COMPETITION ECONOMISTS GROUP

Vertical integration and liquidity in NEM hedge markets

June 2018

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1 Executive summary

1. There are three key conclusions of this report.

2. First, 'liquidity' in National Energy Market (NEM) financial hedge markets is a measure of how easy it is to trade an instrument without moving the price paid/received against the trader. This is a function of the responsiveness of both supply and demand to changes in prices. Liquidity is generally strongly correlated with the stock of value of the asset in question and/or its trading volume. However, this correlation is not causation and there are circumstances where the outstanding value of the stock/trading volumes falls and liquidity, properly defined, stays constant or even rises.

3. Second, vertical integration will not change the liquidity in financial hedge markets. Vertical integration will reduce the outstanding value of financial hedge contracts and may, somewhat, reduce the volume of trading. However, market prices will not be any more sensitive to individual trades. This is because, while vertical integration reduces the merged entities' optimal level of external financial contracts, it does so by replacing infra-marginal external hedge contracts with an infra-marginal natural hedge. It will not alter the optimal marginal response to price changes. The merged entity will have the same optimal supply/demand response to a 5% change in futures prices as would the two entities if they were standalone. For example, the optimal increase in supply of futures contracts when futures prices rise 5% will be the same for the merged entity as it was for the sum of the standalone entities. In short, the marginal responsiveness of a vertically integrated firm to a price change in hedge markets will be the same as the combined marginal responsiveness of its constituent parts were they standalone. Thus, the market response to a change in price, i.e., liquidity, will be unaffected by vertical integration.

4. Third, notwithstanding that hedge trading volumes are not the same thing as market liquidity, there is no evidence of falling hedge trading volumes on the ASX. Indeed, ASX trading volumes have recently been at, or near, all-time highs.

2 Introduction

5. This report provides a discussion of 'liquidity' in NEM financial hedge markets and the impact of vertical integration. It has the following structure:

- **Section 3.** This section explains that 'liquidity' in a market is a measure of how easy it is to trade an instrument without moving the price paid against you. Section 3 also explains that vertical integration will not reduce market liquidity so defined.
- **Section 4.** This section provides an analysis of a time series of various proxies for market liquidity. It concludes that there is no evidence to support a conclusion that market liquidity has declined or that it has been adversely affected by vertical integration events.

3 Defining liquidity in energy financial markets?

6. This section defines liquidity in financial markets and also provides an analytical basis for thinking about the effect of vertical integration in the electricity market on liquidity of the market for financial hedge contracts. This issue (the impact of vertical integration on liquidity of financial hedge contracts) is addressed, using more formal/mathematical analysis, in Appendix A.

3.1 What is liquidity?

7. The term 'liquidity' is sometimes used in economic discussions without a very clear definition. In this report, we adopt the standard definition from the finance literature where liquidity is defined as the degree to which an asset or security can be quickly bought or sold in the market without affecting the asset's price. The more liquid a market the easier it is to observe the 'fair' market price and the less likely it is that an individual trader will move the market price against themselves by the act of trading in the instrument.

8. This definition is consistent with that commonly used in financial markets. For example Governor Kevin Warsh of the US Federal Reserve System defines liquidity as follows:[1]

> *The traditional concept of liquidity relates to trading: An asset's liquidity is defined by its ability to be transformed into another asset without loss of value. …*
>
> *As noted, 'liquidity' in the sense of "trading liquidity" reflects the ability to transact quickly without exerting a material effect on prices.*

9. Another simplistic definition of 'liquidity' is the volume of trading in an asset. This simplistic definition is typically strongly correlated with true liquidity (as defined above). This is because, as discussed in section 3.5 below, high levels of aggregate trading are typically correlated with high levels of sensitivity of supply and demand to (marginal) changes in price. However, as also discussed in section 3.5 below, it is important to keep in mind that this correlation is not causation. Specifically, that certain changes in market structure/conditions might reduce aggregate trading while simultaneously having no effect (or even increasing) true market liquidity. Vertical

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1 Governor Warsh, Speech, Market Liquidity: Definitions and Implications, March 2007. Available at <https://www.federalreserve.gov/newsevents/speech/warsh20070305a.htm>.

integration in electricity markets is one such change that can be expected to reduce aggregate trading without reducing liquidity.

3.2 Liquidity in asset markets is achieved by traders altering their portfolio in response to price changes

10. Liquidity in an asset market depends on the willingness of buyers and sellers to adjust their portfolio for small changes in price. That is, a change in the desired portfolio of one party must be matched by offsetting changes in the portfolio of other parties. This is how a market achieves equilibrium in response to a change in one party's desired portfolio. For example, if one party wants to hold more US Treasury bonds, it follows that other parties must, in aggregate, hold fewer (or the US Government must issue more (have a more negative portfolio)).

11. The question then becomes, how much do prices have to change in order to elicit the offsetting change in portfolios of other parties? In a liquid market, prices have to change only modestly. In an illiquid market, other parties require a large price change in order to elicit the offsetting change in their (aggregate) portfolios.

12. By way of illustration, imagine that a market was made up of buyers and sellers who had fixed ideas of what their portfolio must look like. In the context of electricity hedge markets this would involve:

    - each generator taking the view that they must issue a specific number of base load futures; and
    - each retailer taking the view that they must hold a specific number of base load futures; then
    - let those specific numbers be insensitive to the price at which the base load future is struck (in the sense that very large price changes are required to cause participants to change, even modestly, their desired portfolio); [2] and
    - for the purpose of illustration, let the total number of base load futures that generators want to sell and that retailers want to buy happen to be 1,000 each such that the market was in balance.[3]

13. This market would be illiquid. If one market participant, say a retailer, wanted to increase their holdings of base load futures then other market participants must

2 In fact, if each market participant's desired number of base load futures issued/bought was truly perfectly insensitive to price then the market would not clear – because there would be no mechanism to equate supply and demand.

3 Of course, this can only have been achieved in reality by the price of base load futures having adjusted until supply and demand were in equilibrium as discussed in the previous footnote and also in the text below.

adjust their portfolio in an offsetting manner (other retailers have to hold fewer based load futures and/or generators have to issue more base load futures). The way that the market achieves this is by the base load future's price rising; giving other participants the incentive to accommodate the desired trade by selling base load futures.[4] If all market participants' desired portfolios are insensitive to price then a large price increase is required to elicit the necessary reduction in holdings that will accommodate the retailer who is seeking to increase their holdings.

14. By contrast, if all market participants' desired portfolios of base load futures are very sensitive to the price of base load futures then the market will be highly liquid. In this case, the price of futures only has to rise by a small amount in order to elicit the necessary accommodating increase in supply by generators and/or reduction in other retailers' holdings.

3.3 Liquidity is determined at the margin in response to price changes (not by the aggregate level of infra-marginal trading)

15. It is important to clearly understand that the above examples of an illiquid and a liquid base load futures market do not rely on any fact or assumption about the total volume of trading required for all parties to achieve their desired portfolio. Indeed, the above example is constructed so that both the liquid and the illiquid market have the same base level of trading required to achieve retailers' and generators' initially desired portfolios (1,000 units).

16. What matters for market liquidity is not the size of this 1,000 units of infra-marginal trading. Rather, what is important is the sensitivity of the desired portfolio to changes in market prices. That is, what is important is the marginal sensitivity to price of each participant's desired portfolio. If this marginal sensitivity is high then the market will be liquid. If this marginal sensitivity is low then the market will be illiquid.

3.4 Vertical integration does not reduce marginal incentives to trade in response to price changes

17. The difference between marginal and infra-marginal trading is important to understand in the context of this report because vertical integration:

- **will** reduce the infra-marginal trading in base load futures (e.g., the creation of a natural hedge might reduce the number of base load futures desired to be sold/bought from 1,000 to 900); and

4 Generators issuing more and/or other retailers reducing their net holdings of base load futures.

- **will not** reduce, at least in any obvious way, the sensitivity to price of the vertically integrated supplier's portfolio (relative to the sensitivity to price of its constituent parts were they stand-alone).

18. In order to understand the second dot point, consider the impact of a 1% increase in the base load futures price for a quarter. Holding constant market participants' expectations of the future spot price distribution, this makes issuing/holding futures contracts more profitable/expensive. This will, in turn, incentivise all parties to sell base load futures (the effect of which for retailers is to reduce their net holdings). The size of this adjustment, in response to a change in price, defines the liquidity of the market. Small adjustments in quantities are associated with illiquid markets and large adjustments are associated with a liquid market.

19. The critical question for this report is whether vertical integration between a generator and a retailer causes the vertically integrated entity to have a smaller adjustment to a 1% price increase than the sum of the adjustments if the entities were they stand-alone. There is no obvious reason to believe that this would be the case and one could easily imagine that, if anything, the opposite would be true.[5]

20. Let the following describe the base-case stand-alone scenario:

- At a futures price of 80 $/MWh, expected spot prices and the futures price are aligned.
  - At this price the hypothetical stand-alone generator would issue 100 futures contracts with the sole objective of minimising volatility of profit.
  - Similarly, the hypothetical stand-alone retailer would hold 100 futures contracts with the sole objective of minimising volatility of profit.

    (There is no gain in terms of the level of actuarially expected profit from futures trading because, by assumption, the futures price matches the actuarially expected spot price.)
- At a higher futures price 90 $/MWh (and holding expected spot prices constant):
  - the generator/retailer would expect to raise expected profits by selling more futures contracts; however
  - this will also raise the volatility of expected profits.

    (Recall that the volatility of expected profits is minimised when each party issues/holds 100 contracts (which is what they would issue/hold if the futures contract price was aligned with actuarially expected spot prices));

5 For example, vertical integration may have the effect of strengthening the overall balance sheet of the entities, allowing the vertically integrated firm to take on more risk in responding to price signals than the two stand-alone entities combined.

- Let both hypothetical parties respond to this increased incentive to sell futures contracts by issuing 10 additional futures contracts (20 in total). The effect of this is to raise/reduce the net portfolio of the generator/retailer from 100 units to 110/90 units.
- This 20 unit increase in net supply is their stand-alone contribution to market liquidity. That is, their contribution to the supply of additional futures contracts in a market where rising prices signal a need for additional supply.

21. Now, consider whether there is any reason to believe that, if these entities merged, the vertically integrated entity would respond any differently? Is there any reason to believe that the vertically integrated entity would not also increase the supply of futures contracts by 20 units in response to the same 10 $/MWh increase in futures prices relative to expected spot prices?

