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3 Executive summary

The Australian water market is mainly used by farmers to supply their demand of freshwater. In the 1980's it was evident that the fresh water resources in Australia were fully or over-allocated. This led to reforms in the 1990's and in the 2000's regulating the market to secure sufficient and stable supply. In this paper the water market in Australia that resulted from the reforms will be presented and analysed. The participants in today's market are able to buy water that is divided into different subclasses, based on how reliable they are. The market consists of both profit and utility motivated traders. The analysis is conducted by evaluating the market through the four characteristics: liquidity, volatility, transaction cost and informative prices. It concludes that the market overall suffers from a low grade of liquidity. The analysis also shows that the transaction costs in the market is high, which can explain some of the low liquidity. The volatility in the market is considered as sufficient enough to generate opportunities for speculators to make a profit by trading, but still low enough to attract utilitarian traders. Market prices are not reflecting the available public information, as well as it differs between exchanges, and is therefore considered low-form efficient at most. In total the water market in Australia is not considered well-functioning by regular financial market standards. However, as a water market it is considered well-functioning and perhaps the most well-functioning water market there is.

4 Introduction

This paper aims to give the reader valuable insight into the water market in Australia and look if the market can be characterised as well-functioning. To do this, the paper will analyse the market by using characteristics of a well-functioning market. Firstly, the paper will present water as a commodity in Australia and the market setup will be elucidated. Then follows theory describing the four characteristics with including analysis for each of them. The analysis will be based on the available market and weather data from 2017-2019, as well as correspondence with a water exchange representative with experience from the market. Finally, the findings from the analysis will be presented and debated, and the limitations of the analysis will be identified.

5 Water as a commodity in Australia

Australia is the driest populated continent on earth with an annual average rainfall of 469mm per year. After several drought- and overconsumption periods, the Australian Government's approach to this challenge has been to establish a regulated water market. The objective of introducing this market was mainly to allocate water more efficiently for agricultural purposes and also to reduce inefficient use of the water resources (Buiter, 2017). In Australia there is currently an ongoing debate on if the market regulations benefit the farmers, or if the result of the regulation is that this simply restricts the availability of water (Sullivan, 2019).

The Australian market consists of different districts, and in 2018 93% of all water trades took place in the Murray-Darling Basin (MDB) area (Sullivan, 2019). Because of the size and magnitude of the MDB area, this paper will focus on this area, assuming that it is representative for the whole market. The geographical location of this area is shown in figure 1; the MDB covers Queensland, New South Wales, Victoria and South Australia.

