# Impact of late rebidding on the contract market

Final report to the Australian Energy Market Commission

11 September 2015

EY

Building a better working world

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# Investigation of the impact of late rebidding on the contract market

Dear Stuart,

In accordance with our Panel contract with the AEMC dated 14 January 2011 and our letter of appointment dated 15 August 2015 (collectively the Engagement Agreement), Ernst & Young (we or EY) has been engaged by the Australian Energy Market Commission (the AEMC, you or the Client) to conduct an investigation of the impact of late rebidding on the contract market in the National Electricity Market (the Services).

## Purpose of our Report and restrictions of its use

The results of our work, including the assumptions and qualifications made in preparing the Report, are set out in the enclosed report (Report). You should read the Report in its entirety. A reference to the Report includes any part of the Report. We understand that this Report will be used by the AEMC for the purpose of informing the AEMC's assessment of the Bidding in Good Faith rule change proposal (the Purpose). We understand that it may also be posted on the AEMC website.

This Report was prepared on the specific instructions of the AEMC for the Purpose and should not be used or relied upon for any other purpose.

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Scope and nature of our work

The scope and nature of our work, including the basis and limitations, are detailed in our Engagement Agreement and in this Report.

This investigation considers a number of propositions developed by the AEMC and EY in relation to the relationship between late rebidding the contract markets. These propositions do not necessarily represent the full range of possible relationships and it is acknowledged that other relationships may exist.

Limitations

This investigation was completed based on information available in the public domain. Such contracting information is limited to the public futures exchange operated by ASX Energy (previously d-cypha Trade). The publicly traded contract market represents only a fraction of the total volume and value of contracts traded.

This Final Report was completed on 11 September 2015. Our Report does not take into consideration any other event or circumstances arising after the date it was first completed.

This letter should be read in conjunction with our detailed Report, which is attached.

Thank you for the opportunity to work on this project for you. Should you wish to discuss any aspect of this Report, please do not hesitate to contact Ben Vanderwaal on 07 3227 1414 or Stuart Bright on 02 8295 6483.

Yours sincerely

Ben Vanderwaal
Executive Director

Stuart Bright
Partner

# Executive Summary

To support the AEMC's continued analysis related to the bidding in good faith provisions, EY has been engaged to provide both a theoretical and a statistical based assessment of the impact of late rebidding on contract markets. This analysis builds upon work previously conducted by ROAM Consulting (now acquired by EY) that considered the impact of late rebidding on wholesale markets.

Both the previous ROAM Consulting work and the current analysis have shown that late rebidding has the potential to create "price spikes". This is not to say that late rebidding in general results in an increase or decrease in annual average wholesale market prices. Rather, that there has been historical price volatility that has been in part caused by strategic late rebidding, particularly in Queensland.

Given that late rebidding has the potential to cause price volatility, there is also the potential for late rebidding to increase the price of electricity market futures contracts. The price of these contracts reflects in part, the market's expectation of the level of price volatility that will occur in the future. It is likely that this expectation is partially informed by historical observations of price volatility. Therefore, where additional price volatility has occurred due to strategic late rebidding, it is probable that this resulted in higher prices than would otherwise have occurred in the contract market.

Statistical analysis has shown that there are strong, consistent relationships between observed levels of price volatility that occur and the subsequent increase or decrease in the price of electricity futures contracts. These relationships are mostly strongly observed at the quarterly level. In the short-term, relationships between contract price movements and market prices and rebidding activity are more sporadic and inconsistent.

As a result of this analysis, we have found that late rebidding may have a material impact on contract markets. We have used two possible approaches to estimate the possible historical impact of strategic late rebidding in Queensland. The two approaches are documented in Section 5.1.1 and 5.1.2. These methodologies provide estimates of the impact of strategic late rebidding on futures contract market payouts and the movements in the prices electricity contracts in future periods. The following tables shows the estimated increases in the payout/price of the publicly traded futures cap products that have been attributed to strategic late rebidding. The tables show the response in the futures contract market for the current quarter, the next quarter and the same quarter in 12 months from the observed behaviour for Methodology A and Methodology B respectively.

Reduction in cap contract prices – Methodology A ($)

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.8 | 0.4 | 0.3 |
| 2013 | 1 | 2.2 | 0.5 | 0.4 |
| 2014 | 1 | 11.2 | 2.4 | 2.2 |
| 2014 | 4 | 9.0 | 1.9 | 1.7 |
| 2015 | 1 | 8.8 | 1.8 | 1.7 |

Reduction in cap contract prices – Methodology B ($)

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.7 | 0.4 | 0.3 |
| 2013 | 1 | 1.2 | 0.3 | 0.2 |
| 2014 | 1 | 11.1 | 2.3 | 2.1 |
| 2014 | 4 | 8.3 | 1.7 | 1.6 |
| 2015 | 1 | 7.3 | 1.5 | 1.4 |

The assumed reductions in contract prices have been applied to the quantity of contracts held at the start of each quarter using the 'open interest' quantity supplied by ASX Energy. This results in an estimate of the total magnitude of the effect of strategic late rebidding on publicly traded contract markets. The magnitude of the impact on cap and base futures contracts, using Methodology A, are provided in the following tables.

Magnitude of impact from removal of strategic late rebidding ($m) – cap futures– Methodology A

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.1 | 0.3 | 0.1 |
| 2013 | 1 | 3.4 | 0.2 | 0.2 |
| 2014 | 1 | 7.9 | 0.9 | 0.8 |
| 2014 | 4 | 11.0 | 2.5 | 0.3 |
| 2015 | 1 | 17.2 | 1.2 | 1.8 |

Magnitude of impact from removal of strategic late rebidding ($m) – base futures– Methodology A

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 5.0 | 1.1 | 0.2 |
| 2013 | 1 | 6.3 | 1.1 | 0.4 |
| 2014 | 1 | 30.8 | 7.3 | 2.7 |
| 2014 | 4 | 36.4 | 7.1 | 4.0 |
| 2015 | 1 | 54.4 | 8.5 | 2.6 |

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# 1. Introduction

## 1.1 Background

In December 2013, the South Australian government submitted a rule change to the AEMC in relation to the bidding in good faith provisions in the National Electricity Rules (the Rules). The rule change proposes to change the provisions such that generators would be required to demonstrate what material circumstances have changed as the basis for rebids. The rule change further proposes to enforce that rebids are submitted to reflect changes in those material circumstances as soon as reasonably practicable.

The AEMC has made a draft rule change that attempts to address the issues raised in the initial rule request. The amendments to the Rules include:

- Replacing the bidding in good faith requirement with a prohibition against making false or misleading offers
- Obligating participants not to mislead the market by requiring generators to submit rebids as soon as practicable
- Introducing additional reporting requirements for generators that submit rebid offers close to the dispatch period

As part of the original consultation on the rule change request, ROAM Consulting (now acquired by EY) was engaged to undertake quantitative analysis on rebidding activity by generators in the NEM. The objective of the analysis was to understand the nature of rebidding activity in the NEM. This also involved analysis to identify and understand any significant relationships between the frequency, timing and nature of rebidding and market variables such as demand, high pool prices, pre-dispatch price forecasts, etc. This work was published with the release of the AEMC Options Paper in December 2014.

The key findings of that analysis related to the relationships between late rebidding and pool price spikes. Our analysis found that there was strong evidence of a relationship between late rebidding and high pool prices in Queensland in 2014, and to a lesser extent South Australia in 2013. The analysis also showed that high pool prices forecast in pre-dispatch often have a strong relationship with generators responding by adding additional capacity into the market at low prices.

The AEMC is now seeking to understand the impact of late rebidding on the prices and traded volumes in electricity futures contract markets.

## 1.2 Scope of Work

The AEMC has requested EY to provide both a theoretical and a statistical based assessment of the impact of late rebidding on contract markets. The scope of work is divided into three stages.

*Stage 1: Theoretical impact of late rebidding behaviour in the NEM*
This stage considers the theoretical impact of late rebidding on contract markets. This takes into account how late rebidding affects the wholesale market, and how these wholesale impacts may translate to movements in the price of contracts.

*Stage 2: Statistical investigation*
EY has utilised our database of historical bid data to investigate the potential statistically significant relationships between late rebidding and contract market prices and traded volumes. The relationships between wholesale market outcomes and futures contract price movements and traded volumes are used as the basis for this analysis.

The statistical analysis uses data between 1 January 2007 and 30 June 2015 – this extends the time range that was used in the ROAM Consulting analysis of the impact of late rebidding on the wholesale market.

*Stage 3: Assessment of materiality*
Using the outcomes of Stage 1 and 2 described above, EY presents an assessment of the materiality of late rebidding in electricity contract markets.

## 1.3 Structure of this Report

This report is structured as follows:

- Section 2 outlines the data sources used in this analysis
- Section 3 provides a theoretical assessment of the impact of late rebidding on contract markets
- Section 4 details the results of statistical analysis of the impact of late rebidding and wholesale market price volatility on the market for futures contracts
- Section 5 summarises the analysis and provides an assessment of the materiality of the impact of late rebidding on futures contract markets

# 2. Data sources

## 2.1 Contract market data

EY has sourced contract market data from the publicly traded ASX Energy futures exchange. This data provides the daily data for each contract market type. Although this dataset provides data for a range of contracts, EY has focused on the following types of contract:

- Quarterly base futures
- Quarterly cap futures

We have not considered quarterly peak futures as these contracts have generally less liquidity than the base futures and represent a subset of the base futures contract.

The key pieces of information for each contract type used in the statistical analysis are the:

- Settlement prices
- Traded volumes

EY has processed the contract market data to investigate a range of relationships, particularly related to the time or lag between wholesale market outcomes and contract market outcomes. In particular, we have focused on considering the impact of late rebidding or wholesale prices on contract price movements and traded volumes over the current trading day[1] and over the next week.

The contract data described above provides a single daily observation for each variable (e.g. settlement price) for each trading day. This daily contract data is used to determine the potential relationships that exist within each quarter.

EY has also aggregated the daily data to the quarterly level. This is used to analyse whether the wholesale market conditions and trading behaviour for each quarter is related to the movements in contract prices over the entire quarter.

