they are dispatched, which limits their incentive to withhold generation or raise prices; generators that have entered hedge contracts have a similar incentive. While prices may rise somewhat in periods of capacity constraint, the generator will still have an incentive to ensure it is not displaced (paragraphs 314-315).

The Tribunal's observation that it is competitive conduct, not market structure, that determines outcomes for consumers bears citing in full:

> There is nothing inherently wrong with a market in which three large firms compete vigorously for market share where there are incentives to steal customers away from rivals. It is behaviour that matters, not structure per se. It appears to the Tribunal that it

> has been invited to assume that the "Big 3" will not constitute a competitive market principally on the basis of their combined market share immediately post-acquisition on an assumption that competition between them would become muted over time. In the opinion of the Tribunal, oligopolies should not be thus prejudged.
>
> The Tribunal does not consider that any shift to an uncompetitive oligopoly is likely. It is accepted that AGL will be long in generation and will have a real commercial incentive to achieve some level of balance between its generation capacity and its retail load in the longer term. It can only do so by winning customers from [the other gentailers, which] can be expected to resist. The competitive environment that is likely to exist in that situation may be hostile to small, non-integrated retailers or it may present niche opportunities. However, the Tribunal cannot conclude that a more atomistic market structure that favours a particular class of competitors is intrinsically better for consumers in the long run. It is the competitive mindset that matters, not market structure.
>
> …In a product as homogeneous as electricity it is hard to conceive that independent action could be taken successfully to give less and charge more, as this Tribunal put it in *Re QCMA* many years ago. If one gentailer sought to do this, the potential gains to a rival by not doing this would be commercially obvious. (Application for Authorisation of Macquarie Generation by AGL Energy Limited, 2014, paragraphs 369-70, 372)

4.3 Commentators seeking forced separation

Vertical integration between electricity generators and retailers has become somewhat of a 'lightening rod' for commentators unhappy with the performance of the electricity sector. Government intervention to separate, to varying degrees, generation activities from retail activities would, in the view of some commentators, lead to better outcomes for consumers.[23] To our knowledge, none of the commentators who suggest vertical integration is a problem has published any supporting analysis, either conceptual or empirical.

4.3.1 Anomalous analogy

Several of these commentators have suggested the comparatively recent split of Telecom into a network company, Chorus, and a telecommunications and digital service provider, Spark, as providing a model for reform of the electricity sector, seemingly unaware that both industries are subject to similar legislation separating (and revenue regulating) the network component from the content and retailing activities.[24] Analysis by analogy is prone to error, especially when the analogy is anomalous.

[23] See for example, https://www.stuff.co.nz/business/opinion-analysis/300383610/power-blackout-highlights-nzs-electricity-problem; https://www.energynews.co.nz/news/electricity/95733/nz-lacks-basic-power-competition-rules-octopus; https://www.pundit.co.nz/content/has-our-electricity-system-burnt-itself-out

[24] https://www.stuff.co.nz/business/opinion-analysis/300383610/power-blackout-highlights-nzs-electricity-problem; https://www.pundit.co.nz/content/has-our-electricity-system-burnt-itself-out.

4.3.2 Vertical integration and liquidity in contract markets

A notion repeated recently by commentators is that vertical integration results in less liquidity in contract markets. The Electricity Price Review set this argument out as follows (Electricity Price Review, 2018):

> Another drawback of vertical integration is that it can result in less use of contract markets – where companies buy and sell electricity ahead of time to lessen their exposure to wholesale price volatility. Vertically integrated companies have no inherent need for contract markets, whereas independent generators and retailers rely on them heavily. If large portions of the generation and retailing sectors have little use for contract markets, there will be low liquidity and muffled price signals, making it difficult and costly for independent companies to manage electricity price risks. An effective contract market, in contrast, supports ready access to contracts on reasonable terms, and sends clear price reference points for buyers and sellers.

In the early stages of the evolution of competitive wholesale and retail markets, some writers postulated what they referred to as a vicious cycle (Boroumand & Zachmann, 2012):

> [A]s long as derivative markets are not sufficiently liquid, retailers will strive to vertically integrate to better hedge their risk exposure … The more retailers are vertically integrated the less likely is the development of a liquid contract market, thus forcing non-integrated retailers to leave the market or to move towards physical integration.

We doubt that this proposition was ever valid for electricity markets, and if it were, the changing market dynamics place it amongst yesterday's problems.

We agree that liquidity is a beneficial feature of any derivatives market. Liquidity is characterised by frequent trading where prices are stable when trading occurs and contracts are readily available. Liquidity in electricity futures markets is particularly valuable for smaller firms as it provides the ability for them to adjust their risk position using futures contracts—larger firms are more likely to be able to diversify their volume risk reducing the benefit to them of liquidity.