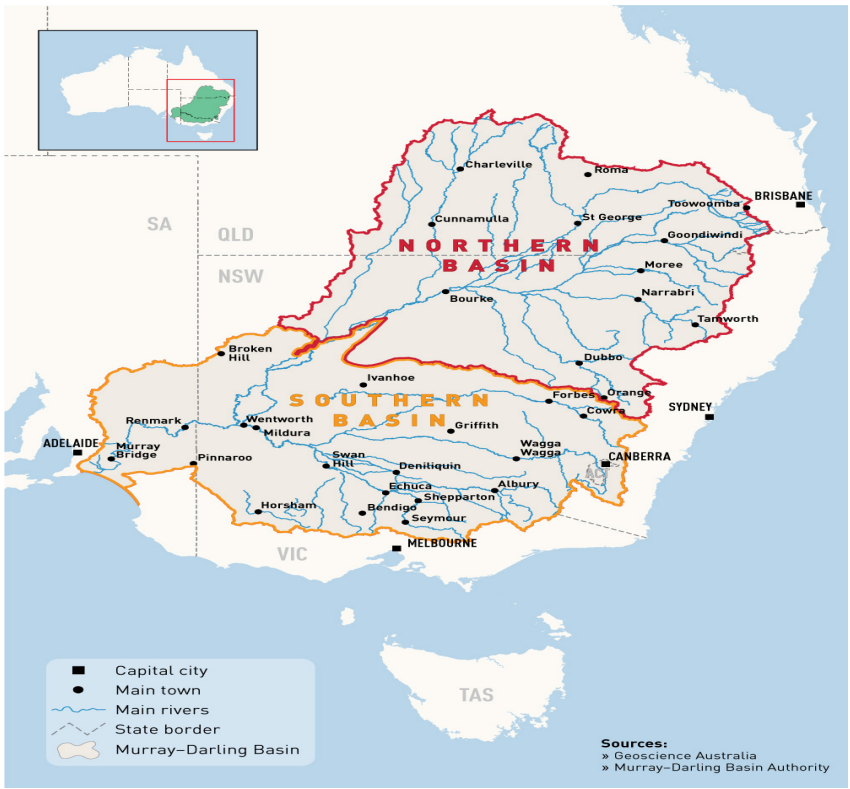


Figure 1: - Geographical representation of MDB (Department of Agriculture, 2018).

This study is not intended to explore if the market functions in compliance with the original governmental purpose, but rather study and analyse whether the water market has developed into a well-functioning financial market or not.

6 Presentation of the water market in Australia

The growth of the Australian water market accelerated in 1994 when the government separated land and water rights (Curran, 2014). Due to reforms in the 1990s and 2000s, the water users in Australia were granted rights to a share of the water from a given water resource to prevent over-allocation of the resources (Department of Agriculture, 2019). Water trading rules allow these rights to be openly traded in the market. The market is based on two main water assets; water entitlements are permanent rights to a volume of water each year; and water allocations are a temporary allocation of water for the year (Department of Agriculture, 2019).

The water resources are divided into subclasses; high and low reliability (HR and LR) and high and general security water (HS and GS), where HR and HS water has a priority over LR and GS water (Victorian Water Register, 2019). Originally MDB consists of 30 subregions, but are in this paper divided into six groups based on location and entitlements/allocations traded. The groups are named: SA Murray (South Australian Murray district), VIC Murray HR (Victoria Murray High Reliability), VIC Murray LR (Victoria Murray Low Reliability), NSW Murray HS (New South Wales High Security), NSW Murray GS (New South Wales Low Security) and North (North in Murray, general definition because of less trading in this area). As shown in figure 2 the average prices per m^3 varies between the different subregions and security types.

Subregion	Security	Average price for one m^3 in AUD
SA Murray	N/A	$ 3.77
VIC Murray	HR	$ 3.07
VIC Murray	LR	$ 0.43
NSW Murray	HS	$ 4.21
NSW Murray	GS	$ 1.75
North	N/A	$ 1.56
Average (MDB)	N/A	$ 2.47

Figure 2: Average price per m3 (Data from Department of Agriculture, 2019)

The Australian water market is an order-driven market, mainly accessed by electronic exchanges or by using water brokers. This enables traders to handle the transactions in an effective way. There are three main exchanges for water trading; H20X, Water Exchange and Waterfind, as well as numerous brokers (Feuerherdt, 2019).

This market is driven by two main motivations: utility- and profit motivated. Utility motivated traders are in the market to support their need of water and are crucial for the market existence. If the utility motivated traders discontinue their market activity, the substance and foundation of the market will vanish since only profit motivated traders remain (Schenk-Hoppé, 2019). Utility motivated traders consist of mostly farmers motivated by getting access to water for agricultural use (Curran, 2014). On the other hand, the profit motivated traders consist of speculators, which ranges from family farmers to investors without any land (Feuerherdt, 2019).

In 2014, the possibility to trade forwards and futures, commodity derivatives, was introduced. Before this the exchanges only allowed landowners and farmers to buy and sell rights on the spot market (Curran, 2014). This feature provides the utility motivated traders a security against drought and water shortage by using hedging techniques. The derivatives consist of megaliters (1000 m^3) of water and secures the water supply at a fixed date in the future.

The introduction of commodity derivatives opened up the possibility for speculators to enter the market. 14% of each trade made per year is done by participants that do not own any land (Sullivan, 2019). About 10 % of the water entitlements in the market is owned by foreign traders (Isa & Schremmer, 2019). There is an ongoing discussion about speculators in the market who manipulates prices by buying big shares and not selling them back. On the basis

of this, H2OX has sent an inquiry to the Australian Competition and Consumer Commission (ACCC). They believe that if water was listed on only one exchange with one price, the speculating would be reduced (Feuerherdt, 2019).