## 2.2 Bidding and market data

EY has used, and extended, the bidding data that was developed by ROAM Consulting in analysing the impact of late rebidding in wholesale markets. This data has been aggregated to the contract trading day level, allowing for the opening hours of the electricity contract markets. As a result, each daily output reflects the bidding behavior of generators within each region since the close of the previous contract market trading day. For example, on Monday, this will account for the bidding behavior since the close of the contract market on the previous Friday.

A similar approach was used to aggregate wholesale market price data to the contract market trading day and quarterly level. The key price metrics considered include:

- Average regional pool price
- Number of price spikes (dispatch interval prices >$300/MWh)
- Total dollar value of prices during spikes
- Total dollar value of prices during spikes in the 6$^{th}$ dispatch interval

The bidding metrics considered include:

- Average number of rebids submitted within the last dispatch interval (last five minutes)

[1] Trading days refer to days in which electricity contracts are traded, i.e. weekdays, excluding some public holidays.

- Average number of rebids within the last dispatch interval that represent a movement of capacity to prices above $300/MWh
    - As per both of the above – limited to price spike periods

A more detailed explanation of how bidding data was collected, aggregated and classified can be found in the ROAM Consulting report available on the AEMC website.[2]

[2] http://www.aemc.gov.au/getattachment/387f3a8d-c29c-408f-808c-7cc6a6087d46/Analysis-of-rebidding-activity-in-the-NEM-%E2%80%93-ROAM-C.aspx

# 3. Stage 1: Theoretical impact of late rebidding on contract markets in the NEM

## 3.1 Introduction

As part of the consultation on the original rule change request, a number of participants highlighted the importance of contract markets in managing market risks associated with price volatility. However, a number of submissions also proposed that the importance of the contract market exacerbates issues associated with price volatility that results from late rebidding. Late rebidding has the potential to impact both the price of contracts and also the level of liquidity in contract markets.

The following discussion is broadly separated into the impact of late rebidding during the current period and on the expectation of future contract values.

## 3.2 Impact of late rebidding on current contract period outcomes

Contracts are able to be traded during the current contract period. For example, a Q1 2014 Base Futures contract can be traded up to its expiry at the end of March 2014. Clearly the value of the contract during the quarter is in part reflective of the actual outcomes during the quarter and also reflective of the expectation of wholesale prices in the remainder of the quarter.

For example, if in January 2013, sufficient price volatility occurred in Queensland such that the payout for Q1 caps already exceeded $18, i.e. if prices remained below $300 at all times for the remainder of the quarter, then cap contracts would have paid $18. At the end of January, cap contracts were valued at over $30. This value reflected an expectation of an additional $12 of cap payout for the remainder of the quarter – this would have equated to approximately 30 trading intervals at $2,000/MWh; approximately the outcome where the price in one dispatch interval is at or near the Market Price Cap (MPC). Ultimately there was very little volatility in February and March and the final cap payout was $21.

This example demonstrates that wholesale market outcomes have a direct pass-through effect to the value of contracts in the current period. Therefore, the potential for late rebidding to cause price volatility may directly impact the “locked in” payouts for cap contracts and/or contribute to the expectation of average prices that drive the value of swap contracts.

The occurrence of price volatility in and of itself does not necessarily increase the value of contracts for that period. The value of contracts at the start of the quarter/year reflects a market expectation of market prices and/or price volatility for the whole contract period. If volatility does occur, but the resulting overall level of volatility is below market expectations for the whole period, then the price of contracts may decrease over that period.

For example, in Q1 2014 there were a number of periods of price volatility in Queensland that have been linked to late rebidding. This resulted in a payout of cap contracts for the quarter of $12. However, this represented a decrease in the value of cap contracts over the quarter. The value of cap contracts at 1 January 2014 of $15 reflected that the market expectation of price volatility during the quarter exceeded that which occurred.

Therefore, although actual pricing outcomes are a key driver of contracts within their term, it is how these pricing outcomes compare to market expectations that drive the movement in contract values over time.

This section has focused on the impact of price volatility on the contract payout component of contract value within the current contract period. The other component of contract value is the expectation of future outcomes. Clearly, the cause of historical price outcomes may influence this expectation. However, the cause of actual price outcomes is irrelevant in how it impacts the contract

payout component of contract value. Therefore, for this component, price volatility resulting from late rebidding is comparable to the same level of price volatility caused by supply-demand conditions, extreme weather, transmission outages etc.

## 3.3 Impact of late rebidding on expectation of future outcomes

As discussed above, the second component of contract value is the expectation of future wholesale prices of participants in the contract market. For contracts not yet within their term, the entirety of the value of the contract is attributable to expectations of future outcomes. It should be noted that some participants may offer to buy/sell contracts at higher/lower prices than their market expectations. For example, a participant may choose to buy contracts above their expectation of the expected payout of the contract to maintain market risk below a certain threshold. That is, other factors such as the risk policies of organizations exposed to the energy market may influence the nature of trading observations, separate from pure wholesale market expectations.

There has been considerable discussion relating to the ability of late rebidding to result in price volatility. The ROAM Consulting report demonstrated that in Queensland in 2014 and South Australia in 2013, there was a strong statistical relationship between high pool price outcomes and the incidence of late rebidding. The objective of this report is not to reexamine the impact of late rebidding in the wholesale market. It has been shown that late rebidding has the potential to result in price volatility; this is not to say that late rebidding necessarily increases prices. However, the focus of this report will be to examine how the high pool prices that may be caused by late rebidding affect prices and trading in the contract market.

The value of contracts attributable to the expectation of future wholesale prices is affected by a range of factors such as a view of the underlying supply-demand conditions within each region, weather projections, expectations of plant availability, the possibility of the introduction/removal of carbon pricing, etc. Participant behavior is also a key driver of this expectation. Participant behavior includes, but is not limited to, the late rebidding that is the subject of the rule change proposal.

In part, the expectation of future wholesale prices is informed by observations of actual market prices that have occurred under certain conditions. Price volatility that has occurred due to late rebidding is one such factor. There is potentially a difference between how price volatility that occurs due to late rebidding impacts on the expectation of future wholesale prices compared to price volatility that is due to extreme temperatures, generator and/or transmission outages, etc.

Price volatility that occurs due to extreme temperatures for example, does not necessarily increase the expectation of future price volatility. The market expects that when temperatures are at very high levels that price volatility could result from a shortage of supply, capacity deratings at generators and on transmission elements, etc. If the market behaved in a way that was not outside expectation in response to the high temperature event, then it is unlikely that there should be a material change in the market's expectation of future price volatility. The occurrence of extreme temperatures does not necessarily alter the expectation of future extreme temperature events. Clearly there may be some reaction in the futures markets. For example, if participants had been unprepared to manage the risks in their wholesale position, the extreme weather event may increase their appetite for risk mitigation products such as electricity futures contracts. The critical point is that expectations of future price volatility that may result from high temperatures or other events will arguably continue to be driven by an understanding of the fundamental supply-demand dynamics within each region.

On the other hand, price volatility that occurs from late rebidding may be removed from any underlying supply-demand driver. A number of submissions have asserted that late rebidding causes price volatility that is divorced from the fundamentals of supply and demand, occurring at times in which there is significant surplus supply. Forecasting price volatility that results from late rebidding is likely to be significantly more difficult given that the key drivers are behavioral, as well as being potentially related to the confidential contracting positions of portfolios within each region. Therefore, this places an increased reliance on observed historical outcomes in building an expectation of future wholesale market prices.

The proposition thus becomes, it is possible that price volatility linked to late rebidding compared to price volatility related to underlying supply-demand conditions will have a greater impact on expectations of future wholesale prices and therefore on the value of electricity contracts. However, this may also be influenced by myriad other factors. Price volatility may not be related to late rebidding but may still reflect a behavioral impact, such as a willingness for generator portfolios to withhold capacity. This volatility provides information to the market and therefore guides expectations of future pricing outcomes.

Furthermore, the above discussion highlighted that there may also be a linkage between late rebidding and the contracting position of generation portfolios that engage in such behavior. This indicates that there is the potential for significant information asymmetry in contract markets as intermediaries and participants looking to hedge wholesale risk trade with counterparties who have the potential to influence contract payouts and who have superior knowledge about the likely payouts of the contracts being traded. It is not the purpose of this report to comment on the materiality of this issue. However, it is noted that this information asymmetry has the potential to reduce the liquidity of the contract markets.

# 4. Stage 2: Statistical investigation of the impact of late rebidding on contract markets

## 4.1 Introduction

The objective of Stage 1 was to outline the theory behind the potential for late rebidding to impact on electricity contract markets. The purpose of Stage 2 is to test these linkages using statistical analysis.

This analysis is broadly categorized into quarterly and daily observations. The intention of the two categories is to consider the impact of late rebidding and price volatility on contract markets at two levels.

The quarterly analysis considers whether the wholesale market prices and bidding activity that characterises a quarter results in a material impact on the price movement of contracts over that quarter. In analysing the initial outcomes of the study it was found that outlier results from 2007 and 2008[3] were heavily influencing results. We have therefore excluded these years from the aggregated quarterly dataset.

The daily analysis considers the impact of wholesale prices and bidding activity *within* quarters. This analysis is therefore relevant for much shorter timeframes than the quarterly analysis. Our analysis considers whether wholesale market prices and/or bidding activity affects contract price movements and traded volumes during that trading day or over the next week.

As a result, determining whether a relationship exists between two sets of observations is always based on a comparison within the quarter. For example, in considering whether price spikes impact the price of cap contracts in the next quarter, the daily analysis effectively compares the movements in contract prices on days where there was price volatility compared to days when there was not price volatility.[4]

This daily analysis considers the impact of wholesale market events and late rebidding on contract price movements and trading volumes over the:

- Current trading day
- Next week

These two timeframes consider both the immediate pass through of wholesale market events into the contract market and a more delayed reaction as information is processed by market participants and contract market positions are adjusted.

Given the focus of this analysis on late rebidding, and in particular the potential to cause price volatility, we have generally focused on cap contracts, which are more representative of the market's expectation of price volatility than base future contracts. Base futures prices are more heavily influenced by other factors, for example, carbon pricing. Some results are presented for both types of contracts.

The symbols and colours used to illustrate the results of the statistical analysis are provided in Table 1. Where relationships are found to have a level of significance above 10%, these are described as having no relationship. A grey square indicates that there is insufficient data to develop a relationship. This generally results from a lack of price volatility and/or a lack of movement in contract prices over the relevant period (particularly in the earlier years of the study).