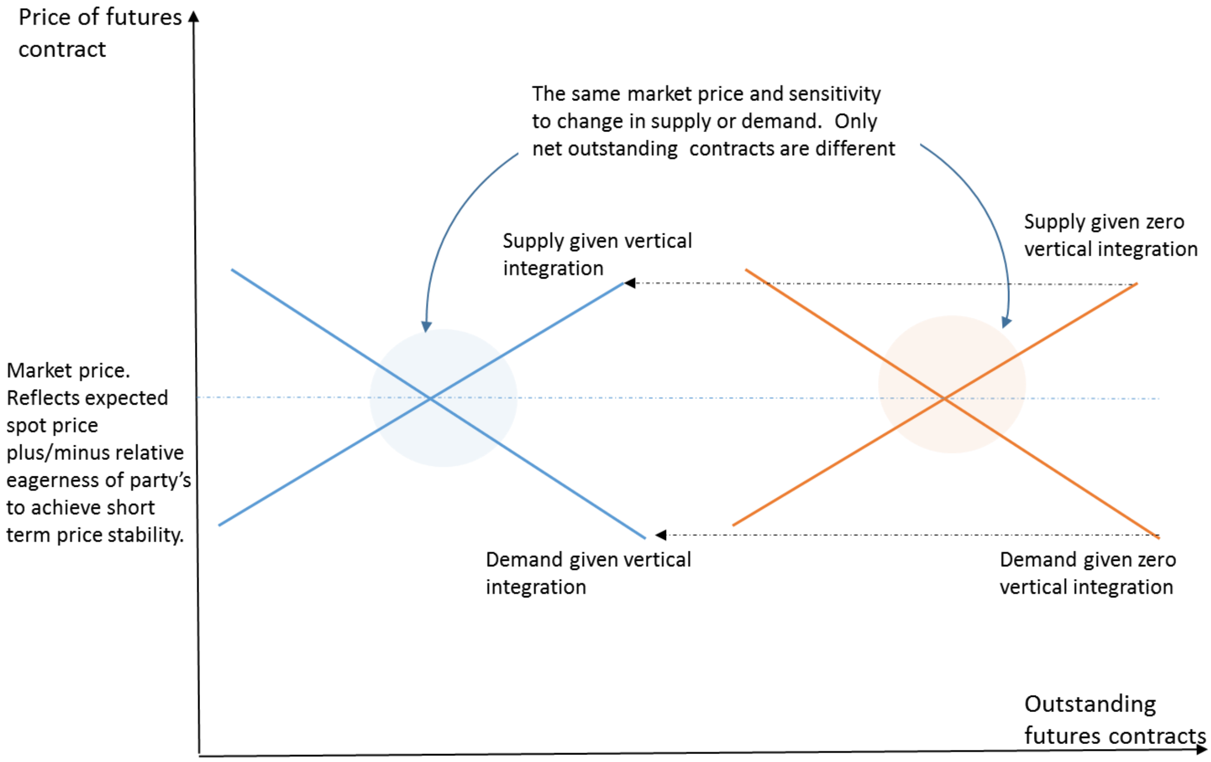
22. It may well be that, at the initial futures price of 80 $/MWh, the hypothetical merged entity would rely on the existence of a natural hedge such that it would neither issue nor hold futures contracts. However, as the price rose above 80 $/MWh, the new firm would have the same incentives to increase supply as its stand-alone constituent elements had. There is no obvious reason for the merger to have any effect on the marginal propensity to trade in the face of changing prices:

    - The expected profit from issuing an additional 20 contracts would be the same as the aggregate impact across the stand-alone entity (20 times the $10 differential between futures prices and expected spot prices);
    - The expected impact on volatility of profit would be the same (20 times the expected variance in future spot prices relative to the expected mean);
    - The combined ability of the new entity to absorb such profit variation would be the same as the combined ability of the stand-alone entities (the new entity would have the combined balance sheet of the stand-alone entities).

23. In short, there is no obvious reason to believe that the merger will result in any change in the marginal sensitivity of supply and demand of futures contracts to changes in price (i.e., market liquidity). The merger will result in a reduction in the total number of observed trades (e.g., at a price of 80 $/MWh the number of observed trades will be 100 units lower). However, this reduction is purely a reduction in the infra-marginal trading (trading that is not driven by price). There is no reason to believe that price sensitive trading, of the kind that supplies liquidity, will change.

24. This is illustrated in the stylised supply and demand diagram at Figure 3-1 below. This figure illustrates a market for hedging products with and without vertical integration. The only difference is that, in one case, one or more generation portfolios are combined with one or more retail portfolios.

Figure 3-1: Illustration of markets with identical liquidity but different size



25. The impact of vertical integration is to reduce the outstanding futures contracts in the market. In the above figure, the reduced need for outstanding financial futures as a result of vertical integration is illustrated by the shift in the market supply and demand curves to the left.

26. However, there is nothing about this leftward shift of demand and supply that alters the slopes of the curves (i.e., that alters market liquidity). Market liquidity is driven by the combined slope of the supply and demand curves around equilibrium and there is no reason (at least no obvious reason) that this will be altered. The leftward shift in supply and demand should be thought of as swapping one form of infra-marginal hedging (financial contracts) for another (a natural hedge).[6] This leaves the

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6 Something is infra-marginal if it is not the subject of optimisation. In this context, imagine that a generator, given its balance sheet, would always sell 50% of its output on the hedging market irrespective of the price in the hedging market. Similarly, imagine that a retailer, given its balance sheet, would always buy 50% of its energy in financial markets. The firms will optimise hedging above these levels as market conditions change (e.g., sometimes choosing 90% and sometimes choosing 60%) but never below. The 50% hedging position is a 'set and forget' position. It contributes nothing to market liquidity or price discovery because trading in these volumes is not sensitive to market conditions.

Now imagine that these two firms merge. Let the merger create a level of 'natural hedge' of, say 60%. The combined entity no longer needs to source is baseline 50% hedge position in financial markets. Its combined firm's ongoing optimisation, using financial contracts, to its hedge position unchanged. This ongoing optimisation (adjustment to market prices/conditions) is what delivers financial market liquidity. A vertically integrated firm has the same needs and desires to adjust to changes in circumstances/prices as its constituent parts. Therefore, a vertically integrated firm will make the same contribution to market liquidity that its constituent parts would have made had they been standalone operations.

27. Indeed, to the extent that there is any reason to believe that liquidity would be affected then it would seem most plausible that it would be increased. This would be the case if the natural hedge provided superior hedging properties relative to external contract hedges. In this case, the merger would reduce the overall risk of the merged entity relative to the (hedged) stand-alone entities. This in turn would improve the merged entity's ability to pursue profits in the hedging market by responding more aggressively to deviations of futures prices from expected spot prices

3.5 Do not confuse the correlation between infra-marginal trading and liquidity with causation

28. True market liquidity and the level of aggregate trading are, typically, very strongly correlated. That is, typically the more of one in any given market the more of the other. For example, the US Treasury bond market has daily turnover measured in the hundreds of billions of dollars. It is also a very liquid market in the true sense of the term. That is, only small changes in price are required to elicit large changes in aggregate supply and demand – such that even large individual trades do not need to materially raise/lower prices in order to elicit the desired supply/demand for the trade.

29. This correlation between trading activity and liquidity is not purely coincidental. High trading activity is a sign that there are many market participants, many of whom have very large balance sheets, who are constantly monitoring prices and responding with countervailing trades as prices change.

30. However, the amount of trading activity should not be taken as the cause of liquidity. The driver of liquidity is the aggregate willingness of traders to respond to higher/lower prices with more sales/purchasers. Other things equal, this will be correlated with the aggregate turnover of the asset. However, it is perfectly possible to imagine a reduction or rise in the aggregate turnover in a market that is not

baseline holdings of financial contracts will fall dramatically. However, its need to continually trade and optimise its hedge portfolio between 50% and 100% is unchanged. This will be achieved via day-to-day trading in financial markets just as it would have been had the two operations remained standalone. The contribution to market liquidity from the combined entities is the same.

associated with any change in the aggregate willingness of traders to respond to higher/lower prices with more sales/purchasers.

31. For example, imagine that the interest rate environment changed from one with a large amount of uncertainty to one with only minimal levels of uncertainty. In this case, there would be less scope for differences in valuation of US Treasuries between market participants and, consequently, less reason to trade. Aggregate trading in US Treasuries would fall but this would not be associated with a reduction in true liquidity. Indeed, true liquidity would likely increase because, with the same number of traders backed by the same balance sheets, and more commonly shared valuations of the underlying asset, the aggregate response to a change in price (true liquidity) will be larger.

32. There is a clear parallel here with the impact of vertical integration on aggregate trading. Vertical integration will tend to reduce the amount of aggregate trading in contract hedges by virtue of the replacement of some financial contracts with a natural hedge. However, vertical integration will not alter the aggregate level of monitoring of market prices, nor will it obviously alter the sensitivity of market participants' aggregate supply/demand response to changes in price. As already noted, if anything, vertical integration may well raise that sensitivity (if it supplies a superior hedge to financial contracts).

3.6 Common valuations are an important driver of liquidity

33. Assets do not need to be heavily traded to be liquid. By way of example, I might offer to sell bundles of $10,000 in AUD notes on Ebay for $10,000. It is unlikely that I will ever trade that asset at that price – precisely because there is a perfect common understanding of what its value is. There is no scope for differences in valuation and therefore no reason to trade. Yet, the asset is highly liquid. If I were to drop/raise the price by a fraction of a percent, there would be flood of orders/sales.

34. As already noted, liquid assets do, typically, tend to also be heavily traded assets. However, it is important to understand the direction of the causation. Liquid assets are heavily traded because they are liquid. It is not the case that liquid assets are liquid because they are heavily traded. US Treasury bonds are heavily traded in financial markets because the common valuations amongst traders mean that they can fulfil something like the role "money" in the financial system (with the added benefit over actual cash of being interest-bearing). (The valuations are not identical (as in my Ebay example above) such that there will still be scope for disagreements about value and, therefore, scope for trading.)

35. In order for an asset to be liquid, market participants need to have a common valuation technique leading to broadly similar valuations. That is, unlike a piece of art or an individual suburban house, a large number of potential buyers and sellers must share a (broadly) common view of what the asset is worth. There also must be

no material 'inside information' such that the act of buying/selling does not signal that the true valuation of the asset is different to the counterparty's valuation (e.g., the true value of used cars is often inside information to the seller). If there are common valuations then the price of the asset cannot diverge materially from the common valuation without a large number of parties wishing to trade. It is this sensitivity of buyers and sellers to changes in prices that creates a liquid market.