Although the intention of allocating and prioritising the water resources may be a good idea, everything depends on if the market is working efficiently and as intended. Hence, theory of a well-functioning market will be presented along with an analysis if this market can be considered well-functioning.

7 Theory and analysis of a well-functioning market

If a financial market is recognised as a well-functioning market, there are some characteristics that must be present. In this paper the characteristics are narrowed down to four factors; liquidity, volatility, transaction costs and informative prices. They are all significant determinants of the quality of a financial market and this selection secures an overall look of the market from different perspectives. Before an analysis of the Australian market can be conducted, theory regarding these determinants needs to be presented. The structure in this part of the paper will therefore be a theoretical presentation of one of the factors, before a following analysis of the market is conducted in regards of that factor. When the theory and analysis of one factor is finalized, the same structure will be applied to the remaining factors.

In the analysis the factors will be analysed and tested with market data provided by the Australian Department of Agriculture and weather data from the Bureau of Meteorology. The market data consist of trading information in the MDB from January 2017 to June 2019. The prices we have used throughout the term paper is based on the VWAP gathered from the government reports. Alongside the data, information provided from dialogue with Craig Feuerherdt from the independent exchange H2OX will be used to analyse the market from different angles. H2OX is independent as they do not operate as brokers.

7.1 Theory - Liquidity

Liquidity is the ability for a trader to trade when he or she wants to trade (Harris, 2003). Furthermore, it is the ability to make the trade with a large order, or frequent orders, at a low cost without affecting the price of the financial instrument. Exchanges like liquidity because

it attracts traders into their markets, while traders like liquidity because they can trade and implement their strategies in a cost-effective manner. Regulators like liquidity because liquid markets are usually less volatile than illiquid markets (Harris, 2003).

Financial instruments with a higher demand amongst traders are more liquid than instruments with a lower demand. The same phenomenon occurs for instruments with little information regarding the fundamental value as they tend to be more illiquid than instruments where the fundamental value is known. This occurs because the market is reluctant to make trades in competition with informed traders. Trading with informed traders in an illiquid market may cause the possibility of being on the wrong side of the market when it turns, with little or no possibility to get out of the current position. Traders wants to avoid this risk.

In order for a financial market to be well-functioning with regards to liquidity, it has to reach a liquid-level that attracts different types of traders. Profit-motivated traders cannot make money without utilitarian traders and numerous types of traders also typically means more transactions being completed (Harris, 2003). This means that the order book normally contains a wider supply of bid and ask prices, which enhances the possibility of making frequent trades without having a significant impact on the price.

Liquidity also impacts other factors in a well-functioning market, such as transaction cost and volatility. These effects enhance the role liquidity plays in order for a market being well-functioning.

7.2 Analysis - Liquidity

Liquidity can be analysed from different perspectives, in this case from two different angles. First the total number of trades being completed will be presented. This gives an indication of how often traders trade water, and how many traders that are in the market. At least, it can not be more traders in the market then the number of transactions made times two. After that, the total volume of water being traded in the market will be presented and analysed. The liquidity in the water market in MDB based on the total number of trades is presented in figure 3.