[3] In some regions in 2007 and 2008 there were very large movements in contract prices with relatively low traded volumes.

[4] This is a simplification of the process, as the magnitude of price volatility is also considered.

Table 1: Results key

| Inference | Symbol | Direction | Significance Level |
|---|---|---|---|
| Mildly significant | | Positive | 10% |
| Moderately significant | | Positive | 5% |
| Highly significant | | Positive | 1% |
| Not significant | | - | - |
| Insufficient data | | - | - |
| Mildly significant | | Negative | 10% |
| Moderately significant | | Negative | 5% |
| Highly significant | | Negative | 1% |

## 4.2 Limitations

There are a number of limitations in this analysis:

- The contract market data supplied by ASX Energy provides information on contract prices and traded volumes for the publicly traded market only. This represents only a portion of the contracting that occurs in the Australian electricity sector. The 2014 Australian Financial Markets Report[5] estimates that approximately 60% of contracting occurs through the ASX. The remainder occurs through OTC negotiations. This lack of data may impact the accuracy of the inferences drawn from considering the relationships between contract market outcomes and wholesale market and late rebidding outcomes.

- The analysis is also impacted by the limitations described in Section 7.3 of the ROAM Consulting report related to the interpretation of bidding data. This section describes the limitations with using regional bidding data where all rebids are equally weighted and that the relationships are evidence of correlation, rather than causation. Statistical analysis cannot accurately classify whether a price spike was caused by late rebidding. Rather, the analysis suggests that price spikes were generally associated with periods of late rebidding, where that relationship was found to be significant.

- Contract price movements may reflect a variety of factors related to the expectation of future wholesale outcomes. For example, the expectation of carbon pricing, and the expectation of the removal of carbon pricing during the period being examined had a significant impact on future contract prices. Similarly, the announcement of a generation investments, generation retirements, etc. if not known to the market could also impact future expectations of wholesale prices. This analysis does not explicitly consider the range of possible other factors influencing contract price movements. This may therefore cloud the analysis of the impact of late rebidding on contract prices.

## 4.3 Results – Impact of price volatility on contract prices

The ROAM Consulting analysis showed that at times, late rebidding has been closely related to periods of price volatility, particularly recently in Queensland and South Australia. The potential for late rebidding to result in price spikes has also been demonstrated through analysis of particular instances of price volatility in the market. It is therefore reasonable to consider that given late rebidding has the ability to cause price volatility, a consideration of the impact of price volatility (no matter the cause) on the contract market is crucial to inform this analysis.

It has also been shown that late rebidding does not necessarily increase wholesale market prices, given that at times late rebidding can both cause and prevent high pool prices. However, when late

[5] Available at http://www.afma.com.au/data/AFMR

rebidding does occur with the objective of, and/or the potential to cause price volatility, this may result in flow on effects to the contract market.

### 4.3.1 Contracts for current quarter

Section 3.2 detailed the theoretical impact of price volatility on contract prices for the current quarter, i.e. price volatility that occurs during the contract period. The quarterly analysis supports this theoretical impact with strong, positive statistical relationships found between the level of price volatility and increases in the prices of both cap and base futures contracts during the quarter. This is shown in Table 2.

Table 2: Impact of price spikes on current quarter contract prices - Quarterly

| Contract Type | QLD | NSW | VIC | SA |
|---|---|---|---|---|
| Base | ↗ | ↗ | ↗ | ↗ |
| Cap | ↗ | ↗ | ↗ | ↗ |

Although the relationship at the quarterly level is consistently strong and positive for all regions, the relationships at the daily level are more sporadic. In New South Wales and Victoria in particular, there is no consistent relationship between days with high price volatility and contract price movements, during current trading day or over the next week.

However, there is some evidence of a consistent, positive relationship in both Queensland and South Australia. In particular, there is relatively strong evidence of a positive relationship between daily price volatility and the movement of cap contract prices during that trading day. Table 3 shows that particularly observable in recent years in Queensland. This indicates that price volatility is often immediately passed through to the value of cap contracts for the current quarter.

Table 3: Impact of price spikes on cap contract prices – Current trading day – Queensland

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | ↗ | ↗ | | ↗ | ↗ | | ↗ | ↗ | ↗ |
| Q2 | ↗ | | | ↗ | | | ↗ | ↗ | |
| Q3 | ↘ | | | | ↗ | | ↗ | | |
| Q4 | | | ↗ | ↗ | ↗ | | ↗ | ↗ | |

Table 4 shows that in South Australia, where a relationship exists between price volatility and cap contract movements that this relationship is generally positive. However, there are a number of quarters which indicate that a negative relationship exists.

Table 4: Impact of price spikes on cap contract prices – Current trading day – South Australia

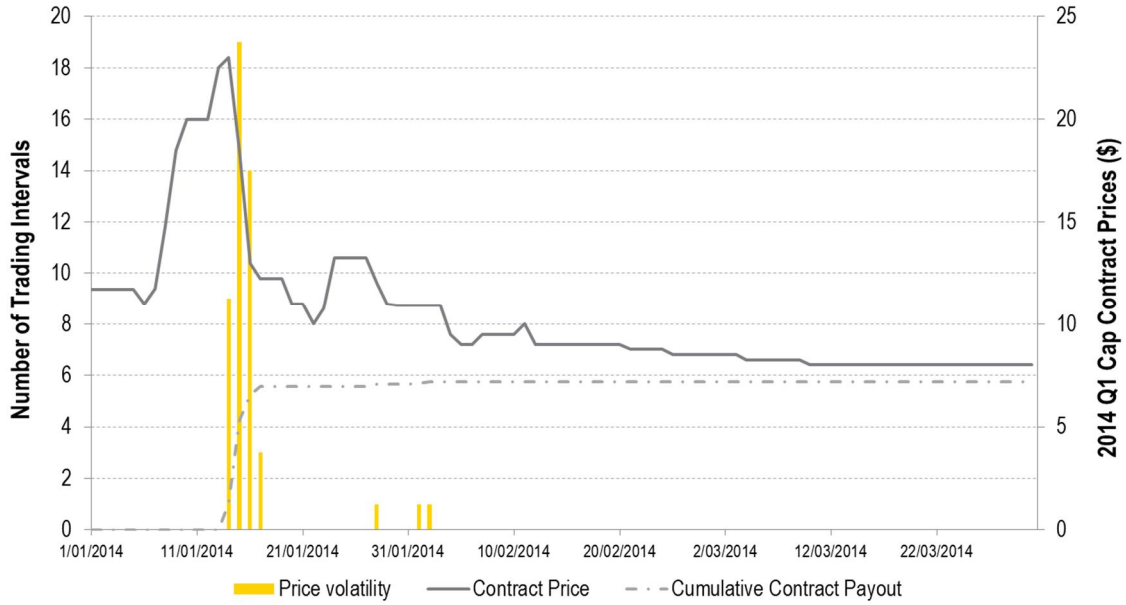
| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | ↗ | | | ↘ | ↘ |
| Q2 | | | | | | | ↗ | | ↘ |
| Q3 | | ↗ | | ↗ | ↗ | ↗ | | ↗ | |
| Q4 | | | ↗ | | | | ↗ | | |

For example, in Q1 2014, there is a strong, negative relationship. Figure 1 shows the price volatility that occurred during the quarter compared to the value of Q1 2014 cap contracts. Leading up to the period of price volatility between the 14th and 17th of January, cap contract prices increase significantly. It is probable that this was the result of an expectation of future price volatility, although as previously mentioned, other factors can drive contracting behaviour. However, when price volatility did occur, cap contracts rapidly dropped back to their original level.

This highlights the critical importance of expectations in considering the impact of the wholesale market on the contract market. Although price volatility occurred, therefore locking in some payment under the cap contracts, this volatility clearly did not meet the market's expectations given

the conditions that were prevailing during this period. The figure clearly demonstrates why a negative statistical relationship was found to exist in this quarter. This does not however, mean that cap contract prices would have been lower had the price volatility not occurred. Rather, this demonstrates that in considering the impact of price volatility on contract markets it is necessary to consider the market's expectations.

Figure 1: South Australia Q1 2014




A comparison between the impacts of price volatility on contract price movements during the current trading day compared to over the next week suggests that the market for current quarter contracts rapidly adjusts to reflect price volatility in the market. In general, the relationship with current day contract price movements is more consistently positive and more statistically significant. The impact of wholesale market events over the next week is likely clouded by additional information such as wholesale market activity in the following days.

## Contracts for future quarters

This section considers whether the occurrence of price volatility affects the prices for future contracts by increasing the market's expectation of future price volatility. In considering future impacts we have determined the existence of relationships between price volatility and contract prices for the next quarter's contracts and for the current quarter of the following year.

At the quarterly level, there is considerable evidence that price volatility results in an increase in contract prices for future contracts. Table 5 and Table 6 illustrate the relationships between price volatility and contract prices for the next quarter and for the current quarter next year respectively. These results show that this relationship is often significant, and where significant is always positive.

Table 5: Impact of price spikes on next quarter contract prices - Quarterly

| Contract Type | QLD | NSW | VIC | SA |
|---|---|---|---|---|
| Base | ↗ | ↗ | | ↗ |
| Cap | ↗ | ↗ | | ↗ |

Table 6: Impact of price spikes on current quarter next year contract prices - Quarterly

| Contract Type | QLD | NSW | VIC | SA |
|---|---|---|---|---|
| Base | ↗ | | ↗ | ↗ |
| Cap | ↗ | ↗ | ↗ | ↗ |

This analysis takes into account the level of volatility within each quarter. A strong relationship indicates that when the relative level of volatility was high that the price of future contracts increased.

Figure 2 demonstrates the relationship between price volatility and the price movements for future contracts during Q1s. This figure illustrates that where price volatility is relatively low that the prices of contracts for both the next quarter and for the current quarter next year generally decrease. However, with the exception of the outlier in 2009, the magnitudes of the price movements for future cap contracts are shown here to be relatively low.