36. Once more, consider the market for US Government Treasury bonds. This market is highly liquid because all potential traders have a more or less common valuation technique applied to the asset. Specifically, the value of a bond is equal to the net present value of expected coupons plus principal. The discount rates that investors use to value the cash-flows on the bond may differ slightly (investors may expect interest rates to change in different ways over the course of the bond's life) and this may give rise to some differences in valuations. However, if a particular trader decided that Treasury bonds were undervalued and wanted to buy $100m, she would only have to offer a tiny fraction above the price that would have prevailed without her order. That is, a tiny fraction increase in price is all that is necessary to bring forward the necessary supply to match her demand (other things equal).

37. There is no obvious reason to believe that vertical integration in the NEM has any effect on NEM participants' distribution of valuation of futures contracts. That is, there is no obvious reason to believe that marginal valuations across participants become less common post vertical integration. It follows that there is no reason to believe that this is a mechanism by which vertical integration would affect hedge market liquidity.

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4 Measurement of liquidity in NEM financial markets

38. It is difficult to measure liquidity directly because it involves a counterfactual. Namely, how did prices change as a result of a trade being initiated relative to the prices that would have prevailed absent the trade?

39. We must, therefore, resort to indirect measures of liquidity such as trading volume and/or quoted bid ask spreads. We report time series for these values in this section and note that there is no apparent reduction in these indirect measures. However, we reiterate that these should not be taken as direct measures of liquidity (sensitivity of price to a change in one party's demand or supply).

40. Indeed, the two measures that we examine tend to move in the same direction – such that high volumes are positively correlated with high bid-ask spreads. Therefore, it is not possible that both are perfectly correlated with true underlying liquidity. If that was the case then high volumes should be associated with low bid-ask spreads. The confounding factor in the data is the level of uncertainty about the future prices in the NEM. When uncertainty is high (such as in 2006-10 (affected by drought, GFC and subsequent 'carbon tax' introduction) and also the 2016 onwards gas shortages) volumes tend to be high as do bid-ask spreads.

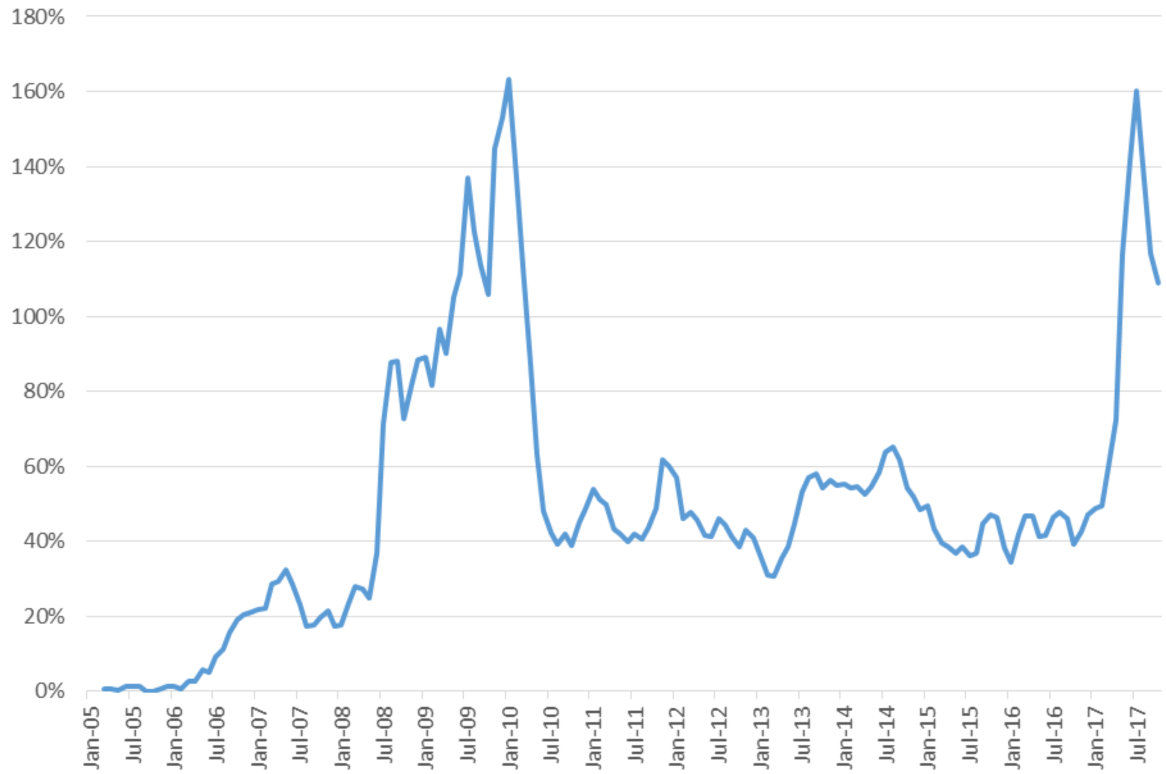
4.1 Volumes

41. Figure 4-1 and Figure 4-2 show the volume of quarterly baseload futures (up to 13 quarters ahead) traded each month as a percentage of:

- Figure 4-1 retail load in the NEM; and
- Figure 4-2 retail load of all retailers that are in excess of their own generation.

42. Baseload futures contracts are the most heavily traded contracts but we also provide data on other contracts in Figure 4-3 below. A three month trailing average of the monthly figures is shown. The percentage reported can be interpreted as the percentage of total demand that is accounted for by baseload futures contracts. If the chart averaged, say, 100% then this would imply that, on average, the quantity of MWh baseload futures contracts traded matched the value of MWh purchased (or, in the case of Figure 4-2, MWh purchased in excess of retailers' own generation).

Figure 4-1: Base load futures trading volume as percentage of total electricity consumption

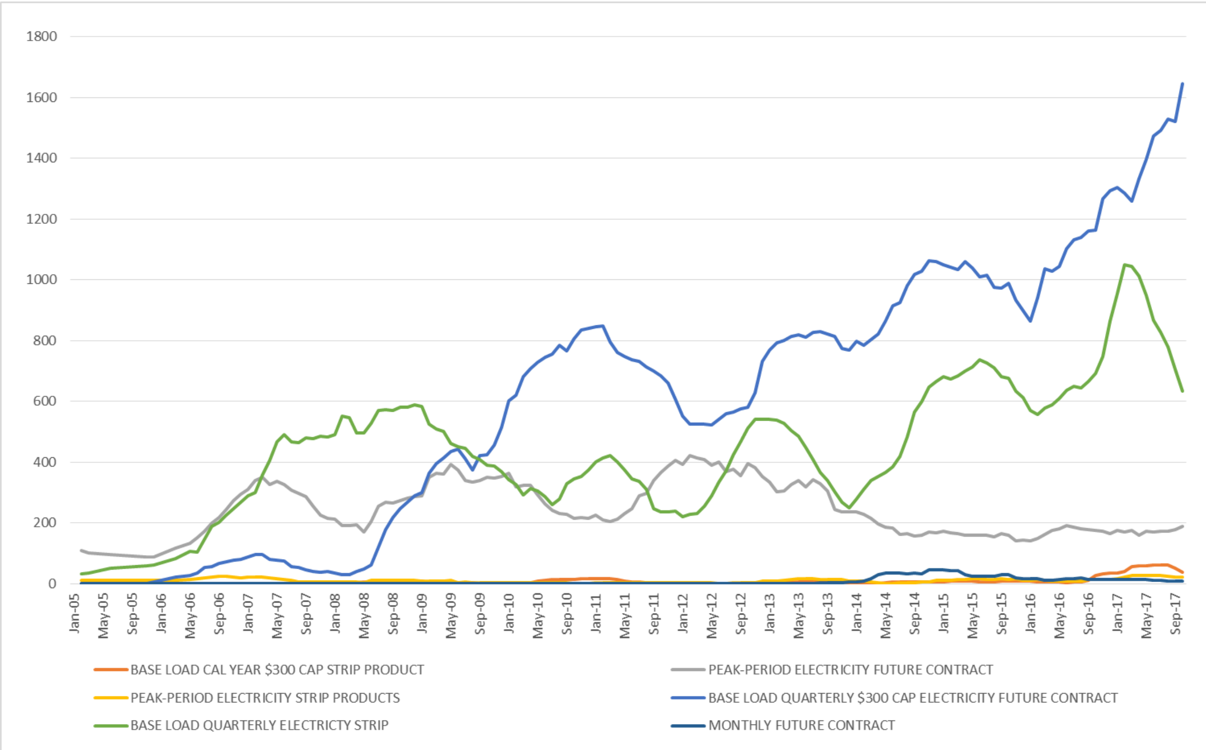


Source: CEG analysis using data from Bloomberg and AEMO

Figure 4-2: Base load futures trading volume as percentage of total retail load in excess of own generation

Source: CEG analysis using data from Bloomberg, AEMO and Origin.

Figure 4-3: Other ASX contract volumes



Source: CEG analysis using data from Bloomberg, AEMO.

43. We do not attempt to express the "other" ASX traded products as a percentage of generation because they are largely made up of option and cap products that are only exercised in certain circumstances. It, therefore, does not make sense to convert these into a MWh value and divide by total MWh consumption.

44. In addition, ASX products only make up a portion of hedging products used by market participants. Alternative hedging contracts include:

- Standardised over the counter (OTC) hedging products; and
- Power purchase agreements and other bespoke agreements between generators and retailers (such as the joint venture announced between Alinta and CS Energy in August 2017);[7] and
- Formal vertical integration via direct ownership.

45. OTC and bespoke products are of unknown volume. For this reason, one should not attempt to gauge from the above charts the percentage of energy that hedging contracts 'cover' because the charts only cover a fraction of those products. Figure 4-2 provides an attempt to adjust for one factor in the above list (formal vertical

7 <http://www.csenergy.com.au/media-(68)-(108)-(318)-Alinta+Energy+and+CS+Energy+help+South+East+Queenslanders+save+on+energy+bills.htm>.

integration). However, this adjustment does not factor in any of the other forms of hedging available and does not deal with the complexities associated with identifying the true level of natural hedge for vertically integrated retailers.

46. What is relevant about these charts is the trend in volumes over time. It can be seen that no downward or upward trend in the volume data for individual products exists. Volumes vary through time depending on the dynamics of the market and uncertainty in the NEM. They have recently been at historically high levels – not seen since 2009/10.