Establishing liquidity in electricity markets presents special challenges. In most futures markets, liquidity is created by the presence of speculators, that is, traders prepared to take on outright risk. Liquidity in electricity futures markets is restricted because the underlying commodity cannot be stored so pricing cannot be linked directly to future physical supply. Trading in electricity futures is dominated more by expectations and risk premiums than in many other commodities. In New Zealand the restraint on liquidity is being addressed through the use of market making schemes.

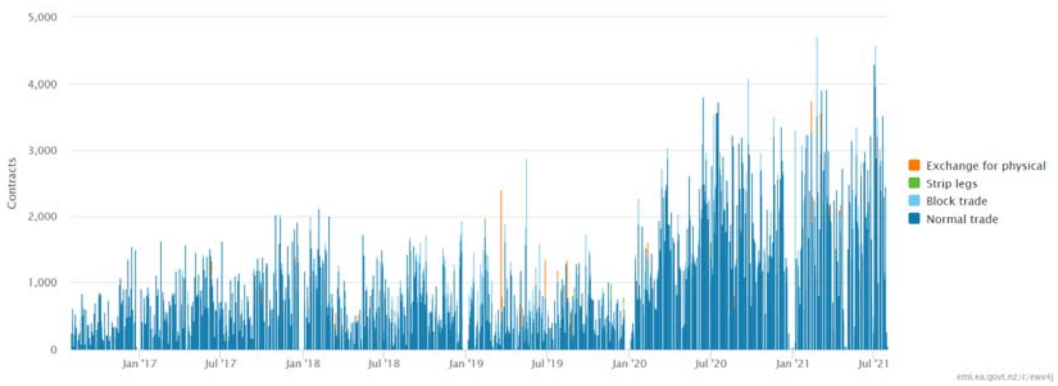
However, vertical integration is not a restraint on liquidity. Opponents of vertical integration suggest that it reduces the need for a financial hedge to manage price or revenue risk because the generator arm is earning the same price that the retail arm pays on the spot market; the argument is that generators no longer have an incentive to participate in futures markets. This argument ignores the (usually) fixed price, variable volume, contracts that the retailer has with their customers. If the retail arm has to pay a higher wholesale price than is embedded in their retail contracts, they lose money. This is the same as the contracting loss suffered by an independent generator when the price rises above the hedge contract price. Therefore, the incentive to participate in futures markets is the same for vertically integrated entities as it is for standalone entities.

The Australian Competition Tribunal reached the same conclusion (Application for Authorisation of Macquarie Generation by AGL Energy Limited, 2014):

- Competition is by its nature challenging. The relevant question is whether the challenge confronting competitors is made more difficult by vertical integration as a result of an impediment to securing suitable hedge contracts to enable them to participate in the market (paragraph 261).
- Individual generators have no incentive to withhold supply of hedge contracts (or raise prices) from competitive retailers because this would reduce revenue and advantage a competitor generator (paragraph 321). It is not feasible to recoup losses later: For a strategy of withholding contracts against generation capacity to be profitable in the long run, AGL would need to be able to recoup the revenue lost by charging higher retail prices in the future. However, the Tribunal was provided no analysis of how this could occur…The commercial reality is that AGL faces substantial retail competition, principally from its vertically integrated gentailer rivals. It cannot manipulate to its own advantage the level and type of competition from these competitors (paragraphs 358-359).
- The fact that from time to time some buyers cannot get the product they want at the price they are prepared to pay does not indicate an illiquid market (paragraph 328).

In any event the four major generator retailers have operated under a voluntary market making scheme since 2011. From Jan 2020 this scheme has operated under more stringent provisions incorporated into the Code including metrics for market making and penalties for failure to meet them. This could be seen as a belts and braces approach to the liquidity question raised by critics of vertical integration or a move by the Authority to remove any niggling doubt. Volumes in the New Zealand electricity futures contract have stepped up accordingly.

Figure 2 All New Zealand Electricity futures products, all maturities, daily volumes 01 Aug 2016 - 31 Jul 2021



Source EMI Electricity Authority

4.4 Market dynamics are changing

More recent theory on vertical integration observes that as competition increases, the incidence of vertical integration reduces. Vertical integration decreases because increased competition reduces bargaining frictions, one of the reasons firms integrate (Acemoglu et al., 2010). Modern organizational economic theory proposes that shocks to product market competition led firms to reorganize production chains and that this effect is transmitted through market prices. In a study of a natural experiment in the United States' coal mining industry, McGowan (2017) shows that an exogenous increase in product market competition due to deregulation of the railroad sector caused a 30 per cent reduction in vertical ownership.