Figure 2: Queensland quarterly contract price movements vs volatility – Q1

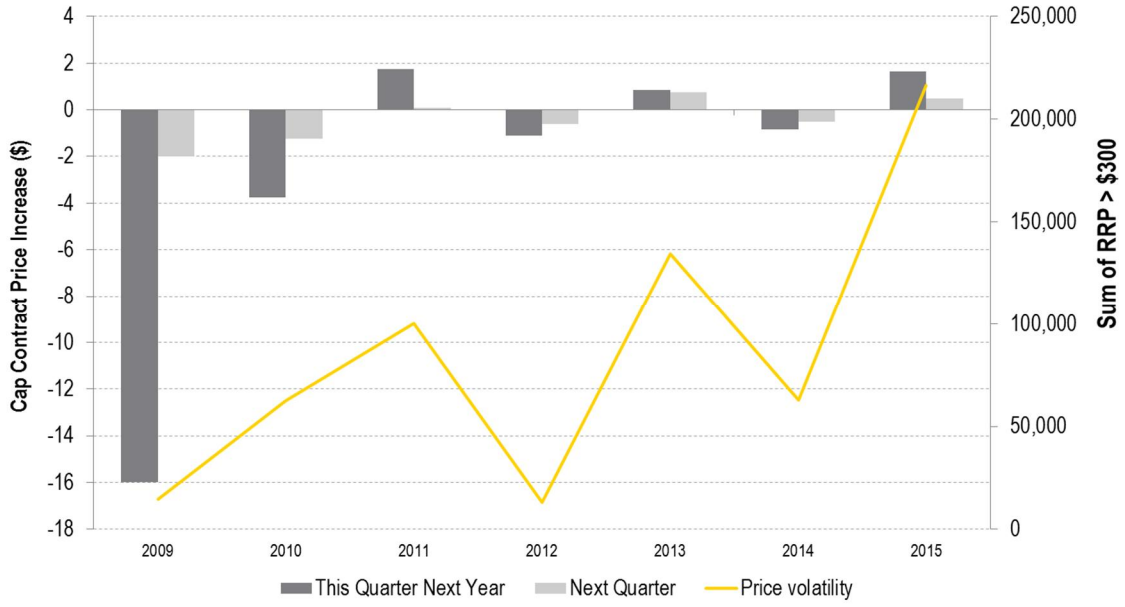



Figure 3 and Figure 4 show the movements in cap contract prices for the next quarter and for the current quarter next year respectively, across all mainland regions. These show that the price of future contracts have at times increased and decreased substantially, particularly for cap contracts in the next quarter. Many of these movements can be attributed to higher or lower levels of price volatility in that quarter, and contribute to the significant relationships described above.

For the next quarter contracts, the majority of the significant movements occur in Q4. This suggests that observations in Q4 influence the expectation of volatility for the subsequent Q1. For contracts next year, the largest movements tend to occur in Q1, indicating that observed price volatility in Q1 at least in part informs an expectation of price volatility for Q1 in the following year.

Figure 3: Cap contract price movements – Next quarter

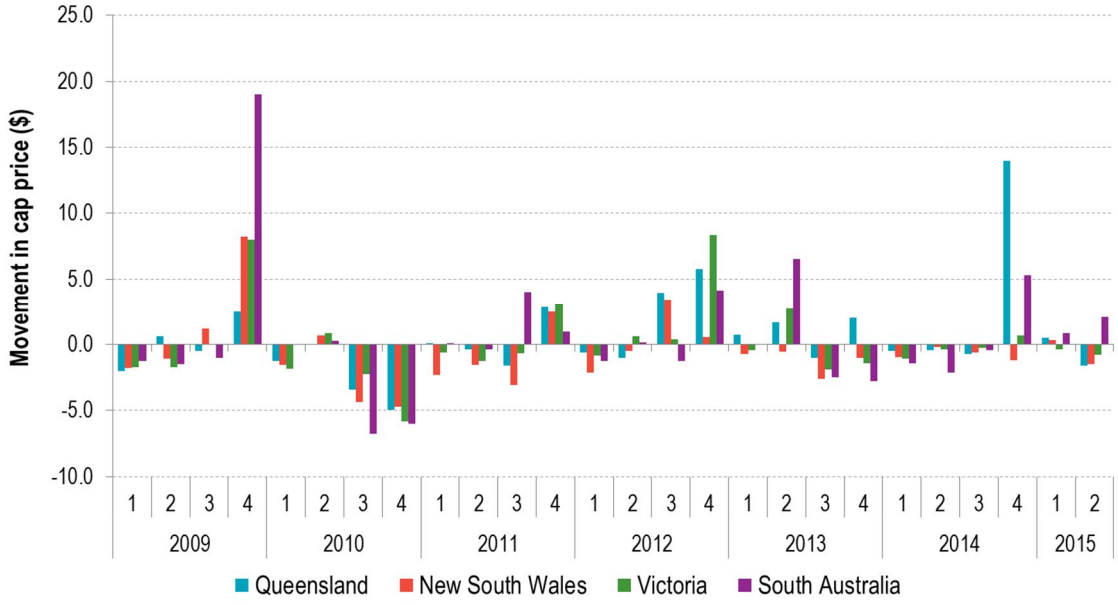
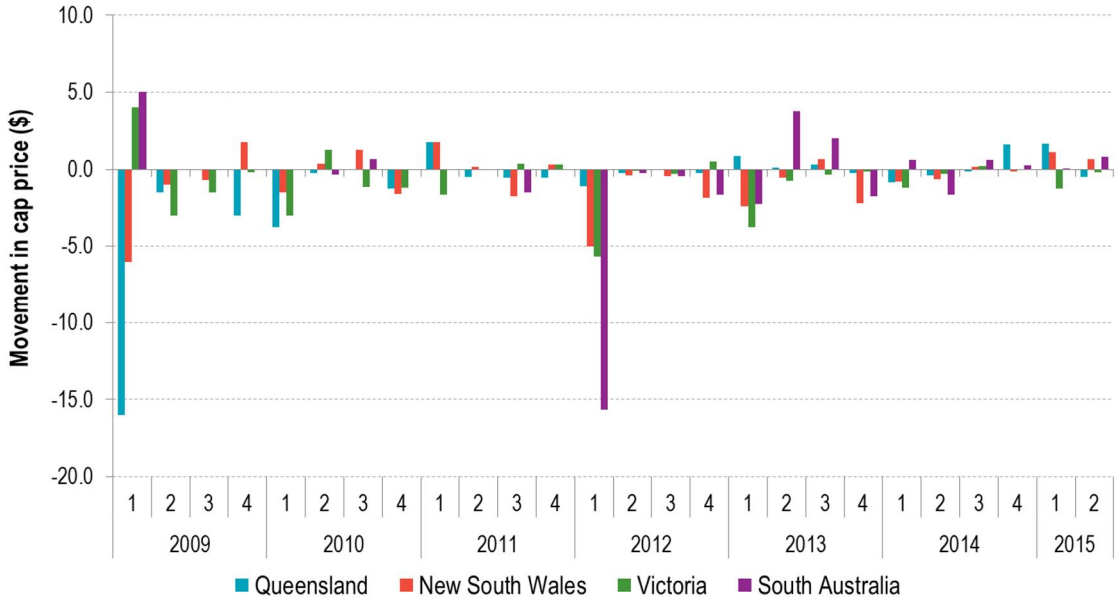



Figure 4: Cap contract price movements – This quarter next year




The evidence of relationships between price volatility and future contract price movements at the daily level is not as strong. The analysis suggests that the effects of price volatility on price movements during the current trading day are more consistent than those observed with price movements over the next week.

This analysis has also demonstrated that issues related to the lagged effect of wholesale market outcomes are complex. Within quarters, there is observational evidence of the pass-through of wholesale market effects immediately, with a number of days delay, and in some instances, pre-emptively. The mixture of lags means that identifying statistically significant relationships at the daily level is challenging. This is unsurprising given the complex behavioral impacts that dominate contract market trading and the importance of market expectations, in addition to the actual occurrence, of price volatility.

The results indicate that the price volatility is more likely to have a positive significant relationship with the price movements for contracts in the next quarter, in comparison with contracts for the

current quarter next year. The statistically significant relationships observed are consistently positive across all regions. These relationships are most frequently significant in Queensland and Victoria, shown in Table 7 and Table 8.

Table 7: Impact of price spikes on next quarter contract prices – Current trading day – Queensland

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | | | | | |
| Q2 | | | | | | | | | |
| Q3 | | | | | | | | | |
| Q4 | | | | | | | | | |

Table 8: Impact of price spikes on next quarter contract prices – Current trading day – Victoria

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | | | | | |
| Q2 | | | | | | | | | |
| Q3 | | | | | | | | | |
| Q4 | | | | | | | | | |

The table above shows that there is some evidence of a relationship between price volatility and the movement in the price of contracts for the next quarter on that trading day in Victoria in Q4 2012 for example. No such relationship exists for Q4 2012 when considering either the movement in Q4 2013 contract prices or when considering the impact on Q1 2013 contract prices over the next week.

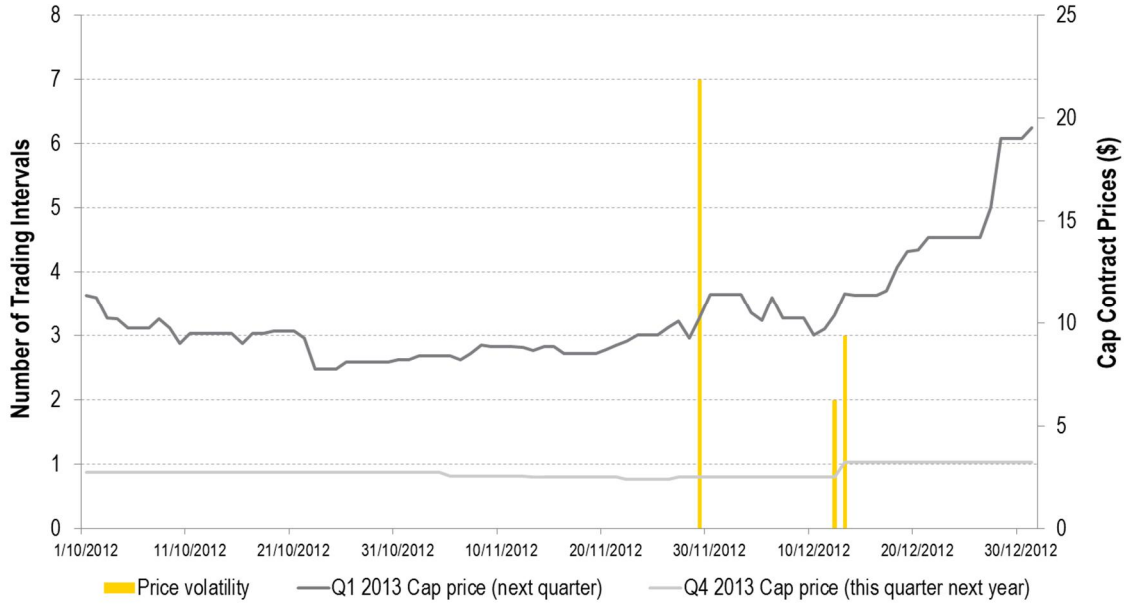
Figure 5 illustrates the relationships described above. Price volatility results in a short-term increase in Q1 2013 contract prices. This effect is not as clearly observable for contract prices for Q4 2013. The price of that contract remains relatively stable over the duration of the quarter.