47. These charts clearly demonstrate that when uncertainty is high, volumes tend to be high. The previous peaks in trading were associated with the 2006 drought and the associated effects on hydro marginal costs as well as the global financial crisis and uncertainty around the introduction, and nature of, any carbon tax. The more recent peak is likely associated with changing market dynamics and uncertainty as a result of the gas shortage in eastern Australia.

48. The specific calculations underpinning Figure 4-1 and Figure 4-2 are as follows:

- We first categorise all baseload futures contracts traded in a month into 14 different categories corresponding to quarters between zero and 13 quarters ahead.
- Then for each of these 14 categories we calculate the total NEM MWh that the contracts apply to (multiply contract numbers (each one being for 1 MWh) by the number of hours in the quarter). This is the numerator for that quarter.
- We then divide each of these numerators by their own denominator which is the retail load (Figure 4-1) in that quarter[8] or retail load in excess of own generation (Figure 4-2).[9]
- We then sum all of these fractions and multiply by three. The result is then reported as the percentage volume for the month in which the contracts were traded. We multiply by 3 because the trading data is monthly but the futures contracts traded are quarterly. Thus, it is necessary to multiply by 3 in order to be able to interpret the average percentage charted as the 'average cover' of the contracts to retail load.

8 For quarters that have not yet occurred we have used the most recent matching quarter for which there is data.

9 We use Origin data to make this adjustment.

4.2 Correlation between volume and price movements

49. In an illiquid market we would expect to see large price changes associated with unusual trading volumes. However, there is no evidence of this when we plot trading volumes and prices in the same chart.

Figure 4-4: Volume and price data, baseload futures Q1 2018, VIC

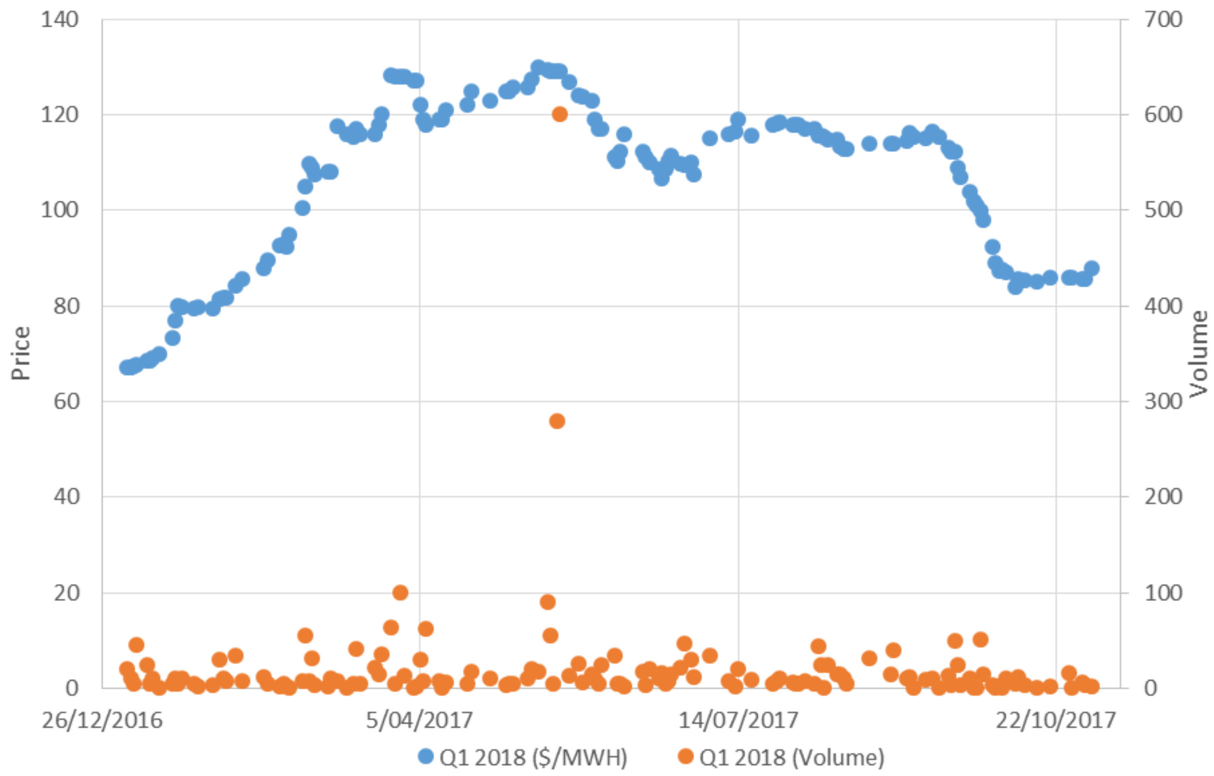


Figure 4-5: Volume and price data, baseload futures Q1 2018, NSW

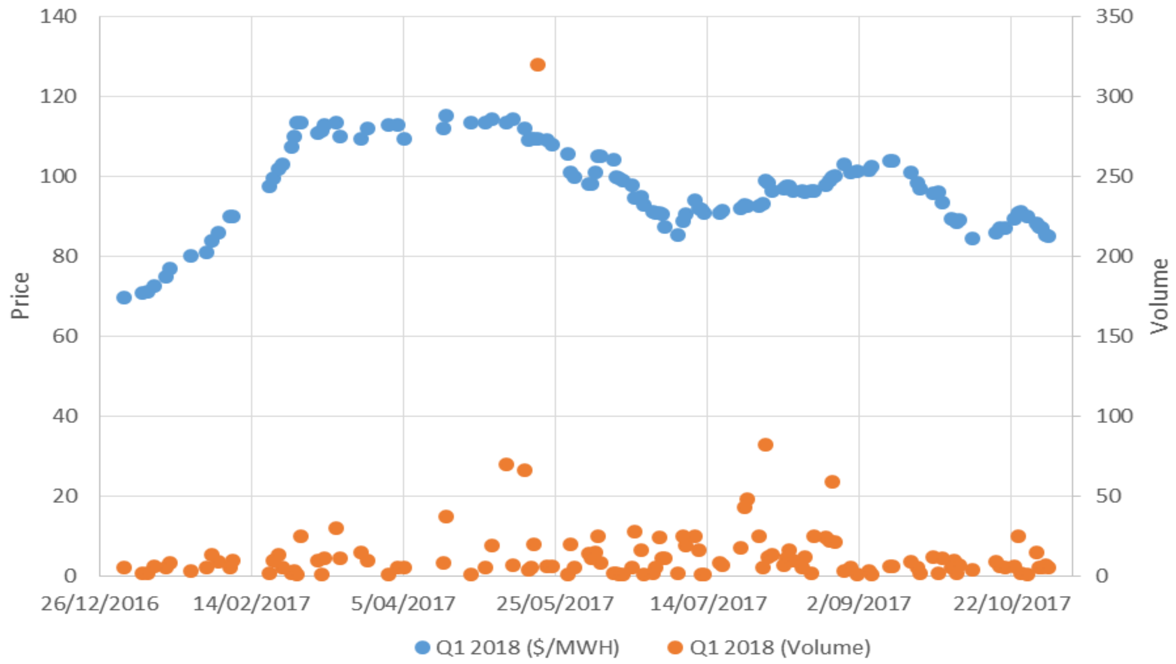


Figure 4-6: Volume and price data, baseload futures Q1 2018, QLD

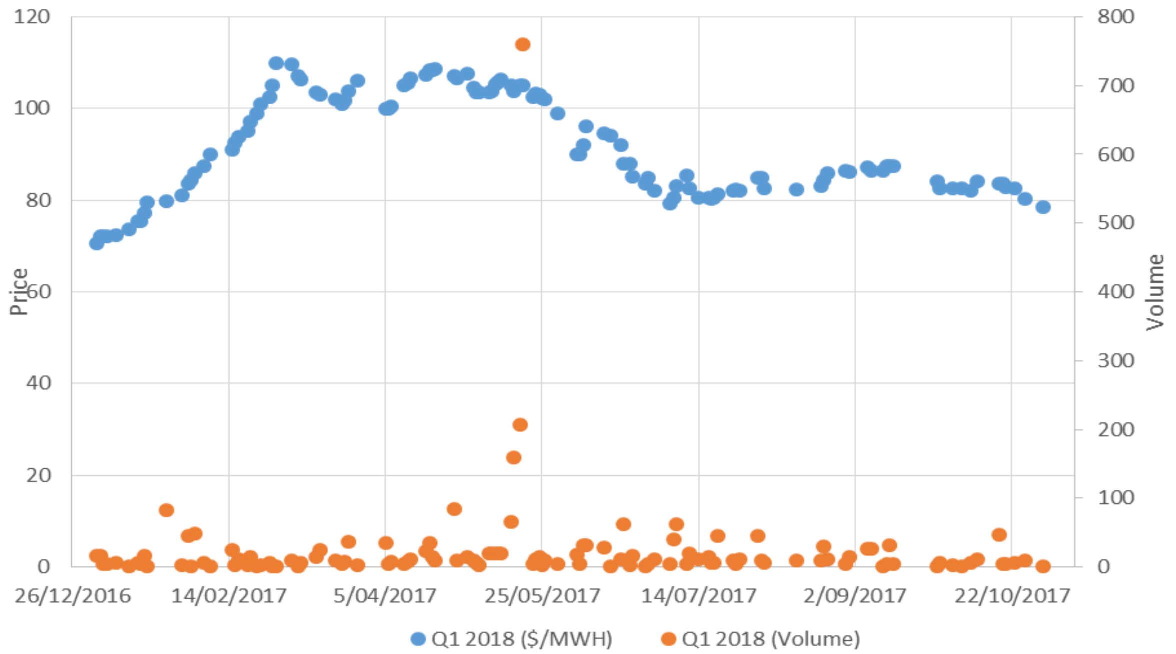
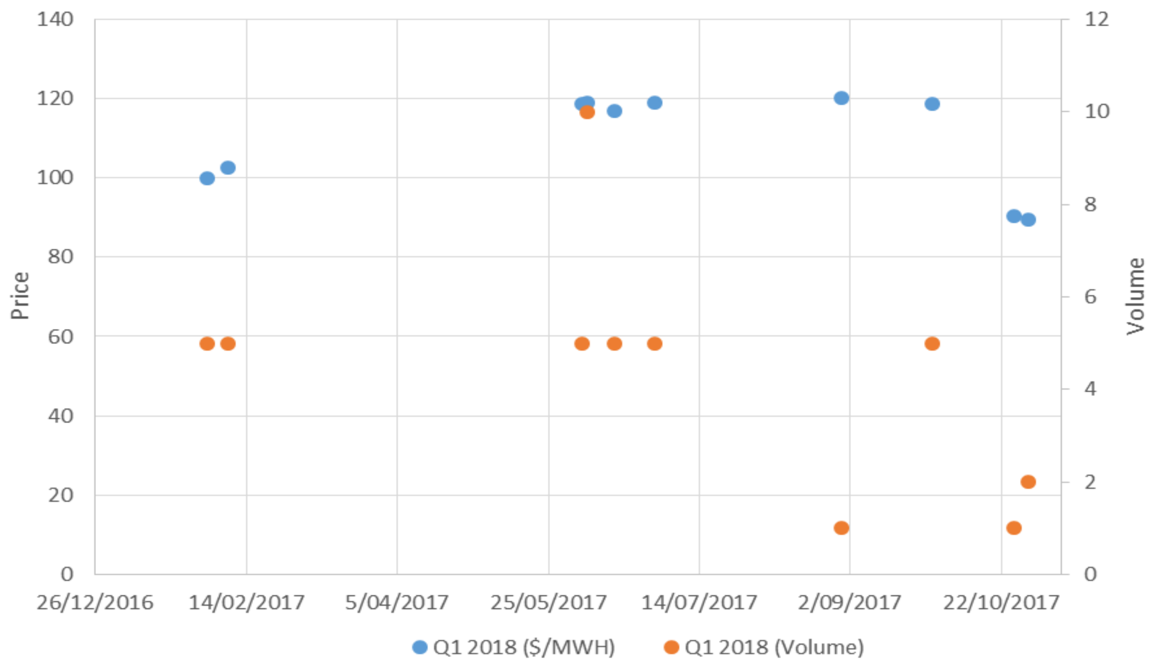