Competition in the New Zealand retail sector has increased significantly over the past decade. It is conceivable that this increase in competition will alter the most efficient organisational form, leading to less vertical integration. More generally, the dynamic changes to the electricity sector are likely to lead to changes to the most efficient corporate form, or at least new experimentation in organizational structure. Trustpower's move to sell its mass-retail base and establish a standalone generation business may be anecdotal evidence of the change in efficiency of different organisation forms. Trustpower is reported as saying changes to the retail energy markets were the "primary" driver of the sale:[25]

> Electrification and decarbonisation, decentralised energy, digital trends in service provision and utilities convergence are all shaking up traditional operating models.

The position the MMR takes is also consistent with encouraging signs in new investment by non-vertically integrated firms.

4.5 Concluding comment

The overwhelming conclusion from the large body of literature we reviewed in preparing this report is that specific features of electricity markets are both statistically and economically important causal factors influencing the decision of firms to vertically integrate, both in New Zealand and internationally. Viewing the New Zealand electricity market through the lens provided by this empirical and theoretical work we draw two primary conclusions:

- vertical integration of electricity generation and retail activities has emerged as an economically efficient organisational form to overcome real-world imperfections in the wholesale and retail electricity markets; if regulatory interventions were to impede efficient vertical integration, the cost of electricity to consumers would increase, potentially substantially
- market reform which reduces market imperfections, including bargaining frictions, will increase competition and lead to a reduction in vertical integration; that is, an increase in competition will reduce the need for firms to vertically integrate (but a decrease in vertical integration imposed through regulation will not increase competition).

[25] https://www.nzherald.co.nz/business/energy-industry-shake-up-trustpower-says-it-could-sell-its-retail-business/OMY3UCZBJU2HXBD73VADUHB2SY/

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Appendix A Risk reduction passes through to lower costs for consumers

The analysis set out above conduces that risk reduction enabled by vertical integration allows a reduction in risk premium. In a workably competitive market, end consumers can expect to benefit from that risk reduction.

Economic theory finds that the extent to which a cost saving (in this case, the reduction in risk premium) is passed on to a consumer depends on the competitive pressure in a market. In the extreme case of perfect competition, there are many sellers of a homogenous product and all firms are price takers with no power to influence or set prices; the market price of an additional unit exactly equals the cost of producing that unit. In this situation, a change in costs will result in all of the cost change being translated into market prices, and consumers would receive the full benefit or incur the full impost of the change in costs.

The other extreme case is a monopoly (a single seller). If we assume that demand can be represented by a linear demand curve,[26] then the monopoly would pass through half the change in costs. This result is shown in a stylised form in Figure 3 below.

A profit maximising monopoly will produce a quantity such that marginal revenue (MR) is equal to marginal cost (MC). A monopoly will target this quantity as a lower level of production would reduce profits as the revenue lost would exceed the cost reduction; similarly, a higher level of production would reduce profits as the additional cost would exceed the additional revenue.

In Figure 3, the quantity where MR is equal to MC is represented by Q_1 (before a change in costs). When a monopolist produces the quantity determined by the intersection of MR and MC, it can charge the price determined by the market demand curve at that quantity, represented by price P_1 in Figure 3.

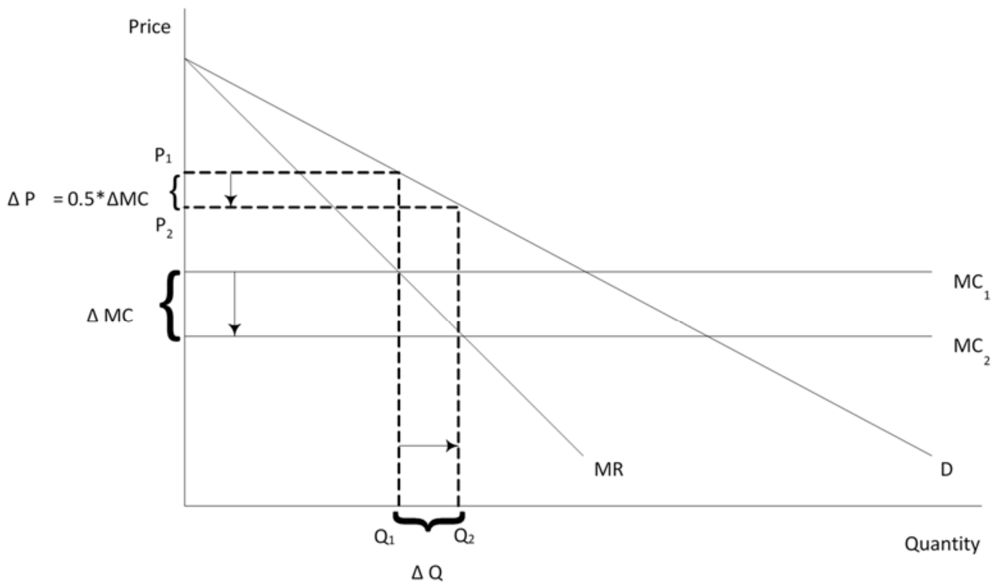
With a linear demand curve, the marginal revenue curve is twice as steep as the demand curve. To sell more, a monopolist must reduce its prices, therefore the net additional revenue from the last unit sold is less than its average revenue on all units sold.[27] Hence, for any shift in the marginal cost curve, the change in price will be half that of the change in costs. This effect is demonstrated in Figure 1; that is, the reduction in price from P_1 to P_2 is equal to half the reduction in marginal cost from MC_1 to MC_2.[28]

[26] A demand curve is the graphical representation of the relationship between the price of a good and the quantity of that good consumers are willing to pay at a certain price at a point in time. In reality, demand curves are rarely linear.