Considering the first day of price volatility, although Q1 2013 contract prices initially rise, this is followed by a gradual decline over the next week. This contributes to the lack of an observable relationship between price volatility and contract price movements over the next week.

Contract prices rise over the last week of the quarter. This is despite no volatility occurring after 13 December. It is possible that this rise is a delayed response to the observed price volatility earlier in the month or quarter. It is more likely that some other factor or combination of factors is the primary contributor to the increase in the expectation of Q1 2013 price volatility. This late increase in the contract price is the key driver of the relationship between price volatility and the short-term increase in next quarter contract price being only mildly significant.

This also highlights that many of the relationships being considered at the daily level involve a relatively low number of relevant observations from which to determine statistical significance.

Figure 5: Victoria Q4 2012




The difficulty in interpreting the lagged effect of price volatility is also clearly observable in Queensland in Q4 2014. During this quarter there was a relatively high level of price volatility and the price of cap contracts for Q1 2015 rose by $15. This quarter therefore contributes to the positive relationship at the quarterly level shown in Table 5.

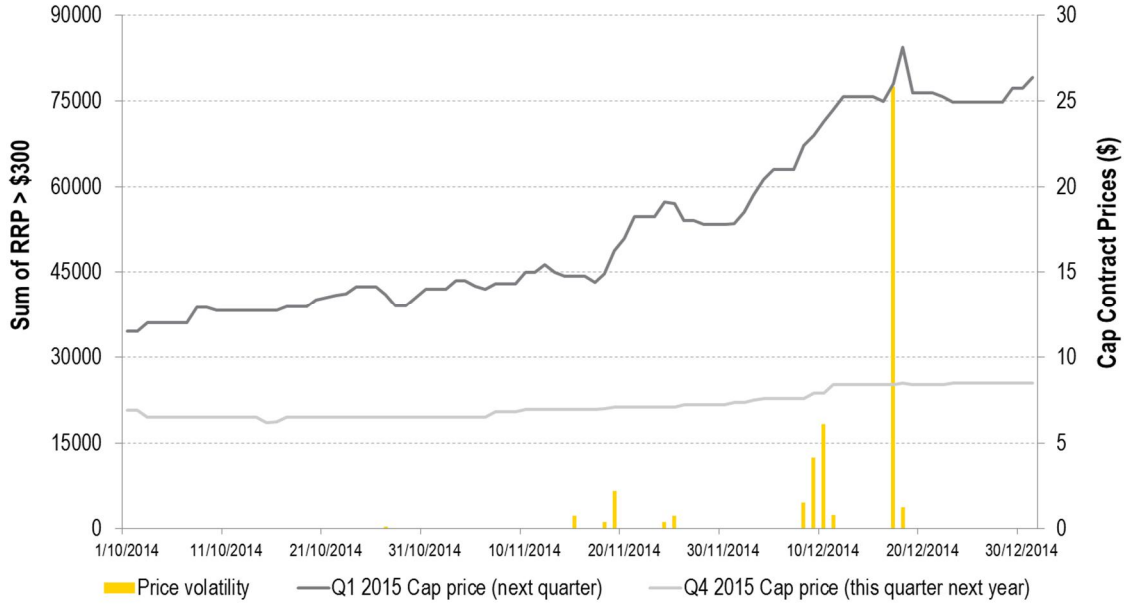
During this quarter, statistically significant, positive relationships were found to exist between price volatility and the price of caps in both the next quarter and this quarter next year when considering the movement in price during the current trading day. However, these relationships were not found to be significant when considering the movement in contract price over the next week.

Figure 6 shows the movement in cap contract prices compared to the incidence of price volatility in this quarter. The effect of price volatility on the short-term movement in cap contract prices is readily observable in this figure, particularly for Q1 2015 cap contract prices. The issues with lagged effects are again observable. The dominant period of price volatility occurs on 17 December. This results in an immediate increase in the price of cap contracts for the next quarter. However, due to the subsequent decline in contract price, the increase over the week following this price spike event is negligible.

It is also evident from the figure below that much of the rise in contract prices occurs before the major volatility event. Between 14 November and 7 December, Q1 2015 cap contract prices rise by over $6. During this period, there is some price volatility although this is relatively minor compared to the period that follows. Between 7 December and the end of the quarter, the price of the cap contract rises by over $5, despite price volatility being far more frequent and large in magnitude over this period.

This quarter provides an observable example of the potential for price volatility to impact the future expectation of price volatility and therefore contract prices. However, this quarter also demonstrates that this does not necessarily mean that there will always be a clearly identifiable and quantifiable relationship in the short-term.

Figure 6: Queensland Q4 2014




## Conclusions

There is strong evidence that when a quarter is characterised by a relatively high level of volatility that the price of contracts for both the current quarter and for future quarters will be higher at the end of the quarter than at the start of the quarter. This indicates that where late rebidding has the potential to increase the frequency and magnitude of price volatility, this late rebidding may increase prices in the contract market.

However, the relationship between the occurrence of price volatility and the movement in contract prices in the short-term is not consistent. In particular, there are mixed lag effects with respect to when and if wholesale market outcomes are passed through to contract market prices. These relationships are less common when considering the impact of wholesale market outcomes over a longer period (e.g. the movement in contract prices over the next week) and for contracts in the future.

## 4.4 Results – Impact of late rebidding on contract prices

We have considered whether the level of late rebidding activity at the daily and quarterly level is related to contract price movements. For this analysis, late rebidding is defined as rebids that were submitted within 1 dispatch interval of the period they applied, and were characterised by an increase in the level of capacity offered above $300/ MWh (and therefore represent rebids that withheld capacity to higher prices).

This analysis does not explicitly consider the impact of late rebidding on wholesale markets. The intention is to determine whether days/quarters in which there is a high level of late rebidding activity is generally correlated with changes in contract prices or trading activity.

At the quarterly level, these results indicate that a high frequency of late rebidding is often statistically related to an increase in contract prices, both for the current quarter and for future quarters. The three tables provided below show that where statistically significant relationships are observed, these indicate a higher frequency of late rebidding is associated with increases in contract prices.

Table 9: Impact of late rebidding on current quarter contract prices - Quarterly

| Contract Type | QLD | NSW | VIC | SA |
|---|---|---|---|---|
| Base | | | | |
| Cap | | | | |

Table 10: Impact of late rebidding on next quarter contract prices - Quarterly

| Contract Type | QLD | NSW | VIC | SA |
|---|---|---|---|---|
| Base | | | | |
| Cap | | | | |

Table 11: Impact of late rebidding on current quarter next year contract prices - Quarterly

| Contract Type | QLD | NSW | VIC | SA |
|---|---|---|---|---|
| Base | | | | |
| Cap | | | | |

It is important to recognize that this does not necessarily provide evidence that quarters with a high volume of late rebidding are causing contract prices to increase. Rather, this shows that there is often a positive correlation – this correlation may result from the interaction of late rebidding with other variables such as demand, changes in the generation portfolio, etc. that in turn, impact wholesale market prices and therefore contract prices.

As with the impact of price volatility, the relationships between late rebidding and contract price movements in the short-term are less consistent than those observed at the quarterly level. Section 4.3 demonstrated that there were statistically significant relationships that existed in some quarters and across the regions between price volatility and contract price increases. However, the impact of late rebidding on contract price movements at the daily level is less clear. The ROAM Consulting work showed that late rebidding was only sporadically related to price volatility. As a result, the relationships between late rebidding and contract price outcomes are clouded by the lack of statistical consistency between late rebidding and price volatility.

In the majority of those quarters where statistically significant relationships are observed between late rebidding and contract price movements, a similar relationship also existed between price volatility and contract price movements.

For example, there is evidence that there is a positive, statistically significant relationship between late rebidding and the short-term movement in the price of cap contracts in the next quarter in South Australia during Q2 2015. This is the only quarter in South Australia that was found to be significant and positive when considering this relationship, as shown in Table 12.

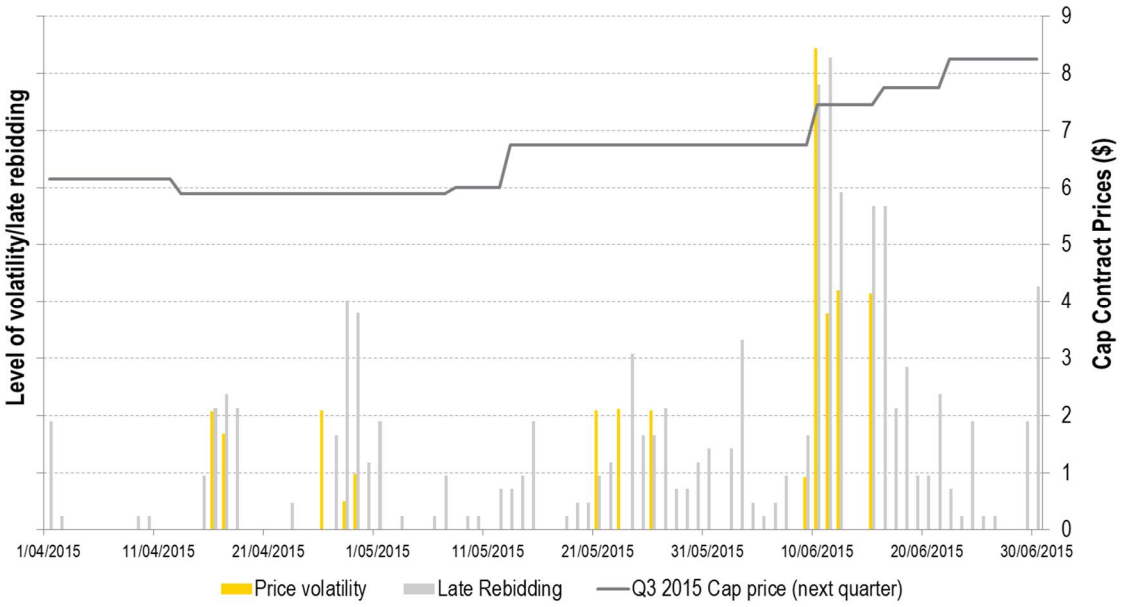
Table 12: Impact of late rebidding on next quarter contract prices – Current trading day – South Australia

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | | | | | |
| Q2 | | | | | | | | | |
| Q3 | | | | | | | | | |
| Q4 | | | | | | | | | |

Figure 7 below shows the price of Q2 2015 cap contracts and the occurrence of both late rebidding and price volatility in South Australia. For this chart, price volatility and late rebidding measures have been normalized to allow the two variables to share the left hand side axis. For this quarter, strong positive relationships were found to exist between contract price movements and both price volatility and late rebidding. This is primarily driven by the activity around 10 June where a period of price volatility and late rebidding coincides with an increase in the price of cap contracts by approximately $1.