Figure 4-7: Volume and price data, baseload futures Q1 2018, SA



4.3 Bid-ask spreads

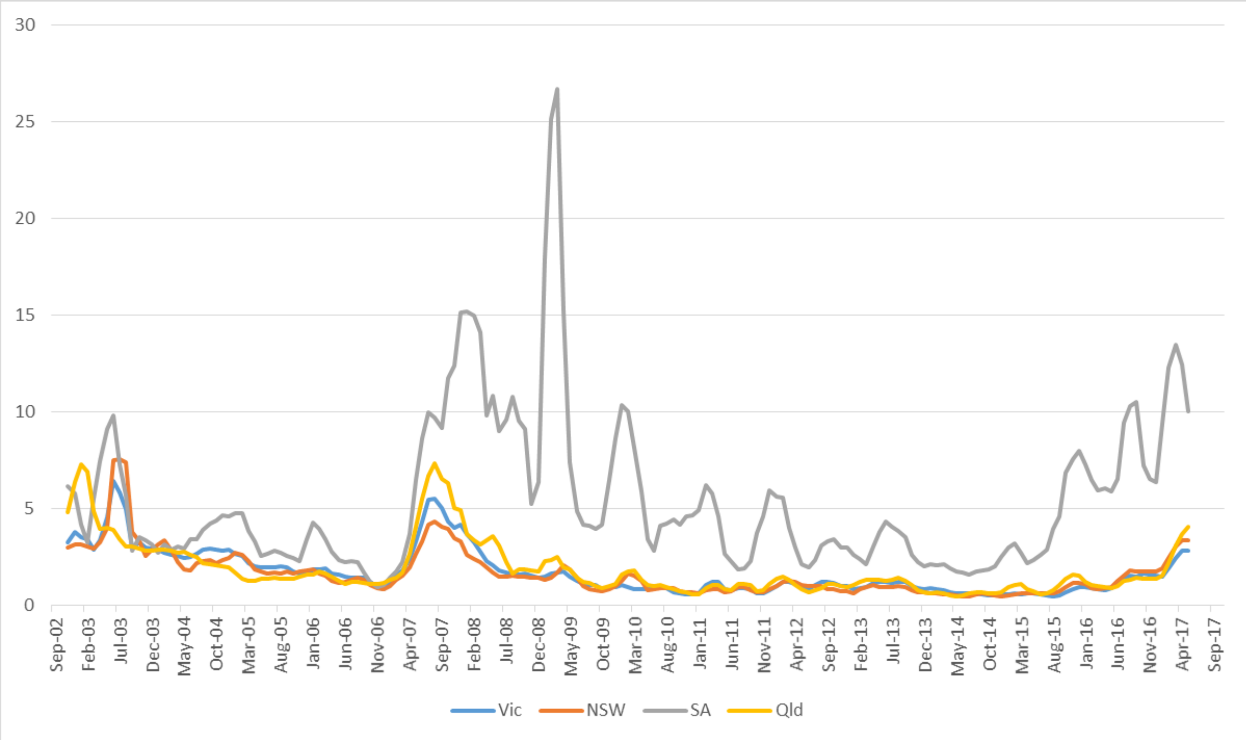
50. Figure 4-8 shows the monthly average of the daily closing bid-ask spread for each state's base load futures from 2005 to March 2017.[10] The spread has hovered around $2-$3 for most of the period for Victoria, NSW and Queensland. However there appear to be three sharp increases in bid-ask spreads for Victoria, NSW and Queensland, with the first increase in early 2003, the second increase in late 2007 and the third increase in 2017. All three increases have been temporary in nature and cannot be explained by changes in vertical integration (which is a long run phenomenon).

51. Bid-ask spreads were initially high in 2003 after the d-cypha SFE electricity futures contracts were first introduced in the Sydney Futures Exchange. They then fell until mid 2007 whereupon bid-ask spreads rose rapidly with uncertainty around the price on carbon and the global financial crisis. Bid-ask spreads subsequently fell and then rapidly increased again in 2017, coinciding with the East Coast gas shortage. This pattern is consistent with the main driver of bid-as spreads being uncertainty about the likely true (actuarially fair) value of a futures contract. There is no obvious effect

10 Data not available after March 2017.

on the bid-ask spread based on the timing in changes in vertical integration from the industry activities mentioned in the ACCC preliminary report.

Figure 4-8: Daily closing bid-ask spread



Source: CEG analysis using Bloomberg data.

4.3.1 South Australia

52. South Australia has both the lowest volume relative to consumption and the highest bid-ask spreads. This has been pronounced since 2007. South Australia has a high level of vertical integration so one might be tempted to infer that vertical integration is the explanation for these observations.

53. However, the level of vertical integration in South Australia is not materially higher than in NSW yet NSW does not have similar metrics to South Australia. Moreover, Queensland has almost no vertical integration but we observe little difference between Queensland and NSW (indeed, Queensland's metrics appear, if anything, less liquid than NSW).

54. Rather than vertical integration, it is more likely that the difference between South Australia and other states is driven by a combination of the fact that South Australia has:

- higher concentration in dispatchable generation than any other state; and

- high levels of uncertainty/volatility in NEM prices due to:
  - high reliance on wind generation; and
  - high levels of concentration (see first dot point).

55. If market power in generation gives rise to hedge contracts being set materially above the fair market price (based on expected spot market prices) then one would expect to see retailers using these products less intensively and substituting to other hedging strategies (such as stronger balance sheets and long term contracts).

4.4 Are liquidity levels in decline?

56. The volume and bid-ask spread data surveyed here does not provide a basis for either concluding that liquidity is falling or that vertical integration has reduced liquidity in NEM financial markets.

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Appendix A

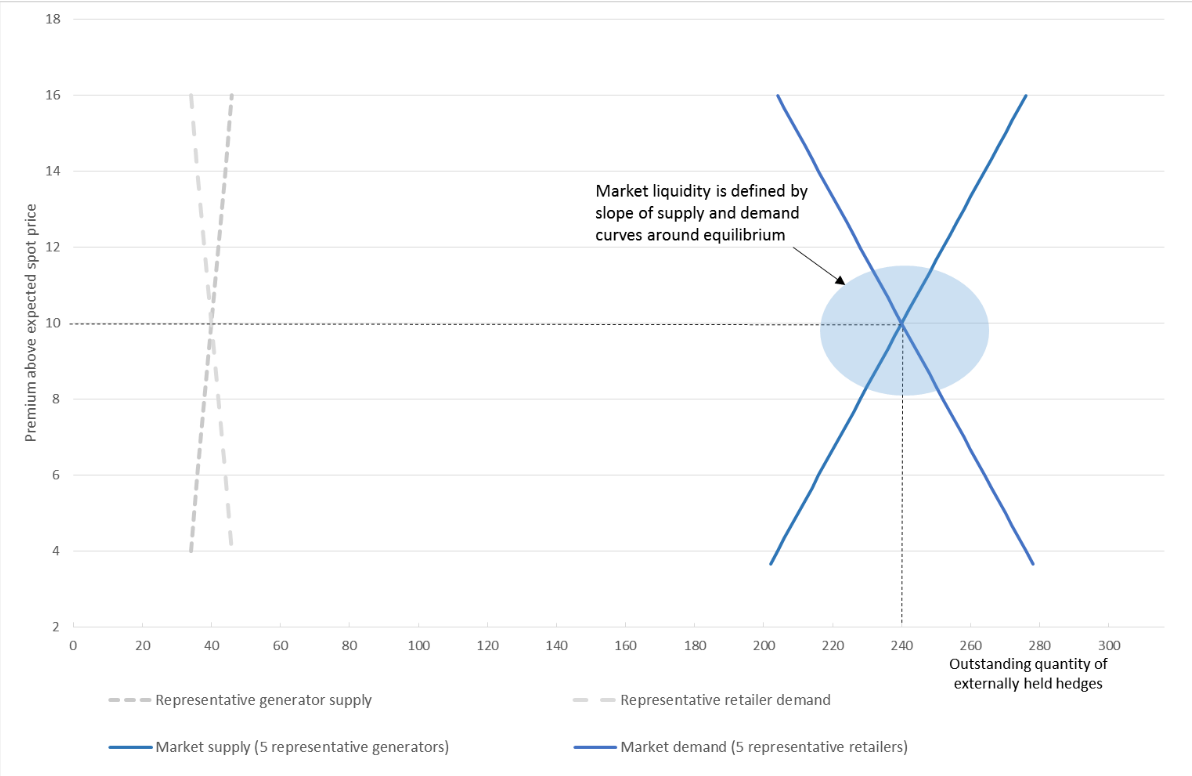
A.1 Market liquidity from individual firm supply and demand responses

57. The market supply and demand curves are simply the (horizontal) sum of individual firm supply and demand curves. For the purpose of illustration, let there be six identical 'representative' generators and retailers. The slope of the market supply and demand curves will be flatter than the individual representative generator supply curve because it represents the cumulative response of all six firms to a change in price. Under these conditions, the market supply and demand curves will:

- be six times further to the right than the representative demand and supply curves; and
- be one sixth of the slopes (six times flatter).