[27] For example, if a monopolist could sell 1 unit for $10 and 2 units for $9, the change in average revenue is $1 and the change in marginal revenue is $18-$10 = $2.

[28] For ease of illustration, a flat marginal cost curve (MC) is shown, but the result is the same for a shift of any shape marginal cost curve.

Figure 3 Cost pass-through by a monopoly



Hence, the greater the competitive pressure, the greater the portion of any cost savings that can be expected to be passed through to consumers. The two cornerstone economic models for understanding how firms interact and compete for market share in markets that are not perfectly competitive (that is, almost all real world markets) are “Cournot” or quantity competition, and “Bertrand” or price competition. Under price competition, each firm sets price given its belief about how the other firms will price. Under quantity competition, firms may behave as though they set quantities based on their knowledge of demand and the quantities they expect other firms to set.

Most academic analysis of the wholesale electricity market we are aware of concludes that the market has a Cournot-like structure, as suppliers simultaneously submit a schedule of quantities (willingness to supply at a range of prices) – see for example (Hogan, 2011). In concept, retail electricity markets exhibit some of the conditions necessary for Bertrand competition—the product sold is largely homogeneous and on a casual analysis the costs to supply might be thought to be more or less similar. However, because the five main retailers are vertically integrated with generation—an organisational form which has emerged in all competitive electricity retail markets to efficiently manage price and quantity risk—all retailers are subject to capacity constraints. This feature of the electricity retail market distinguishes it from textbook Bertrand competition; in Bertrand (or price competition), each firm can potentially take all the market.

Suppliers with physical generation assets face capacity constraints. Economic theory shows that when limits exist on the production capacities of competitors, markets that might otherwise exhibit Bertrand competition yield Cournot outcomes (Scheinkman, 1983). Literature on competition in the British and Norwegian markets (Boroumand D. F., 2011), and observations from the New Zealand market, tend to support a conclusion that electricity retail markets exhibit Cournot competition.

In New Zealand, retailers appear to compete over the number of consumers/ICPs. Annual reports released by retailers suggest that the number of ICPs is a critical success factor, as are measures of churn (gains and losses of consumers). For example, Meridian Energy's annual report lists customer ICPs as a key statistic, and Contact Energy's annual report provides information on churn relative to market average. Importantly, companies note that there is an optimum balance of consumers to generation capacity (Energy, June 2017):

> We aim for a volume of contracted retail sales that optimises our overall earnings relative to market risk.

Additionally, methodologies adopted by investment banks in valuing the retail electricity supply businesses internationally use customer numbers as a key variable in determining the long-term value of the business.

An oligopolistic market, that exhibits Cournot competition, produces a level of cost pass through that is between the monopoly and perfectly competitive outcomes. In a study often cited, (Niels, 2005) found that the price change in an oligopolistic market, with linear demand and a homogenous product, will be equal to N/(N + 1) of the cost change, where N is equal to the number of firms in the market. In the case of the retail energy market, if N is assumed to equal to five (the number of retailers that supply nearly 89% of all consumers), the expected pass through would be 5 / 6 or 83%. If N is larger, to reflect the smaller retailers in the market, the pass-through percentage would increase. For example, if N is assumed to be 10—the number of retailers that compete in every region in New Zealand, the pass-through would be 10/ 11 or 91%.

Appendix B Risk management optimisation model

Model details

The model simulates the payoff outcomes of a generator with 1MW of generation assets (in either the NI or SI) using a variety of different risk management contracts and hedges. These include, retail contracts, forward contracts and call and put options. We run six combinations of these risk management mechanisms (scenarios) for both a NI and SI generator.

There are two important (and related) assumptions for this modelling:

1. there are no transaction costs (or risk premia) for contracting
2. each contract is assumed to have net zero payoff on average.

Under each scenario, the generator is assumed to be minimising their exposure to 'worst case' risk. This is defined as the 95th percentile value at risk (VAR[95]). This measure represents the value of the payoff received by the generator at which 95 per cent of the simulated payoffs will be greater than or equal. Alternatively, only five per cent of outcomes will be worse than this value. As VAR(95) represents a loss, this number is negative. Therefore, a value that is closer to zero (less negative) represents a lower exposure to worst case risk.