From this analysis is it unknown as to whether the late rebidding contributed to the price volatility, was the result of the price volatility, or that there was no direct relationship. However, it is evident given high periods of price volatility coincided with periods with a high frequency of late rebidding that statistical relationships were found to exist between both observations and between late rebidding and contract price increases.

Figure 7: South Australia Q2 2015




## 4.5 Results – Incremental impact of late rebidding on contract prices

Section 3.3 described the potential for price volatility related to late rebidding to have a different effect on the expectation of future price volatility. This section considers whether there is statistical evidence that where price volatility occurs during periods with a high frequency of late rebidding that contract price movements are in any way different compared to other periods of price volatility.

At the quarterly level, there is no evidence of any significant relationships between the type of price volatility (i.e. the volume of late rebids during the dispatch intervals of price volatility) and any additional movement in contract prices, either for the current quarter or for future quarters. This does not imply that there is no relationship between late rebidding and contract prices. Rather, the lack of relationships found in this analysis indicate that there is no evidence that participants in contract markets interpret wholesale market events related to late rebidding differently to similar wholesale market events related to other factors.

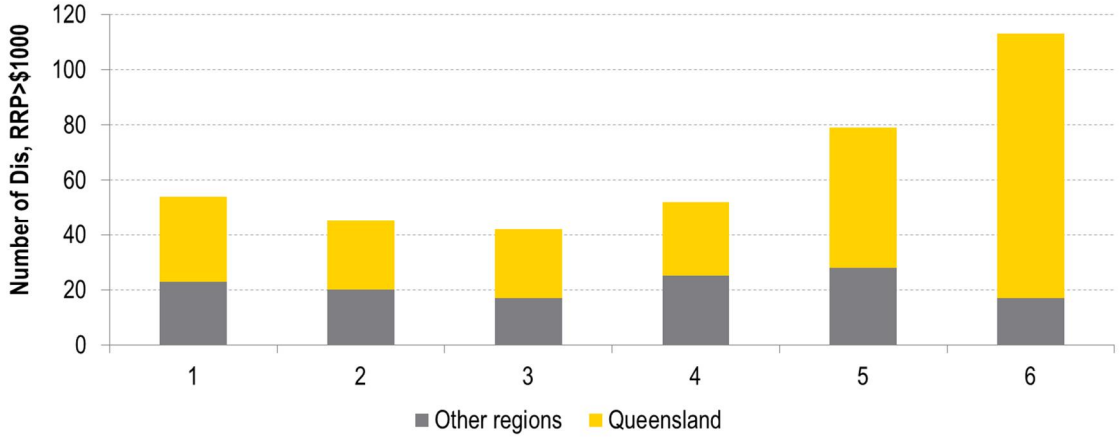
Furthermore, there is no consistent evidence of a difference in the effect of late rebidding price spikes and other price spikes at the daily level. Where relationships do exist, they are approximately as likely to be positive as they are to be negative, and generally occur in quarters in which there are a relatively small number of observations from which to determine potential relationships.

This suggests that the effect of late rebidding on contract market prices is limited to the ability of late rebidding to influence wholesale prices. There is limited evidence that the price volatility that results from late rebidding behaviour has any incremental or otherwise different impact on contract markets when compared to volatility that is caused by other factors.

## 4.6 Results – Incremental impact of 6th DI price spikes on contract prices

Recent volatility in wholesale markets that has been linked to late rebidding has tended to occur towards the end of trading intervals. This can be seen in Figure 8 which shows the frequency of dispatch interval prices in excess of $1,000/MWh since 1 January 2014 across all NEM regions. This chart also demonstrates that this trend is dominated by price volatility in Queensland.

Figure 8: Price Volatility since 1 January 2014




Section 4.5 outlined that analysis has not found a statistically significant difference between the effect of price volatility related to late rebidding and price volatility attributable to other reasons. An alternative measure of the price volatility attributable to late rebidding is to consider the relative frequency of price volatility in the 6th dispatch interval. We have therefore considered whether the occurrence of price volatility in the 6th dispatch interval has an incremental effect on contract prices when compared to price volatility generally.

The results of this analysis are in accord with the previous analysis of the potential difference between late rebidding related price volatility and price volatility generally. At the quarterly level, there is limited evidence that the timing of price volatility within the trading interval has a statistically significant relationship with contract price movements. There is some evidence that there is a positive relationship between the timing of price volatility and the increase in base contracts for the current quarter in South Australia, and also that there is a negative relationship between with the price of caps in the next quarter in Victoria. However, these relationships do not appear to be significant in magnitude, and given their significance and magnitude, may be the result of random variation.

Similarly, relationships at the daily level are rarely statistically significant and where significant, are inconsistent in direction. This analysis indicates that whether using either late rebidding frequency or timing of price volatility as a metric, there is very little evidence that there is a difference between the impact of price volatility related to strategic late rebidding and price volatility generally.

## 4.7 Results – Impact on contract traded volumes

Whereas wholesale market outcomes were generally more consistently related to contract prices at the quarterly level, the effect on traded volumes tends to be more closely related in the short-term. There are relatively few statistically significant relationships between quarterly wholesale market outcomes and traded. This suggests that other factors are more likely significant with respect to the level of trading in the market. This may include the number of active traders, the changing ownership structure within each region, the percentage of trading being conducted through ASX Energy, etc.

There is however some evidence that some wholesale market outcomes result in a response in short-term contract market trading. For example, price volatility has a consistently positive impact on the level of contract trading on that trading day for contracts in the current quarter. This relationship is particularly consistent in Queensland, as shown in Table 13. Similar relationships are shown to exist between late rebidding and contract market trading in Table 14.

Table 13: Impact of price volatility on current quarter cap contract trading– Current trading day – Queensland

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | | | | | |
| Q2 | | | | | | | | | |
| Q3 | | | | | | | | | |
| Q4 | | | | | | | | | |

Table 14: Impact of late rebidding on current quarter cap contract trading– Current trading day – Queensland

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | | | | | |
| Q2 | | | | | | | | | |
| Q3 | | | | | | | | | |
| Q4 | | | | | | | | | |

There is also evidence that price volatility results in an increase in contract market trading for future contracts. Table 15 shows the impact of price volatility in New South Wales on trading volumes for base futures in the current quarter next year.

Table 15: Impact of price volatility on current quarter next year base contract trading– Current trading day – New South Wales

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | | | | | | | | | |
| Q2 | | | | | | | | | |
| Q3 | | | | | | | | | |
| Q4 | | | | | | | | | |

There is limited consistent evidence that the type of volatility (i.e. whether it is related to late rebidding or occurs in the 6$^{th}$ dispatch interval) is related to the short- or medium-term trading activity in contract markets.

# 5. Assessment of the materiality of late rebidding

The analysis presented in this report demonstrates that contract market outcomes are influenced by wholesale market activity, particularly price volatility. Previous work conducted by ROAM Consulting has shown that at times there has been a strong relationship between late rebidding activity and price volatility. This section considers whether the two pieces of analysis provide evidence that late rebidding has a material impact on contract markets, and what the potential magnitude of this effect may have been historically.

The key challenge in testing the effect of late rebidding on wholesale and contract markets is identifying whether wholesale market outcomes are caused by late rebidding. The statistical analysis conducted is not appropriate for identifying this causal relationship. Even sophisticated backcasting techniques that could be applied to determine the impact of historical strategic late rebidding on wholesale prices would be underpinned by the assumption that removing strategic late rebidding does not affect other bidding behaviour.

Therefore, although the statistical analysis shows that there may be relationships between late rebidding and price volatility and/or increases in contract market prices, this does not prove that eliminating or reducing strategic late rebidding would negate these outcomes.

The analysis does however show that there is a very strong relationship between wholesale market outcomes and contract market price movements. This analysis has generally shown that the impact of the wholesale market on contract market prices is more clearly demonstrated over longer periods. There is relatively limited evidence that the market expectation of price volatility is sensitive to price volatility in the short term (e.g. less than a week). Rather, the cumulative impact of price volatility over longer periods, such as during the quarter, is likely to be a factor that influences the market's expectations of future volatility and therefore contract prices.

A consideration of price volatility in recent years in Queensland has demonstrated the potential for strategic late rebidding to cause price volatility. Statistical analysis has shown that late rebidding is at times strongly related to price volatility, acknowledging that statistical analysis has also shown that late rebidding is also commonly related to the avoidance of high prices. These two forms of analysis do however demonstrate that at times, there is arguably a causal link between strategic late rebidding behaviour and price volatility. The results of the statistical analysis presented in this report therefore show that where this causal link is present, it is likely that strategic late rebidding behaviour could lead to higher contract prices.

The following section explores two methodologies for estimating the magnitude of this effect in Queensland over recent years. The analysis focuses on recent historical periods where *strategic* late rebidding may have occurred, with a view of understanding how this behaviour may have influenced the price of a range of $300 cap contracts.

## 5.1 Impact of strategic late rebidding in Queensland

### 5.1.1 Methodology A – Equal volatility across trading interval

*Determining the level of price volatility attributable to late rebidding*
Section 4.6 showed the increasing trend in recent year in Queensland of price volatility occurring late in the trading interval. Prior to 2012, a similar number of "price spikes" tended to occur in each dispatch interval of the trading interval. Since that time however, the bias towards volatility occurring during the latter part of the trading interval has increased. Figure 8 showed the distribution of prices in excess of $1,000/MWh since 2014 in Queensland.