58. This is illustrated in Figure A1 below.

Figure A1: Representative firm and market supply and demand



Source: CEG illustration

59. In the above illustration, the representative firms' supply and demand curves have a constant slope of +1.0 and -1.0 respectively and intersect with the vertical axis (zero supply and zero demand) at prices of -30 and +50 respectively. (Note the scale of the X and Y axis are very different which makes the curves look steeper than they would if the same scale was used.) That is, a generator (retailer) would prefer to have zero hedging if the hedge price was 30 $/MWh below (50 $/MWh above) the expected spot price. (Section A.3 in Appendix A provides a discussion of the practical determinants of supply and demand for hedge contracts by generators and retailers).

60. This is captured by the below equations:

$$Representative\ standalone\ supply = \ Hedge\ premium + 30$$

$$Representative\ standalone\ demand = \ -Hedge\ premium + 50$$

$$Market\ standalone\ supply = \ 6 \times Hedge\ premium + 180$$

$$Market\ standalone\ demand = \ -6 \times Hedge\ premium + 300$$

61. The end result of these assumptions is a market hedge price (where supply equals demand) of 10 $/MWh[11] above the expected spot price (this is true irrespective of the number of representative firms). Each representative firm is counterparty to 40 contracts and, with a market made up of six representative generators and retailers, the equilibrium quantity of hedges outstanding is 240 (six times the outstanding hedges that would be held by the representative generator and retailer).

62. However, what is critical for liquidity is neither the equilibrium price nor the equilibrium quantity. Rather, the liquidity of the market is defined by the slope of the market supply and demand curves. This defines how much the price of a hedge contract can be expected to move in the face of one party seeking to buy or sell (to increase/reduce the number of outstanding hedges to which they are a counterparty). This, in turn, is defined by the slopes of the aggregate supply and demand curves.

63. The slopes of the aggregate supply and demand curves provide the formal measure of the ease with which the market adapts to one party's desire to change their portfolio. All positions in the market must, in aggregate, sum to zero. Therefore, if, say, a retailer wishes to increase the quantity of baseload futures that they hold then other parties must either increase the supply of these (e.g., generators issue more expanding their portfolio or retailers sell more reducing their net portfolio). The slopes of the market supply and demand curves define the price changes necessary in order to bring forth the necessary counterparties to any trader's desired trade.

[11] $Market\ Supply\ = Market\ Demand\ \rightarrow\ 6 \times Hedge\ premium + 180 = -6 \times Hedge\ premium + 300\ \rightarrow\ 12 \times Hedge\ premium = 120\ \rightarrow Hedge\ premium = 10$

64. Specifically, starting in equilibrium a unit increase in price will bring forward counterparties wishing to trade a volume equal to the sum of the (absolute) slopes of the supply and demand curves. In this context, the supply and demand curves are expressed as quantity supplied/demanded as a function of price (as is the case for the equations at paragraph 60) and this is the inverse of the slopes (rise over run) in Figure A1.

$$Liquidity\ is\ proportional\ to:\ abs\left|\frac{d(Demand)}{d(P)}\right| + abs\left|\frac{d(Supply)}{d(P)}\right|$$

65. The intuition behind this measure is simply that markets are more liquid the smaller the increase in price required to bring forth more net supply. Or, equivalently, markets are more liquid the larger the increase in net supply as a result of a unit increase in price. The net supply brought forth is equal to the sum of additional hedges issued by generators plus fewer net hedges held by retailers.

66. In our example, the slope of the market supply (and demand) curve is such that for a unit increase in price (relative to the expected spot price), 6 additional hedges are sold by generators and 6 are sold by retailers. That is, a unit increase in price causes 12 hedge contracts to be available.

$$Liquidity\ is\ proportional\ to:\ abs|-6| + abs|6|$$

$$Liquidity\ is\ proportional\ to:\ 12$$

67. Thus, if, say, a retailer sought to buy 12 additional units of hedging it could expect to have to pay one dollar more than the equilibrium price that would have prevailed absent their trade. Clearly, the higher this number the more liquid is the market (the greater the net increase in supply for a given increase in price and/or the greater the net increase in demand for a given reduction in price).

68. Clearly, the above analysis with linear demand curves and identical representative generators/retailers is a simplification of reality. However, the fundamental point holds in the more complex dynamic real world market. That is, market liquidity is provided by firms adjusting their usage of hedges to any given changes in hedge prices. The more readily firms adjust their usage of hedges to a given change in the price of hedges, the more liquid will be the market.

A.2 Implications of vertical integration

69. A critical question becomes, is there any reason to believe that the vertically integrated entity would, in aggregate, respond differently than would its generation and retail operations if they were standalone?

70. For the reasons set out in this section, there is no reason to believe that this would be the case. The vertically integrated firm has precisely the same incentives to respond to rising futures prices by:

- reducing the amount of generation it buys through futures contracts as would a standalone retailer; and/or
- increasing the amount of generation it sells through futures contracts – just as would the standalone generator.

71. The above conclusions can be shown to hold mathematically. Let us start with the standalone market structure used to illustrate market liquidity in section A.1 above. Then, let us see how market liquidity would be affected if, instead of the six standalone representative generators and retailers (12 firms in total), we merge these firms into 6 'gentailers' – some of whom have retail loads less than generation and some who have more retail loads than generation. For simplicity, let the amount of generation in each representative firm be the same as in the previous example. However, instead of their being six standalone retailers of equal size let each generation firm have a retail arm:

- three of which have load that is only 50% generation; and
- three of which have load that is 150% of generation.

72. Assume that these mergers result in 'perfect' natural hedges. That is, put aside important considerations why perfect natural hedges do not, in reality, exist. With these assumptions made, we have:

- three firms that have 50% of their generation that is not naturally hedged; and
- three firms that have unhedged retail load of the same magnitude (i.e., equivalent to 50% of the generation).

73. That is, there are two sets of three firms with each set being made up of firms that have a representative standalone generator from paragraph 60 plus:

- 50% of a representative standalone (SA) retailer from paragraph 60; or
- 150% of a representative standalone (SA) retailer from paragraph 60.

74. It follows that the new vertically integrated (VI) representative supply and demand curves are:

$$Repr.\ Supply^{VI} = Repr.\ Supply^{SA} - 0.5 \times Repr.\ Demand^{SA}$$

$$Repr.\ \ Demand^{VI} = 1.5 \times Repr.\ Demand^{SA} - Repr.\ Supply^{SA}$$

75. Substituting the equations from paragraph 60 into the above results in the following representative supply and demand curves:

$$Repr.\ Supply^{VI} = 1.5 \times Hedge\ price + 5$$

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$$Repr.\ \ Demand^{VI} = -2.5 \times Hedge\ price + 45$$

76. There are now only 3 firms in each set (as opposed to six in the standalone market structure) so the market supply and demand curves are only 3 times the representative supply and demand curves.

$$Market\ Supply^{VI} = 4.5 \times Hedge\ price + 15$$

$$Market\ Demand^{VI} = -7.5 \times Hedge\ price + 135$$

77. Thus, the market supply of hedges in this example has a lower absolute slope than in the standalone market, but the market demand for hedges has an absolute slope that is higher by an exactly offsetting amount. Consequently, the measure of liquidity defined at paragraph 64 is the same with and without vertical integration. The "with vertical integration" liquidity is as set out below.

$$Liquidity\ is\ proportional\ to\!: \ abs\left|\frac{d(Demand)}{d(P)}\right| + abs\left|\frac{d(Supply)}{d(P)}\right|$$

$$Liquidity\ is\ proportional\ to\!: \ abs|-7.5| + abs|4.5|$$

$$Liquidity\ is\ proportional\ to\!: \ 12$$

78. The without vertical integration liquidity was also 12, as set out at paragraph 66 above.

79. Similarly, when we solve for equilibrium by setting market demand equal to market supply, the equilibrium market price remains at a 10 $/MWh premium to expected spot prices.[12] Thus market price and market liquidity are unchanged. This is because the only effect of vertical integration is that infra-marginal contract hedges have been swapped for infra-marginal natural hedges. The marginal propensities to trade have been unaffected and, thus, price and liquidity are unaffected.

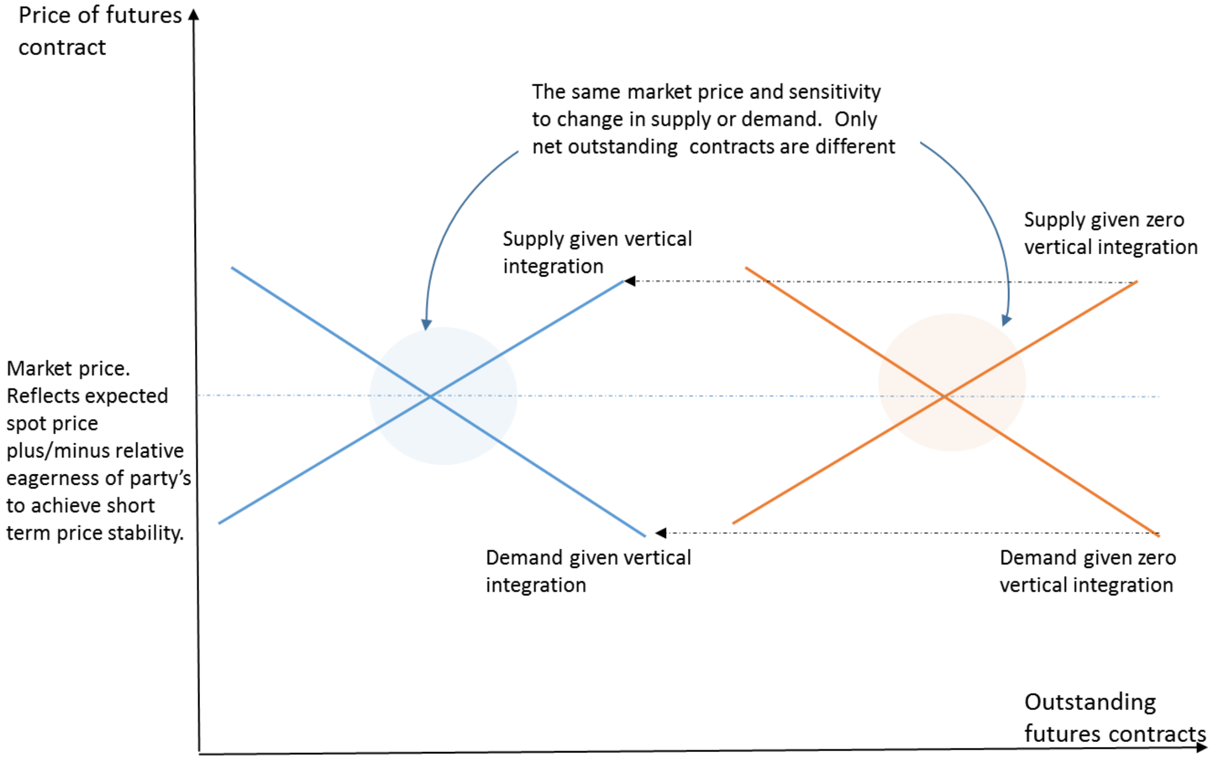
80. At this price the equilibrium outstanding amount of external hedge contracts is 60 (this can be seen by substituting a hedge price of 10 into the equations at 76). This involves a reduction from 240 to 60 outstanding hedge contracts held in equilibrium. It follows from the fact that each firm now holds half as many external hedge contracts on average (consistent with the 50% natural hedge assumption) and there are now half as many independent firms. However, despite the number of outstanding hedge contracts falling to a quarter of the original number, the resulting price and liquidity in the market are unchanged.