The volume of retail contracts (measured in MW) are constrained to be positive. The retail load profile is load following. Retail contracts are normalised such that the average load for a 1 MW retail contract is also equal to 1 MW. The volume of all forwards and options (measured in MW) may be positive or negative. The volume of forwards and options are modelled as constant over the course of a year, that is, a 1 MW forward contract is modelled as 1MW for each trading period in a year.

Results

Table 1 shows the results of the modelling. The VAR(95) column is the main column of interest. As described above, the closer this value is to zero, the less risk the generator is exposed to in a 'worst-case' scenario. It is immediately apparent that any risk management portfolio results in a large reduction in the VAR(95) faced by a generator.

For both NI and SI generators, the portfolios where options are available to use (rows highlighted in grey) to hedge risk create the optimal scenarios. Indeed, the difference in VAR(95) from adding other contracts to the portfolio when using options is minimal. However, liquidity in options in New Zealand is limited.

The remaining scenarios consider the benefits of using retail and forward contracts. For both NI and SI generators, retail contracts provide a smaller VAR(95) than forward contracts alone, while a combination of the two provides even further benefit. The model estimates that the residual risk for a North Island (NI) generator that manages risk with a combination of retail contracts and forward contracts is 19 per cent lower than a generator that only manages risk with forward contracts. The equivalent reduction in risk for a South Island (SI) generator is 14 per cent.

Table 1 Results of VAR(95) optimisation

	VAR(95)	Retail contracts		Forward		Call option		Put Option	
		NI	SI	NI	SI	NI	SI	NI	SI
North Island generation assets									
All contracts	-411	0.02	0.00	-1.29	1.98	0.31	-2.00	-1.06	1.95
Forwards and options	-411			0.25	-0.38	-1.25	0.35	0.47	-0.40
Options only	-411					-1.00	-0.03	0.22	-0.02
Retail and forward contracts	**-1,327**	0.29	0.31	-0.64	0.43				
Retail only	-1,548	0.73	0.00						
Forwards only	**-1,637**			-0.96	0.10				
Generation only	-8,191								
South Island generation assets									
All contracts	-383	0.01	0.05	1.61	-0.66	-1.59	-0.30	1.62	-0.50
Forwards and options	-387			-0.14	0.31	0.14	-1.33	-0.13	0.53
Options only	-387					0.00	-1.02	0.01	0.22
Retail and forward contracts	**-1,307**	0.07	0.72	0.09	-0.09				
Retail only	-1,320	0.00	0.80						
Forwards only	**-1,523**			-0.03	-0.83				
Generation only	-6,233								

Explanation

The net payoff for all contracts/assets (including the retail contract) is zero in expectation. This is the same assumption that Boroumand & Zachmann (2012) use, which allows non-biased comparison between contracts/assets.

> We assume that in a perfect market (no market power, no transaction costs, full transparency, etc.) arbitrage would not allow for the existence of systematic profits. Without this postulate, the method for the evaluation of contracts and assets would drive our results. Indeed, the net loss calculated for each portfolio would be strongly determined by the valuation method of the assets or contracts within the portfolio.

Net payoff functions for each trading period, t, which represents each half hourly period:

$$\pi_{plant,t} = \max(P_t - mc, 0) \times V_{plant} - E\left[\max(P_t - mc, 0) \times V_{plant}\right]$$

$$\pi_{retail,t} = -P_t \times V_{retail,t} + E\left(P_t \times V_{retail,t}\right)$$

$$\pi_{forward,t} = P_t \times V_{foward} - E\left(P_t \times V_{forward}\right)$$

$$\pi_{call,t} = \max(P_t - X, 0) \times V_{call} - E[\max(P_t - X, 0) \times V_{call}]$$

$$\pi_{put,t} = \max(X - P_t, 0) \times V_{put} - E\left[\max(X - P_t, 0) \times V_{put}\right]$$

Where:

$$P_t \ is\ thespot\ price\ for\ period\ t$$

$$mc = marginal\ cost\ of generation\ for\ a\ marginal\ generator$$

$$V_{plant/forward/call/put}\ is\ the\ volume\ of\ each\ contract/asset\ purchased\ or\ sold$$

$$V_{retail,t}\ is\ the\ stochastic\ demand\ for\ electricity\ for\ period\ t$$

$$X = strike\ price\ of\ call/put$$

For simplicity of modelling, the volume of non-retail contracts/assets is assumed constant, and set prior to the start of the year.[29] Retail volume varies with each time period, t, and is estimated such that the optimised volume of retail contact(s) is the expected value of the yearly average load. For instance,

[29] It is likely that risk could be further minimised by employing a strategy that alters the volume of contracts/assets purchased or sold during different periods e.g. peak/off-peak, weekday/weekend, season etc. and the various combinations. However, the same relative trends in risk mitigation between the combinations of contracts/assets will remain.

a 1 MW contract would be expected to have an average load of 1 MW for the year. We assume that the distribution of demand volume for each time-period in our simulation follows the same distribution as historic load (for each island), i.e. it is directly sampled from the historic time series data.