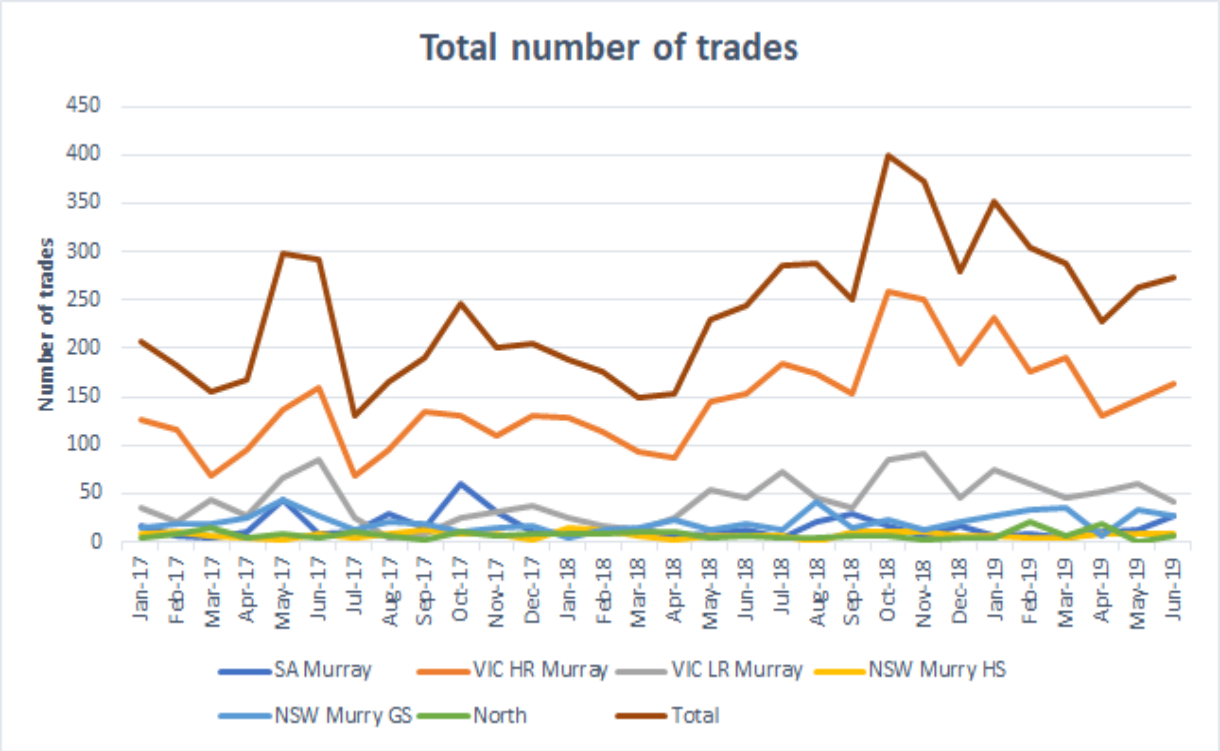


Figure 3: Number of trades in MDB (Data from Department of Agriculture, 2019)

The scarlet line represents the total amount of monthly trades in the MDB region from the beginning of 2017 to June 2019. The data fluctuates between a little less than 150 trades up to 400 trades per month over the period. 150 trades per month is on average five trades a day, which is a low amount of trades compared to other stocks and derivatives on the Australian Stock Index. Compared with commodity markets the numbers are also very low, even other commodities which only trades on physical delivery.

Figure 3 also shows data for the different subregions in the MDB region. The VIC HR Murray contributes with a majority share of the total completed trades. This specific subregion appears to be relatively more liquid than the other subregions based on the number of trades.

The other five subregions have a significantly lower number of completed trades. In these subregions the number of trades varies generally between zero and 25 trades per month. The average is less than one trade per day with a number of days with no trading activities. Based on the low number of trades, these subregions can be assumed illiquid, at least when compared by normal standards for a well-functioning market. It may be in the nature of the water market that the trades take place on a less frequent basis, but at larger volumes. Total volume traded is illustrated in figure 4.