81. This is illustrated in the stylised supply and demand diagram at Figure A2 below. This figure illustrates a market for hedging products with and without vertical

12 $Market\ Supply^{VI} = Market\ Demand^{VI} \rightarrow 4.5 \times Hedge\ price + 15 = -7.5 \times Hedge\ price + 135 \rightarrow 12 \times Hedge\ price = 120 \rightarrow Hedge\ price = 10$

integration. The only difference is that, in one case, one or more generation portfolios are combined with one or more retail portfolios.

Figure A2: Illustration of markets with identical liquidity but different size



82. The impact of vertical integration is to reduce the outstanding futures contracts in the market. In the above figure, the reduced need for outstanding financial futures as a result of vertical integration is illustrated by the shift in the market supply and demand curves to the left.

83. However, there is nothing about this leftward shift of demand and supply that alters market liquidity. Market liquidity is driven by the combined slope of the supply and demand curves around equilibrium and there is no reason (at least no obvious reason) that this will be altered. The leftward shift in supply and demand should be thought of as swapping one form of infra-marginal hedging (financial contracts) for another (a natural hedge).[13] This leaves the combined firm's ongoing optimisation,

[13] Something is infra-marginal if it is not the subject of optimisation. In this context, imagine that a generator, given its balance sheet, would always sell 50% of its output on the hedging market irrespective of the price in the hedging market. Similarly, imagine that a retailer, given its balance sheet, would always buy 50% of its energy in financial markets. The firms will optimise hedging above these levels as market conditins change (e.g., sometimes choosing 90% and sometimes choosing 60%) but never below. The 50%

using financial contracts, to its hedge position unchanged. This ongoing optimisation (adjustment to market prices/conditions) is what delivers financial market liquidity. A vertically integrated firm has the same needs and desires to adjust to changes in circumstances/prices as its constituent parts. Therefore, a vertically integrated firm will make the same contribution to market liquidity as its constituent parts would have if they were standalone operations.

A.3 What determines each firm's supply/demand response?

84. The above discussion starts from the position that each generator/retailer has a supply/demand curve for hedges. This section discusses the likely determinants of what these supply and demand curves actually look like. In order to understand the source of liquidity in financial hedge markets (or, indeed, any market) it is necessary to have a model of how parties value hedge contracts at the margin and how that marginal valuation changes with the number of hedge contracts sold/bought.

85. Imagine that a market participant always valued hedge contracts based on the expected future spot price (i.e., there was no positive or negative risk premium built into their valuation). Under this scenario, if the participant perceived that the actuarially expected average baseload spot prices in a relevant quarter was going to average 60 $/MWh then the participant would:

- buy hedges whenever the hedge price was above 60 $/MWh; and
- sell hedges whenever the hedge price was above 60 $/MWh.

86. However, in reality, most individual market participant will not be prepared to buy or sell an unlimited amount of hedge contracts – even if their perception of future spot prices is different to the market price of hedges. The reason is that market participants are limited by the size of their balance sheets as to how much exposure to future spot prices they can incur before also being exposed to the potential for financial distress.

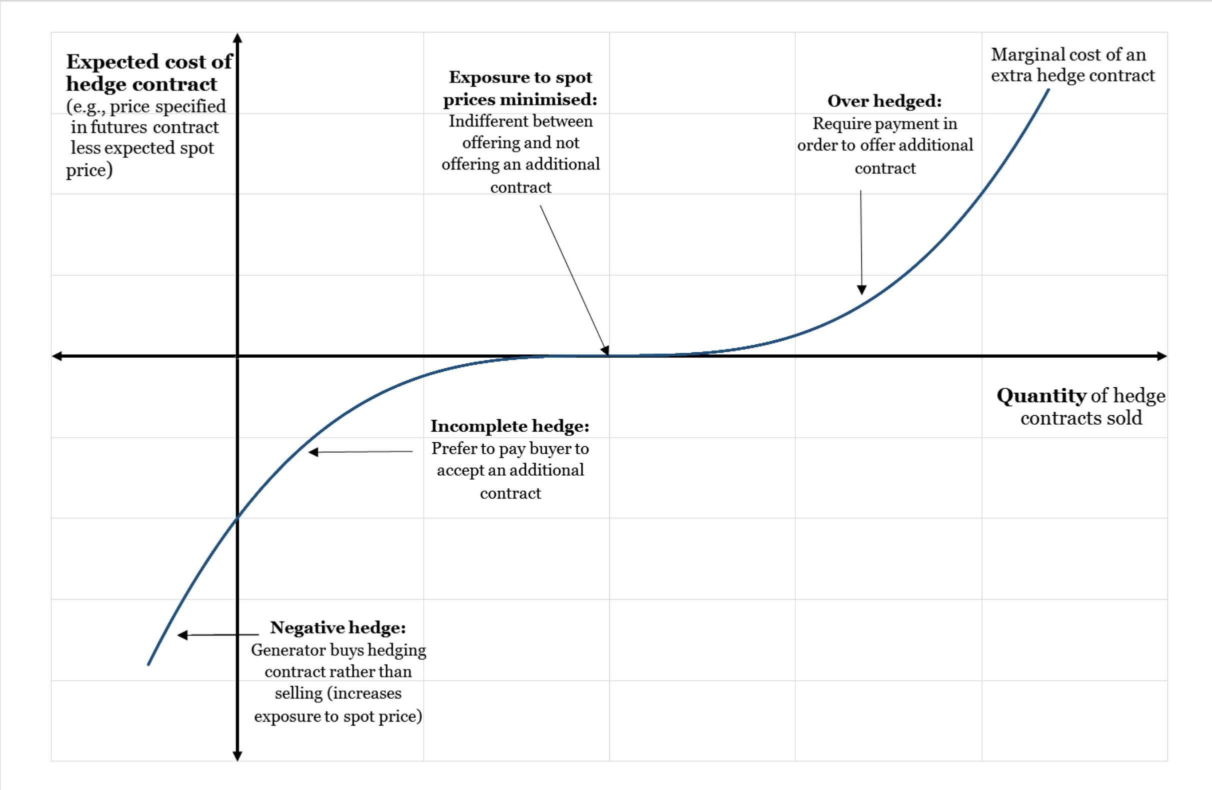
87. One can see this for a generator in Figure below. This figure plots the marginal cost to a generator of selling a hedge contract against the number of hedge contracts sold.

hedging position is a 'set and forget' position. It contributes nothing to market liquidity or price discovery because trading in these volumes is not sensitive to market conditions.

Now imagine that these two firms merge. Let the merger create a level of 'natural hedge' of, say 60%. The combined entity no longer needs to source is baseline 50% hedge position in financial markets. Its baseline holdings of financial contracts will fall dramatically. However, its need to continually trade and optimise its hedge portfolio between 50% and 100% is unchanged. This will be achieved via day-to-day trading in financial markets just as it would have been had the two operations remained standalone. The contribution to market liquidity from the combined entities is the same.

88. The vertical axis is a measure of 'price' of a hedge contract defined as the difference between the price specified in the futures contract and the actuarially fair (i.e., probability weighted) expected spot price. Thus, if the contract price was 60 $/MWh and the expected future spot price was 50 $/MWh then the 'price' of the hedge contract would be 10 $/MWh. At this price, the expectation is that the generator will be paid 10 $/MWh by the retailer). Similarly, if the contract price was 60 $/MWh and the expected future spot price was 70 $MWh then the 'price' to the seller would be negative 10 $/MWh (the expectation would be that the retailer will be paid by the generator).

Figure A3: Illustration of marginal cost curve for an individual generator



Source: CEG

89. Initially, with zero hedge contracts sold, the generator has a strongly negative marginal cost for the first contracts sold. That is, the generator would be happy to sell contracts at a negative premium to the expected spot price. This reflects the fact that with zero hedging the generator is 100% exposed to the spot price. Unless they have a very strong balance sheet,[14] having zero hedging will mean that there is a significant exposure to very low spot prices, causing negative cash-flows and

14 That is, access to liquid assets in excess of the potential negative equity cash-flows that could result from 100% exposure to the spot price for an extended period.

triggering financial distress. Consequently, the generator would, if necessary, be prepared to sell hedge contracts at a discount to the expected spot price in order to reduce the risk of financial distress and, therefore, reduce the expected costs of financial distress.

90. However, as the number of hedge contracts issued increases, the probability of lower spot prices causing future financial distress is reduced. Consequently, the generator places a lower marginal valuation on selling each incremental hedge contract. Thus, the marginal value/cost of issuing a new hedge contract rises (becomes less negative).

91. At some point, the sale of incremental hedge contracts will cease to provide any further hedging benefit. That is, the sale of one more contract will not reduce (or increase) the volatility of cash-flows. This is the point at which exposure to spot prices is minimised. (This can be thought of as a position that is 'fully hedged' – although this is potentially misleading given that a true complete hedge is not possible due to outages and other factors.) At this point, the marginal cost of issuing another contract is zero and the generator is indifferent between issuing and not issuing the contract.