The net annual payoff for a generator is simply the sum of each of the individual payoffs of each contract/asset employed:

$$\pi = \sum_{t=1}^{17520} \begin{matrix} V_{plant,island} \times \{\max(P_{island,t} - mc_{island}, 0) - \mathrm{E}[\max(P_{island,t} - mc_{island}, 0)]\} + \\ V_{retail,NI,t} \times (P_{retail,NI} - P_{NI,t}) + \\ V_{retail,SI,t} \times (P_{retail,NI} - P_{NI,t}) + \\ V_{forward,NI} \times (P_{NI,t} - X_{NI}) + \\ V_{forward,SI} \times (P_{SI,t} - X_{SI}) + \\ V_{call,NI} \times \{\max(P_{NI,t} - X_{NI}, 0) - \mathrm{E}[\max(P_{NI,t} - X_{NI}, 0)]\} + \\ V_{call,SI} \times \{\max(P_{SI,t} - X_{SI}, 0) - \mathrm{E}[\max(P_{SI,t} - X_{SI}, 0)]\} + \\ V_{put,NI} \times \{\max(X_{NI} - P_{NI,t}, 0) - \mathrm{E}[\max(X_{NI} - P_{NI,t}, 0)]\} + \\ V_{put,SI} \times \{\max(X_{SI} - P_{SI,t}, 0) - \mathrm{E}[\max(X_{SI} - P_{SI,t}, 0)]\} \end{matrix}$$

Where

$$mc_{island} = median(P_{island,t})$$

$$P_{retail,island} = \frac{E(V_{retail,island,t} \times P_{island,t})}{E(V_{retail,island,t})} = load\ weighted\ average\ price\ for\ 1MW\ contract^{30}$$

$$X_{island} = E(P_{island,t})$$

mc, P_{retail}, and X are estimated separately for each island using 3,000 simulations of yearly data (see below).

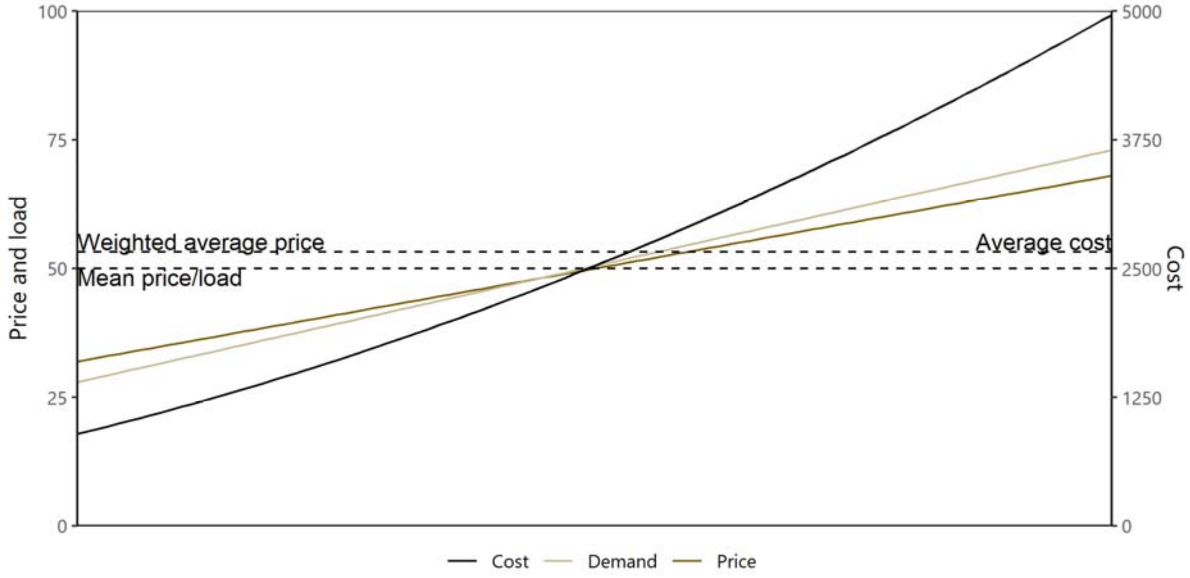
Setting the marginal cost of plant generation, mc, at the median price, assumes a marginal plant. That is, the plant will generate, on average, during 50 per cent of the periods. For simplicity we assume that when the plant generates, it generates at capacity. This also differentiates plant assets from the put option, where the strike price is set at the mean price. If $mc_{island} = X_{island}$, then the payoffs between generation and put options would be identical in the model.