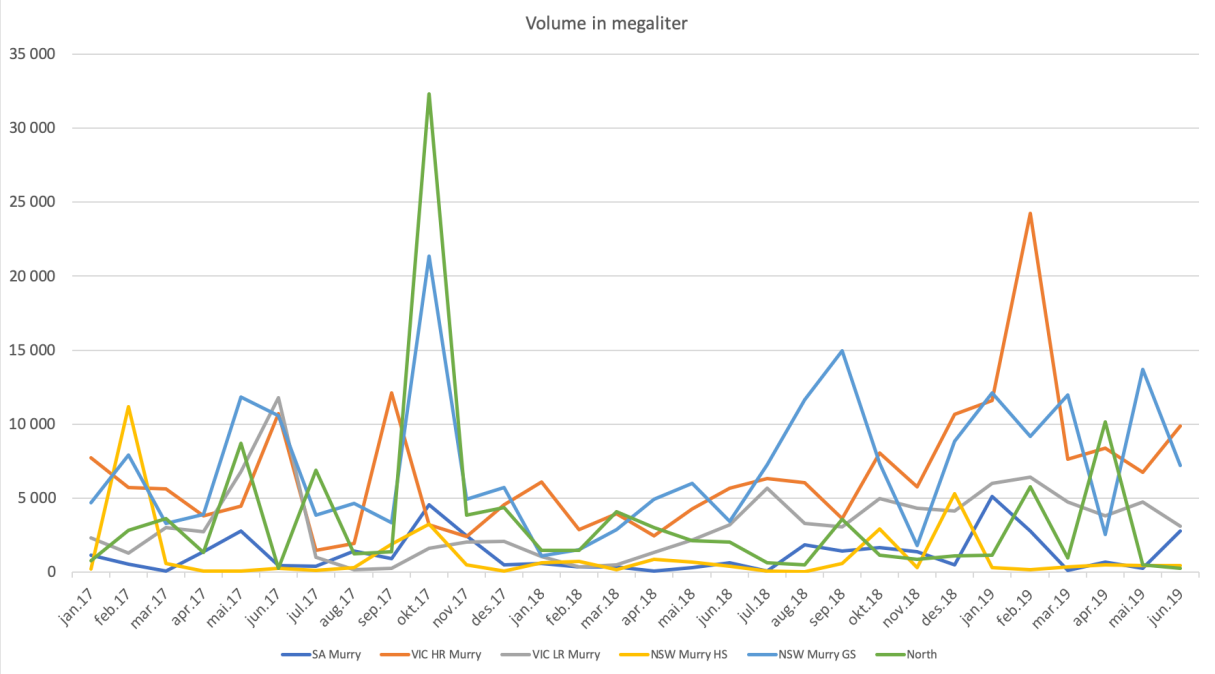


Figure 4: Amount of megaliters traded in MDB (Data from Department of Agriculture, 2019).

It is noteworthy that there is a lower volume differences between each district compared to the total number of completed trades as shown in figure 3. Figure 4 shows that the North and the SA Murray-subregion often exceeds the VIC HR Murray-subregion considering the total traded volume. This changes the perspective of liquidity for the market slightly. An assumption can be made that water markets in general, because of its nature, produces less trades but in larger volumes. Then figure 4 will be a better representation of the reality of the liquidity in the market.

The aggregated traded volume in MDB varies from 10 to around 65 thousand megaliters (10-65 million m^3) per month. It sounds like a high volume being traded, but it is difficult to compare the numbers to other markets. There are few similar water markets like this, and comparing the numbers to other financial markets may not be representative for concluding about the liquidity in this water market.

Taking the different factors into consideration, the liquidity in the water market overall are relatively low. There is a very low number of trades being completed, with subregions that can go several days without a single trade. Some of the subregions contributes immensely to the overall liquidity, making the liquidity for most of the regions less than satisfactory. The total volume traded in the market seems high, but it is also difficult to measure accurate

numbers of how much water is to be considered a high volume. Despite the large amount of water being traded in some of the months in some districts, the liquidity in MDB is a concern of the well-functioning of the overall market.

7.3 Theory - Volatility

Volatility can be defined as the tendency for prices to change unexpectedly (Harris, 2003). If the price of a financial instrument changes rapidly over a short period of time the volatility is high. If there are only small fluctuations in the price, the volatility is low. There are many causes resulting in volatility such as political regulations, news about the trading asset, changes in macroeconomic indicators and uncertainty in the value of the asset. Liquidity also affects volatility since liquid markets tend to be less volatile compared to illiquid markets.

Profit-motivated traders prefers volatility because the fluctuation in prices allows for short-term profits. However, if the volatility is very high it is very risky for a trader, even for a profit-motivated trader, to be in the market. Markets with high or extreme volatility are usually not well-functioning and because of this, regulators pay close attention to the volatility of a market (Harris, 2003).

Commodities that have a high storage cost are often volatile (Harris, 2003). This usually happens because the inventory of the commodity is quite small, and if there is excessive demand the inventories can become empty which will drive the price of the commodity up. The volatility in these types of markets is determined largely by how fast the commodity can be produced and distributed into the market.

A well-functioning market needs some volatility to attract a sufficient number of traders, and at the same time avoid extreme levels of volatility in order to not intimidate traders and attract attention from the regulators.