92. In order to be convinced to sell additional contracts beyond the quantity that results in a 'fully hedged' position, the generator must expect to be paid a premium relative to the expected spot price. This is because, beyond this point, selling additional hedge contracts increases the generator's exposure to spot prices. That is, the generators becomes 'over hedged' in that the additional liabilities under hedge contracts, in the event of high spot prices, exceed the additional spot market revenues it receives. Consequently, selling additional hedge contracts increase the probability of future financial distress and, therefore, increases the expected costs of financial distress.

93. It follows from the above analysis that the marginal valuation/cost curve for the generator's supply of hedging contracts is directly derived as:

- The change in the probability of reaching various levels of financial distress as a result of selling the contract; multiplied by
- The costs associated with the levels of financial distress.

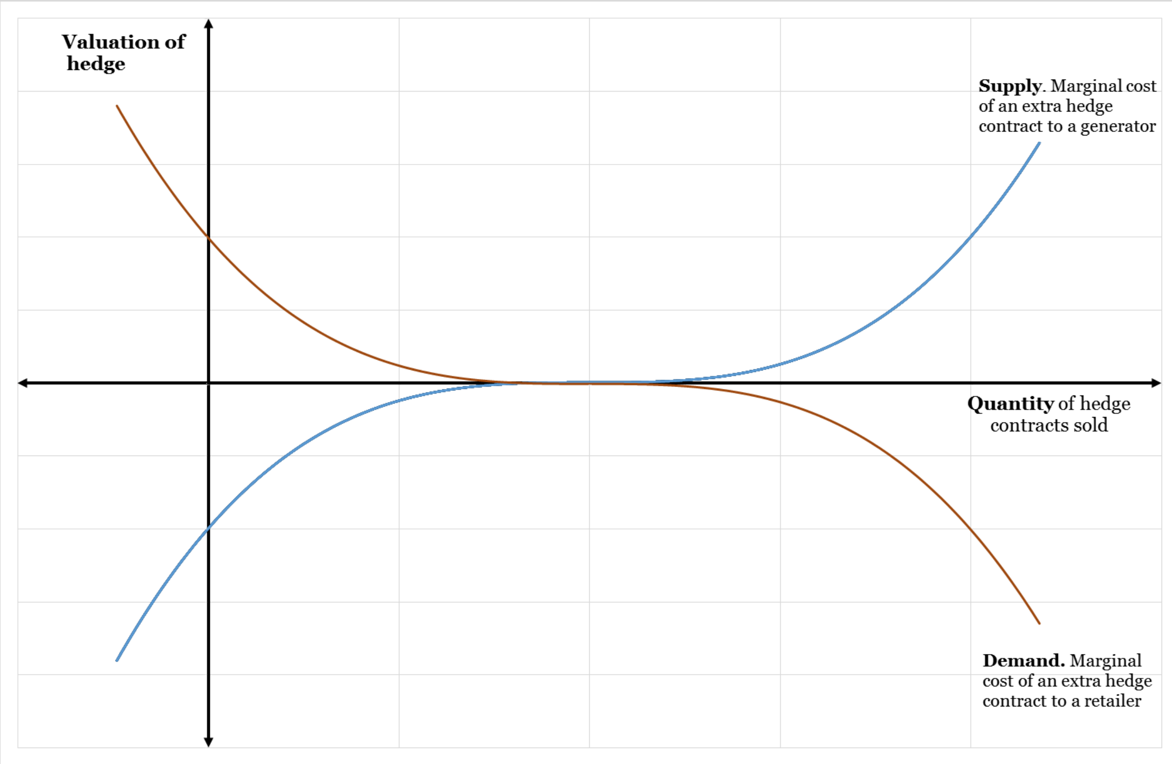
94. The marginal valuation/cost curve has been drawn with a 'sideways S' shape to reflect the fact that, beyond a given point, the costs of financial distress increase rapidly with incremental losses in cash-flow. The middle of the curve is drawn relatively 'flat' to reflect the fact that, starting with even a modest balance sheet, some additional spot market exposure does not materially increase the probability of high cost financial distress. However, as one moves away from the middle of the curve, the probability attached to high cost financial distress increases more and more rapidly – which is why the slope of the marginal cost curve is steeper the further away from the 'fully hedged' middle position on the curve.

95. The entirety of the above logic applies in reverse to retailers. That is, absent an extremely strong balance sheet, a retailer with zero hedging will place a very high

valuation (willingness to pay) for a marginal hedge product. However, this marginal valuation will decline as the number of hedge contracts bought increases. Eventually, the marginal valuation will turn negative as additional hedge contracts actually increase exposure to spot price volatility rather than reducing it.

96. On the assumption that a retailer was otherwise identical/symmetrical to a generator (e.g., had the same balance sheet, the same load and profile etc. and also faced the same costs in the event of financial distress), then the retailer's marginal valuation curve would simply be the "mirror image" of the generator's marginal valuation curve. This scenario is illustrated in Figure A4 below.

Figure A4: Generator and retailer marginal valuation curves



Source: CEG

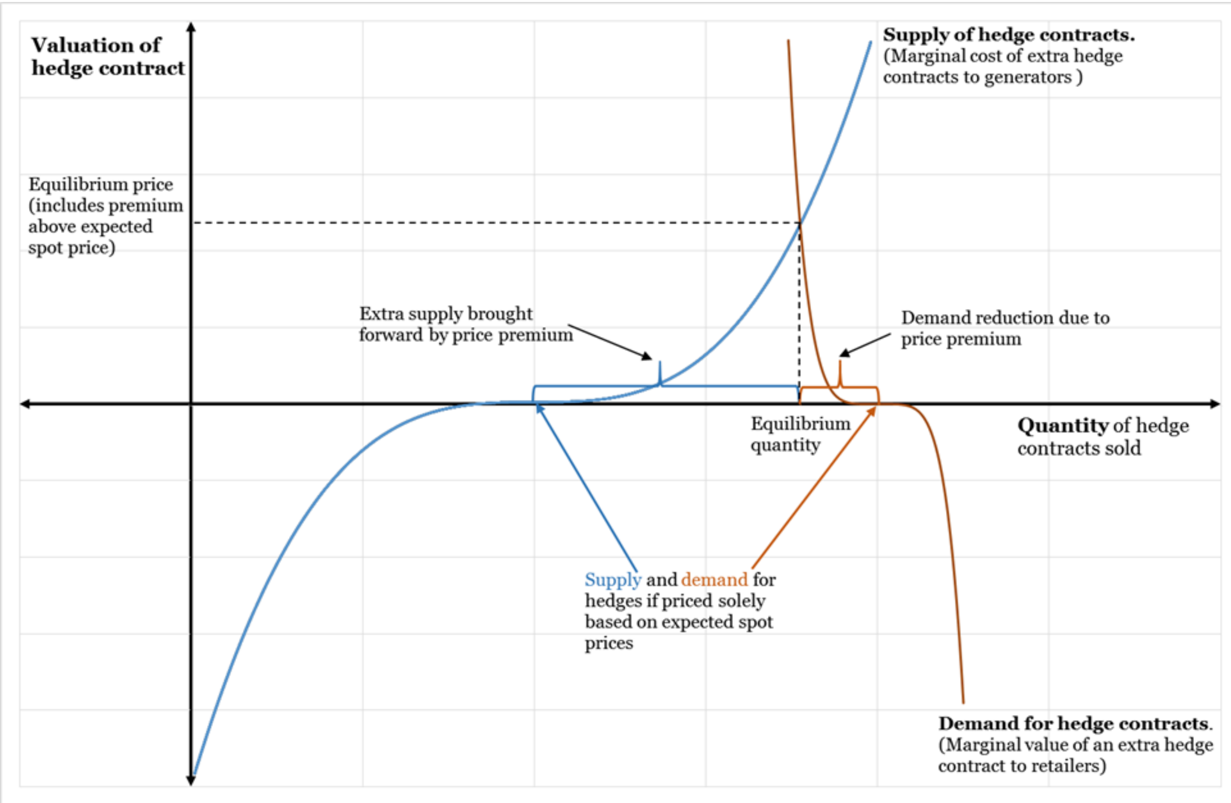
97. This diagram is useful in that one can easily see hedge market dynamics operating. Imagine that the above cost curves were typical of all generators and retailers. In which case, before any hedge contracts were sold, retailers would have a high valuation on hedge contracts and generators would have a very low valuation. Consequently, market forces would 'kick in' and generators would sell hedge contracts to retailers. However, the more contracts sold the lower the gap between valuations would become. Eventually, enough contracts would have been sold for the gap in valuations to fall to zero, at which point equilibrium is achieved.

98. As drawn in Figure A4, based on the assumption of symmetry between retailers and generators, equilibrium is achieved at a 'price' of zero (where the contract price equals the expected spot price). However, other equilibrium outcomes are possible and, indeed, likely.

99. For example, assume that retailers typically chose to have a lower level of exposure to spot prices than generators. This may, in turn, reflect a decision to enter with a relatively weaker balance sheet than generators and also that the downside for retailers of not being hedged during extreme high price events is worse than the downside for generators of not being hedged during low priced events. (Noting that it is downside events that trigger financial distress and the associated costs of that financial distress.)

100. The net result is that the marginal valuation curve for retailers will be shifted to the right relative to that of generators. This is illustrated in Figure below for a 'typical generator' and a 'typical retailer'.

Figure A5: Asymmetrical generator and retailer marginal valuations



Source: CEG illustration.

101. Given the assumptions underpinning this scenario, if hedge contract prices just reflected expected spot prices then there would be excess demand. This would cause a premium to be built into the price of hedge contracts with the effect that:

- generators would increase their supply of hedging products by becoming 'over hedged' and accepting more exposure to the spot price (the price premium providing the incentive to do so); and
- retailers would reduce their demand for hedging products by becoming under hedged (i.e., accepting more exposure to the spot price rather than be fully hedged using contracts that include a positive hedge premium).

102. In this equilibrium, retailers are effectively shifting some of their risk to generators. Generators are better able to bear this risk given their stronger balance sheets, and the hedge market provides a means for retailers to, in effect, make use of generators' balance sheets. However, retailers must pay generators for this privilege – with the premium in hedge contracts relative to expected spot prices effectively a 'rental charge' for using generators' balance sheets (convincing generators to over hedge in aggregate).

103. It appears to be well accepted that hedge prices in the NEM typically are struck to include a premium on the expected spot price. If this is correct, then the market is characterised by something like Figure A5.