This approach is based upon the assumption that the increased likelihood of price volatility in the 5$^{th}$ and 6$^{th}$ dispatch intervals is the result of a change in generator behaviour during the trading interval. We have therefore applied a methodology that assumes that the additional price volatility that occurs in these dispatch intervals (in comparison with the level of volatility in the first four

dispatch intervals) is the result of strategic late rebidding. This assumption is used to determine the reduction in price volatility that may have occurred had strategic late rebidding not occurred.

*Limitations in the determination of the reduction in price volatility*
This methodology uses the higher levels of price volatility that occur in the 5th and 6th dispatch intervals as an estimate of the price volatility that is attributable to strategic late rebidding. This methodology has a number of limitations:

- This relies on the assumption that the higher level of volatility in the 5th and 6th dispatch intervals is solely attributable to strategic late rebidding. The elevated levels of volatility in those dispatch intervals could be the result of other factors, including random variation. Furthermore, there may be the potential for bidding strategies to be more profitably implemented during the later dispatch intervals that reflect new information and were submitted as soon as practicable. This approach could therefore overstate the level of volatility that is attributable to strategic late rebidding. Methodology B considers an alternative approach that addresses this limitation.

- This approach assumes that strategic late rebidding does not result in price volatility in the 1st to 4th dispatch intervals. Although strategic late rebidding is most commonly linked with volatility in the latter dispatch intervals of the trading interval, there is the potential that this behaviour has also resulted in price spikes in earlier dispatch intervals. By assuming this has not occurred, the approach may understate the level of volatility attributable to strategic late rebidding.

- It is assumed that the removal of strategic late rebidding would not result in an increase in volatility in other periods. Reducing the ability of portfolios to use strategic late rebidding may result in the use of other bidding strategies that increase wholesale prices using other methods. Therefore, the net reduction in price volatility assumed using this approach may be partially offset by other changes in bidding behaviour.

These limitations demonstrate that the approach used to estimate the reduction in price volatility that results from the removal of strategic late rebidding could be higher or lower than the actual effect.

*Applying the reduction in late rebidding to contract market impacts*
This analysis focuses on a selection of quarters in Queensland where either significant levels of volatility occurred, or where a high proportion of the volatility that did occur was during the 5th and 6th dispatch intervals. For each of these quarters, we have determined the reduction in the volume of price volatility that can be attributed to strategic late rebidding.

In conducting the statistical analysis presented in this report, we have considered the relationship between observations of historical price volatility at the quarterly level, and the movement of contract prices during each quarter. From this analysis, we have found that there are positive, statistically significant relationships between price volatility and increases in the price of cap contracts.

We have considered the impact of price volatility on:

- Cap contract prices for the current quarter
- Cap contract prices for the next quarter
- Cap contract prices for the current quarter, next year

For each of these contract types, we have used linear regression techniques to estimate the effect of an increase/decrease in the quarterly volume of price volatility on contract price movements for the quarterly cap contracts described above.

These estimates can therefore be used to determine what impact the reduction in price volatility that results from the hypothetical removal of strategic late rebidding would have had on contract price movements during each quarter. It is important to note that this does not determine the reduction in contract prices that would result from the removal of strategic late rebidding entirely. Rather, this estimates the impact of the elimination of the assumed level of strategic late rebidding in each individual quarter.

However, the estimates of the impact on cap contract payouts (current quarter contracts) across the range of quarters considered do provide some estimate of the potential for the reduction in strategic late rebidding to affect the market's long-term expectations of price volatility. This reduction could flow through, at least in part, as reduced contract prices.

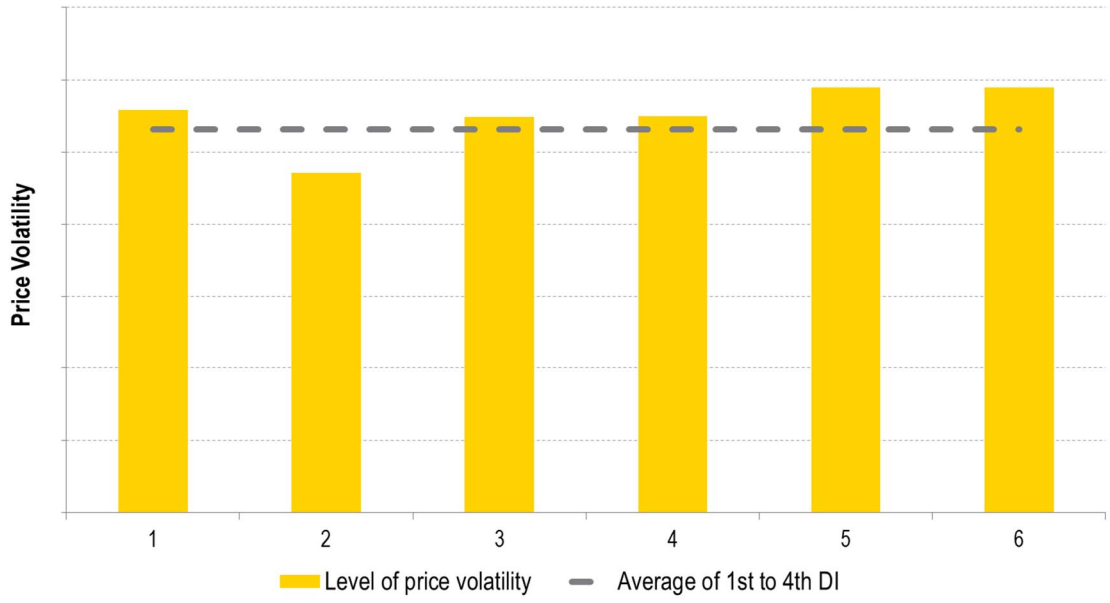
### 5.1.2 Methodology B – Historical distribution of volatility across trading interval

This methodology adjusts Methodology A to account for the potential for price volatility to be higher in the later dispatch intervals without strategic late rebidding. This alternative methodology addresses the first limitation described above. Instead of assuming that price volatility in the 5$^{th}$ and 6$^{th}$ dispatch intervals is equal to the average level of volatility in the 1$^{st}$ to 4$^{th}$ dispatch intervals, this method uses historical price volatility observations.

The price volatility outcomes in Queensland between 2009 and 2011 have been used to determine an alternative distribution of price volatility across the trading interval. This period covers the period of the dataset before the trend of increasing volatility in the later dispatch intervals began to develop.

Figure 9 shows the magnitude of price volatility for each dispatch interval over this period. The level of volatility in both the 5$^{th}$ and 6$^{th}$ dispatch intervals is 111% of the average of the volatility observed in the 1$^{st}$ to 4$^{th}$ dispatch interval.

Figure 9: QLD price volatility distribution 2009-2011




This result is used to determine the counterfactual level of volatility after the removal of strategic late rebidding. In the Methodology A, the level of volatility is assumed to be equal to the average volatility in the first four dispatch intervals (i.e. 100% of the average volatility). Instead, the counterfactual level of volatility in the 5$^{th}$ and 6$^{th}$ dispatch intervals is assumed to be 11% higher than the volatility observed over the earlier dispatch intervals. The reduction in volatility that is attributed to the reduction in strategic late rebidding is therefore lower when using this approach.

There are a number of alternatives to using the period before 2012 in Queensland as representative of a counterfactual distribution of volatility. For example, the distribution in other regions could be used, considering volatility either over the same period as we are assessing in Queensland (i.e. 2012 to 2015) or over the entire analysis period (2009 to 2015). A comparison between the ratios used and the results of the regional alternatives is provided in Table 16.

It should be noted that some of these ratios have been calculated from data that has a relatively low number of observations (due to low price volatility). This is particularly true in New South Wales and Victoria. For example, in New South Wales there have been only ten dispatch intervals where the price has exceeded $1,000/MWh since 2012. Therefore the results provided below for that period are unlikely to be of statistical significance.

Table 16: Price volatility ratios – 5th and 6th dispatch intervals

| | QLD (2009-2011) | 2012-2015 | 2009-2015 |
|---|---|---|---|
| QLD 5th DI | 111% | | |
| QLD 6th DI | 111% | | |
| NSW 5th DI | | 114% | 105% |
| NSW 6th DI | | 187% | 118% |
| VIC 5th DI | | 131% | 109% |
| VIC 6th DI | | 81% | 101% |
| SA 5th DI | | 85% | 97% |
| SA 6th DI | | 108% | 105% |

The relative level of price volatility in Queensland prior to 2012 has been preferred over using observed volatility in other NEM regions. This is because we consider that the application of observations from other regions to Queensland will potentially fail to capture the conditions specific to Queensland. Using historical Queensland volatility better captures these regional characteristics. Furthermore, a number of the regional volatility distributions are affected by a lack of observations and are therefore a less reliable estimator for the distribution of volatility.

### 5.1.3 Results – Methodology A

*Reduction in price volatility*

Table 17 shows the proportionate reduction in price volatility that results from the removal of volatility that has been attributed to strategic late rebidding, using Methodology A. For example, Q1 2014 exhibits a significant reduction in price volatility as almost all of the price volatility in this quarter occurred in the 5th and 6th dispatch intervals. In contrast, only a slightly above average level of volatility was observed in the latter part of the trading interval in Q1 2013.

Table 17: Impact of the removal of strategic late rebidding on price volatility – Methodology A

| Year | Quarter | Reduction in volatility |
|---|---|---|
| 2012 | 1 | 45% |
| 2013 | 1 | 8% |
| 2014 | 1 | 83% |
| 2014 | 4 | 32% |
| 2015 | 1 | 19% |

*Reduction in cap contract prices*

By applying the regression coefficients calculated in the statistical analysis to these volatility reductions, we have determined that the reductions in contract prices are as provided in Table 18. The reduction in quarters where either price volatility is significant or where a high percentage of price volatility was attributed to late rebidding is relatively high.

Clearly the reduction in cap contract prices during the current quarter is more significant than contract prices in future quarters. The reduction in volatility is directly passed through as a reduction in the payouts for cap contracts in that quarter. The reduction in contract prices for the current quarter is representative of, not in addition to, the assumed reduction in price volatility. Only a proportion of the reduction is passed through to the expectation of price volatility in future quarters.