The definition for P_{retail} sets the price to customers (i.e. retailer income) to a level where the net payoff for a retail contract is zero in expectation. Due to the multiplicative effect of the positive correlation between load and price, the 'load weighted' average price, is higher than the average. A stylised example of this is shown in Figure 4.

This depicts a scenario where price and demand are perfectly (linearly) correlated. Due to the multiplicative effect, cost increases at an increasing rate with price and demand (it follows a quadratic function in this stylised case). This results in the average cost and weighted average price being higher than the product of the mean price and mean demand.

[30] Differs from Boroumand & Zachmann (2012) who assume a fixed payment to offset the difference between the arithmetic and weighted average price.

Figure 4 Impact of load-price correlation on load weighted average price



Source: Sapere analysis

Methodology

Data from Electricity Authority's (EA) Electricity Market Information (EMI). Two file sets with all available (final) data files between 2011 and 2020 inclusive:

- Load Generation Price (LGP). Provides load data which is used to simulate electricity demand.
- Final Prices (FP). Provides pricing data which is used to simulate electricity prices.

Load data from LGP files are aggregated by each half hourly trading period, and island. Price data are extracted from the FP files. The OTA2201 node is used as the reference node for prices for the North Island (NI), while BEN2201 is used for the South Island (SI). Load and price data are combined by trading period, constructing a sampling set with load and price pairs for each island. Some files are missing from LGP therefore only 174,624 rows of data (theoretically should be 175,344).

From these rows, 3,000 sets of 17,520 (the number of half hourly trading periods in a year) load and prices (by island) are randomly drawn, for each island (with replacement and uniform probability). While the sampling could be stratified by time of day, weekday/weekend, season etc, due to the uniform nature of the selection process, selection should be unbiased, and normally select a generally realistic sample. Any additional variation is also useful to highlight potential risks and uncertainties.[31]

[31] Differs from Boroumand & Zachmann (2012) who use an alternative sampling method. The method that we have chosen generates a more 'realistic' situation, rather than forcing variation in the mean/median of the samples. Our methodology also allows for both extreme highs and lows (along with more 'normal' values) with a year/simulation, rather than the truncated nature of the windowed sampling by Boroumand & Zachmann (2012)

Optimisation of the VaR(95) based on the profit function defined early was completed using the DEoptim optimisation function from the R package, RcppDE.[32] Volumes of retail contracts (in MW) were constrained to be positive (or zero). Volumes of other contracts could be positive or negative (or zero), representing the ability to be a buyer or seller of each.

Sample statistics

Table 2 compares the summary statistics of the observed data (historic data from EA's EMI) compared to the samples used in the models. We can see that the observed and sample data are very similar in nature.

Table 2 Observed vs sample statistics

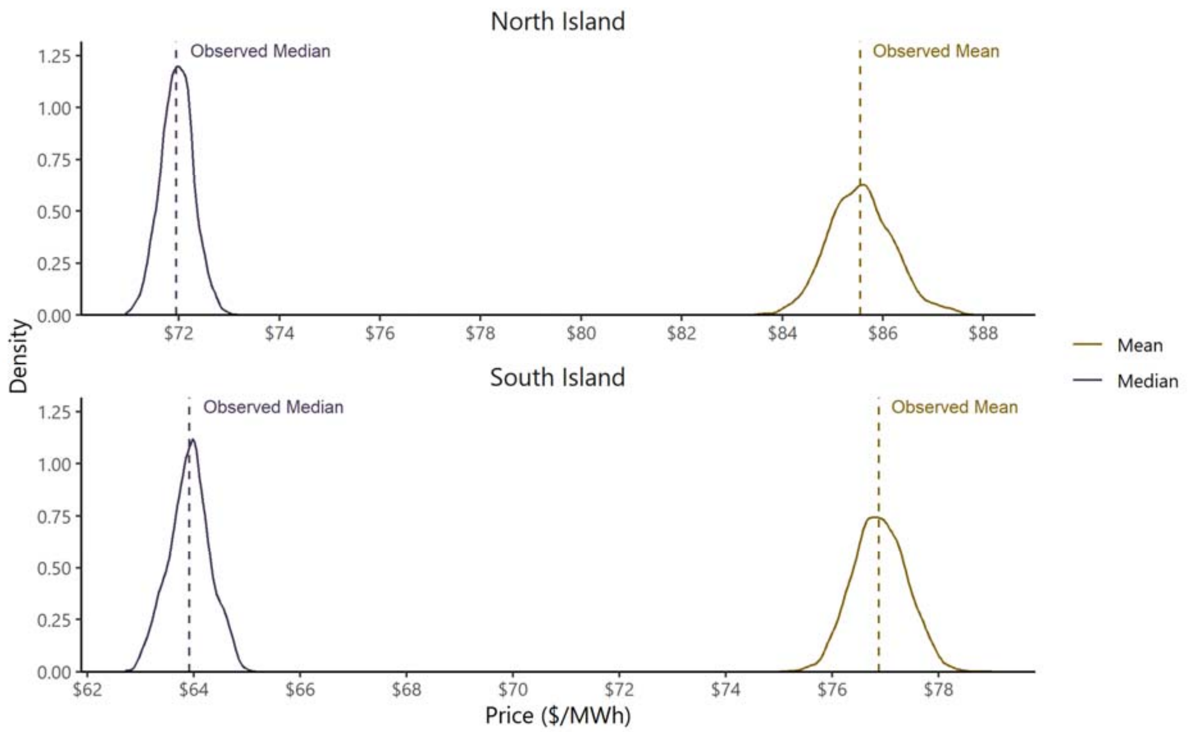
		North Island		South Island	
		Observed	**Sample**	**Observed**	**Sample**
Price ($/MWh)	Median	72.0	72.0	63.9	63.9
	Mean	85.5	85.6	76.9	76.9
	Standard deviation	84.1	84.0	65.6	65.7
Demand (MW)	Median	2,745	2,746	1,650	1,650
	Mean	2,684	2,684	1,640	1,640
	Standard deviation	614	614	205	205