Table 18: Reduction in cap contract prices ($) – Methodology A

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.8 | 0.4 | 0.3 |
| 2013 | 1 | 2.2 | 0.5 | 0.4 |
| 2014 | 1 | 11.2 | 2.4 | 2.2 |
| 2014 | 4 | 9.0 | 1.9 | 1.7 |
| 2015 | 1 | 8.8 | 1.8 | 1.7 |

The tables below show, for each of these contracts, the actual price at the start of the quarter, the actual price at the end of the quarter, and the price at the end of the quarter that would have resulted after applying the reductions provided above.

Table 19: Actual initial cap contract prices ($)

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 16.05 | 1.90 | 15.50 |
| 2013 | 1 | 21.00 | 2.30 | 15.00 |
| 2014 | 1 | 15.50 | 3.50 | 13.30 |
| 2014 | 4 | 5.50 | 12.40 | 6.90 |
| 2015 | 1 | 26.40 | 3.10 | 17.25 |

Table 20: Actual final cap contract prices ($)

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.68 | 2.75 | 14.40 |
| 2013 | 1 | 20.95 | 3.05 | 15.85 |
| 2014 | 1 | 12.05 | 3.00 | 12.45 |
| 2014 | 4 | 27.75 | 26.40 | 8.50 |
| 2015 | 1 | 45.45 | 3.60 | 18.90 |

Table 21: Counterfactual final cap contract prices ($)

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 0.00 | 2.38 | 14.06 |
| 2013 | 1 | 18.79 | 2.60 | 15.43 |
| 2014 | 1 | 0.83 | 0.64 | 10.29 |
| 2014 | 4 | 18.73 | 24.50 | 6.76 |
| 2015 | 1 | 36.70 | 1.76 | 17.21 |

In Q1 2014, prices for the quarter started at $15.50. During this quarter, some volatility did occur. Using the methodology described above, a high proportion of this volatility was attributable to strategic late rebidding. Even though a high proportion of strategic late rebidding occurred, contract payouts for the quarter did not exceed the starting expectation. This suggests that other forms of volatility (such as tight supply-demand balance) did not occur as expected during the quarter, or the

market expected even higher levels of strategic late rebidding. When the strategic late rebidding is removed, the contract payouts for the quarter would have been close to zero. Furthermore, it is estimated that the reduction in volatility would have reduced prices of future cap contracts by over $2.

In contrast, price volatility in Q4 2014 was often not attributable to strategic late rebidding using this method. As a result, even after removing the impact of strategic late rebidding, cap contract prices would have still risen during this quarter, albeit by $9 less than the actual increase.

*Calculation without using statistical inputs*
The approach described above used outcomes of the statistical analysis described in Section 4. The calculation of the reduction in contract payouts can be replicated without using the statistical coefficients. By applying the approach to calculating the counterfactual level of volatility, it is possible to estimate the reduction in cap contract payouts. There is no single method for determining this reduction as there are many factors which marginally influence the reduction in cap contract payout that results from a reduction in price volatility. However, the difference in the resultant cap contract payout reduction between these possible calculation methodologies will be relatively minor.

The following table presents the results of one possible approach. The reduction in cap contract value from the assumed reduction in price volatility uses a relatively simple technique that assumes that all of the periods where price volatility no longer occur in the counterfactual scenario are the only dispatch interval of price volatility in that trading interval and that dispatch interval price was equal to the MPC in the relevant financial year. Table 22 shows that this approach yields a very similar result to the statistical approach when considering the impact of the assumed reduction in price volatility on cap contracts in that quarter.

Table 22: Comparison between statistical and payout approach

| Year | Quarter | Reduction in cap value using statistical approach | Reduction in cap value using payout calculation approach |
|---|---|---|---|
| 2012 | 1 | 1.8 | 1.7 |
| 2013 | 1 | 2.2 | 2.1 |
| 2014 | 1 | 11.2 | 11.0 |
| 2014 | 4 | 9.0 | 8.7 |
| 2015 | 1 | 8.8 | 8.6 |

This approach cannot be applied to the effect on future cap contract prices. However, statistical analysis indicates that the magnitude of the change in cap contract values for the current quarter is strongly related to the change in the cap contract value in future quarters. This is generally in agreement with the results presented in Table 18 where a change in cap values for the current quarter results in a change of approximately 20% of that magnitude in the next quarter and in the current quarter next year.

*Assessment of total magnitude*
This section estimates the total magnitude of the impact of the changes in contract prices calculated using Methodology A. We have used the 'open interest' values supplied in the ASX Energy data as an estimate of the total quantity of each type of contract held at the start of each quarter. This quantity is then multiplied by the contract price movements to determine the total value of the impact of strategic late rebidding.

The analysis presented above calculated the impact of the reduction in price volatility on cap contracts. Depending on the pool price that is assumed for the periods where price volatility has been "removed", the calculated reduction in base contract values will be approximately equal to the reduction in cap contract values. For the purpose of this analysis, we have assumed that the reductions in base contract values are equal to the reductions in cap contract values (provided in Table 18).

The total magnitude of the impacts on cap and base futures contracts are provided Table 23 and Table 24 respectively.

Table 23: Magnitude of impact from removal of strategic late rebidding ($m) – cap futures contracts – Methodology A

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.1 | 0.3 | 0.1 |
| 2013 | 1 | 3.4 | 0.2 | 0.2 |
| 2014 | 1 | 7.9 | 0.9 | 0.8 |
| 2014 | 4 | 11.0 | 2.5 | 0.3 |
| 2015 | 1 | 17.2 | 1.2 | 1.8 |

Table 24: Magnitude of impact from removal of strategic late rebidding ($m) – base futures contracts – Methodology A

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 5.0 | 1.1 | 0.2 |
| 2013 | 1 | 6.3 | 1.1 | 0.4 |
| 2014 | 1 | 30.8 | 7.3 | 2.7 |
| 2014 | 4 | 36.4 | 7.1 | 4.0 |
| 2015 | 1 | 54.4 | 8.5 | 2.6 |

These values represent an estimate of the impact for the contracts held through the publicly traded futures market. The impact on the value of contracts traded in OTC negotiations is likely to be similar to the publicly traded market. Therefore, the total magnitude of the impact of the removal of strategic late rebidding may be substantially higher the values provided above. If we assume that 60%[6] of Queensland contracts over this period were traded through ASX Energy, the total magnitude of the impact would increase by approximately 66%.

### 5.1.4 Results – Methodology B

The application of Methodology B results in a marginally lower reduction in the level of total volatility that is attributed to the removal of strategic late rebidding. A comparison with the results of Methodology A is provided in Table 25.

Table 25: Impact of the removal of strategic late rebidding on price volatility – Methodology comparison

| Year | Quarter | Reduction in volatility – Methodology A | Reduction in volatility – Methodology B |
|---|---|---|---|
| 2012 | 1 | 45% | 43% |
| 2013 | 1 | 8% | 4% |
| 2014 | 1 | 83% | 82% |
| 2014 | 4 | 32% | 29% |
| 2015 | 1 | 19% | 16% |

The differences in the reductions vary across the quarters being examined here. For example, in Q1 2014, the difference in the reduction in volatility is very low. In this quarter, the amount of volatility in the first four dispatch intervals was very low, relative to the remainder of the trading interval. Therefore, whether you assume that volatility in the 5th and 6th dispatch intervals is 100%

[6] See Page 3 of http://www.afma.com.au/data/afmr/2014%20afmr.pdf

(Methodology A) or 111% (Methodology B) of that level, the difference in counterfactual total volatility will be very low.

However in Q1 2013, over 60% of the volatility occurred in the first four dispatch intervals. Therefore, when you apply the two alternative ratios, the difference in counterfactual volatility is relatively large. As a result, the implied reduction in volatility that results from the removal of strategic late rebidding is materially different.

The reductions in cap contract prices applying Methodology B are supplied in Table 26. These values are marginally lower than those supplied in Table 18 – the results of Methodology A.

Table 26: Reduction in cap contract prices – Methodology B ($)

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.7 | 0.4 | 0.3 |
| 2013 | 1 | 1.2 | 0.3 | 0.2 |
| 2014 | 1 | 11.1 | 2.3 | 2.1 |
| 2014 | 4 | 8.3 | 1.7 | 1.6 |
| 2015 | 1 | 7.3 | 1.5 | 1.4 |

The reductions in cap contract prices have been applied using the open interest approach to determine the magnitude of the total impact on cap and base futures contract markets. These are provided in Table 27 and Table 28.

Table 27: Magnitude of impact from removal of strategic late rebidding ($m) – cap futures contracts – Methodology B

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 1.1 | 0.3 | 0.1 |
| 2013 | 1 | 1.9 | 0.1 | 0.1 |
| 2014 | 1 | 7.8 | 0.9 | 0.8 |
| 2014 | 4 | 10.2 | 2.3 | 0.3 |
| 2015 | 1 | 14.4 | 1.0 | 1.5 |

Table 28: Magnitude of impact from removal of strategic late rebidding ($m) – base futures contracts – Methodology B

| Year | Quarter | This quarter cap contracts | Next quarter cap contracts | This quarter next year cap contracts |
|---|---|---|---|---|
| 2012 | 1 | 4.8 | 1.1 | 0.1 |
| 2013 | 1 | 3.5 | 0.6 | 0.2 |
| 2014 | 1 | 30.6 | 7.2 | 2.7 |
| 2014 | 4 | 33.5 | 6.5 | 3.7 |
| 2015 | 1 | 45.7 | 7.1 | 2.2 |

## 5.2 Conclusion

Using the methods described above for estimating the impact of the removal of strategic late rebidding indicates that historical contract payouts could have decreased substantially. If the removal of this behaviour resulted in a similar decrease in the market's expectations of price volatility in Queensland then this could result in significant savings in contracting costs. However, this is underpinned by a number of assumptions and limitations that may overstate or understate the net effect of the removal of strategic late rebidding on market volatility. Furthermore, this analysis does not in any way consider whether the potential reduction in contract prices is a

beneficial outcome, given that some element of strategic bidding is a necessary feature of the energy only market design.

This analysis focused on recent years in Queensland. When applied to the period before 2012 in Queensland or to other regions, the effect is generally very small. However, although late rebidding may not consistently impact wholesale and contract market across all NEM regions, the analysis does indicate that at times, the impact of this behaviour has been significant.

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