Source: Sapere analysis

Figure 5 shows the distribution of the mean and median price of the 3,000 simulated years. The distributions are roughly centred on the observed values. A similar picture is shown for the mean and median price in Figure 6.

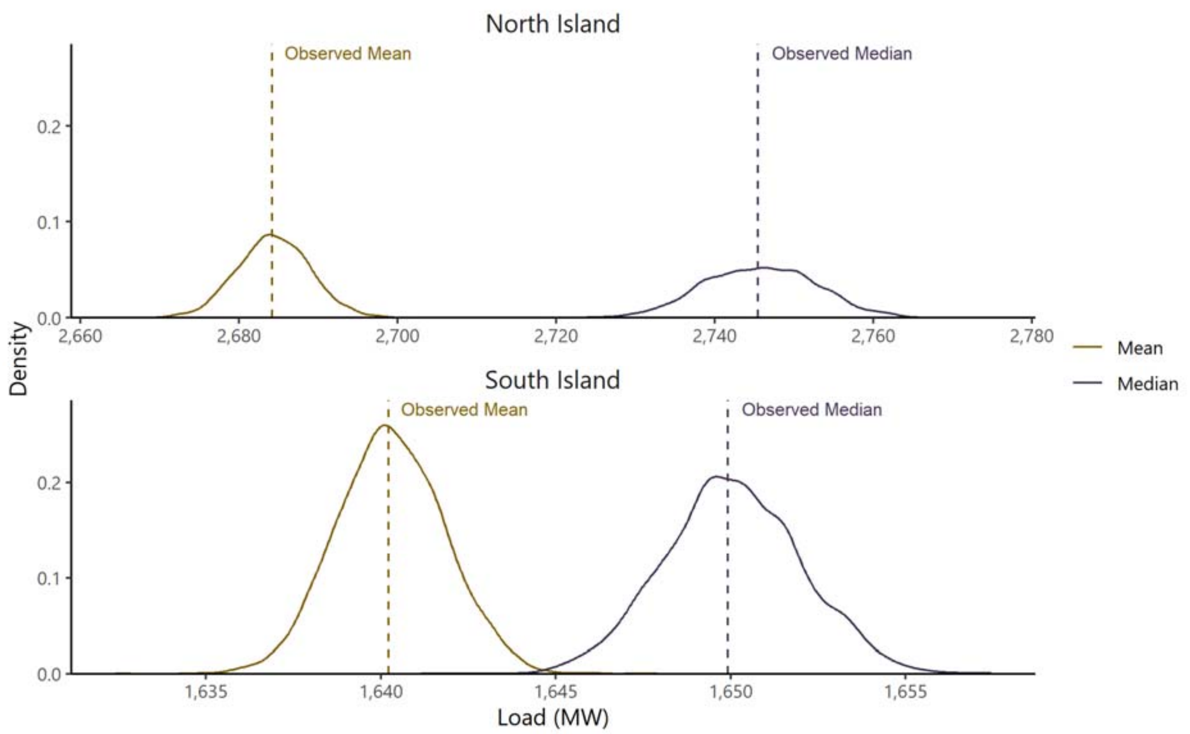
[32] This package uses the Differential Evolution optimisation methodology for non-linear constrained optimisation. Further information on the function and its underlying model can be found at: https://cran.r-project.org/web/packages/RcppDE/RcppDE.pdf

Figure 5 Distribution of sample mean and median price



Source: Sapere analysis

Figure 6 Distribution of sample mean and median load



Source: Sapere analysis

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