7.4 Analysis - Volatility

The analysis of the volatility in the water market will be based on the standard deviation of the price (VWAP) changes in the market. The presented volatility data is based on monthly averages. Data based on shorter time periods such as days or weeks may have higher fluctuations. The fact that for some days where there are no trades, it makes it reasonable to

use monthly averaged data. First the volatility in the MDB region will be discussed, followed by a similar discussion of the volatility in the least liquid subregion. The volatility in the MDB region is presented in figure 5.

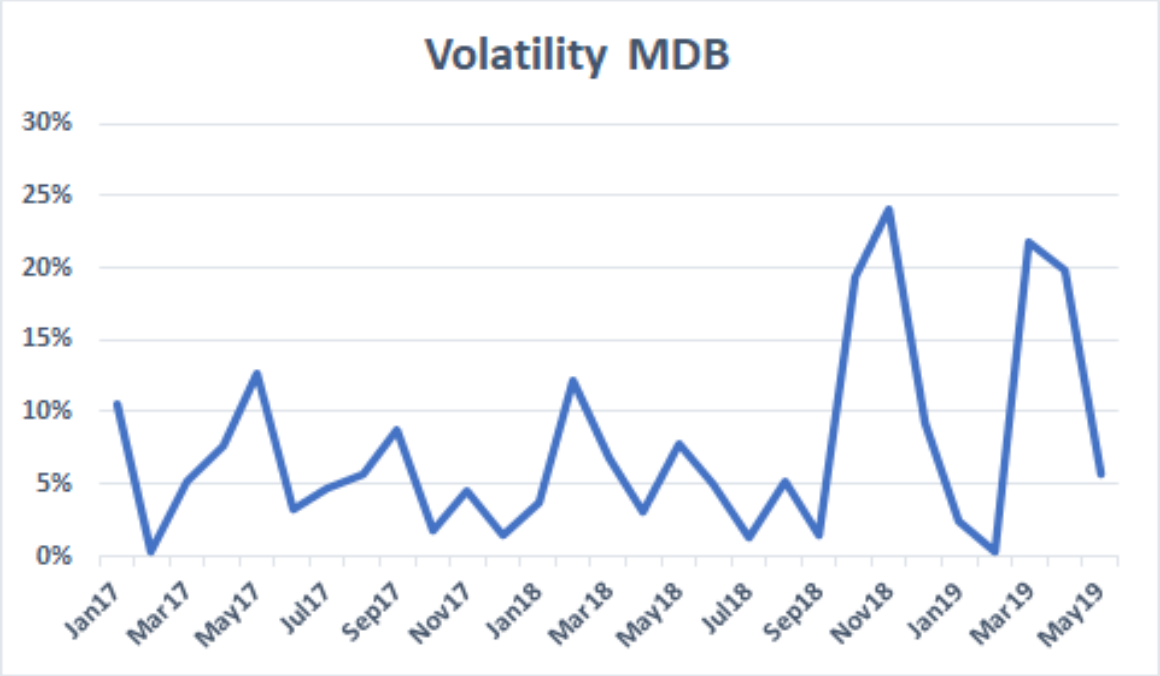


Figure 5: Volatility MDB (Data from Department of Agriculture, 2019).

The average volatility in the MDB during the period of consideration is 9.84%. For a long period until October 2018 the volatility never exceeded 15%. In October and November 2018, and in March and April 2019 the volatility exceeded 20%. In other words, the volatility in MDB have not reached extreme levels, the concern is rather if this volatility is enough to attract speculators in the market. That will depend on each speculator, their personal risk-preference and return on investment. There are therefore no general lines of what is to be considered a sufficient level of volatility to attract speculators. However, since October 2018 the fluctuations have been quite high and well within the range one would assume that speculators need to be present in the market. Before October 2018, recorded fluctuations has been between 5-10%, which may be at the lower bound for what a speculator demands to be in the market. It seems reasonable that the volatility for the whole period is in the lower end of what is enough to draw the attention of the speculators. For isolated regions there may be other conclusions.

The North-subregion was one of the least liquid subregions and should show a higher volatility than MDB. The volatility of the North subregion is illustrated in figure 6.

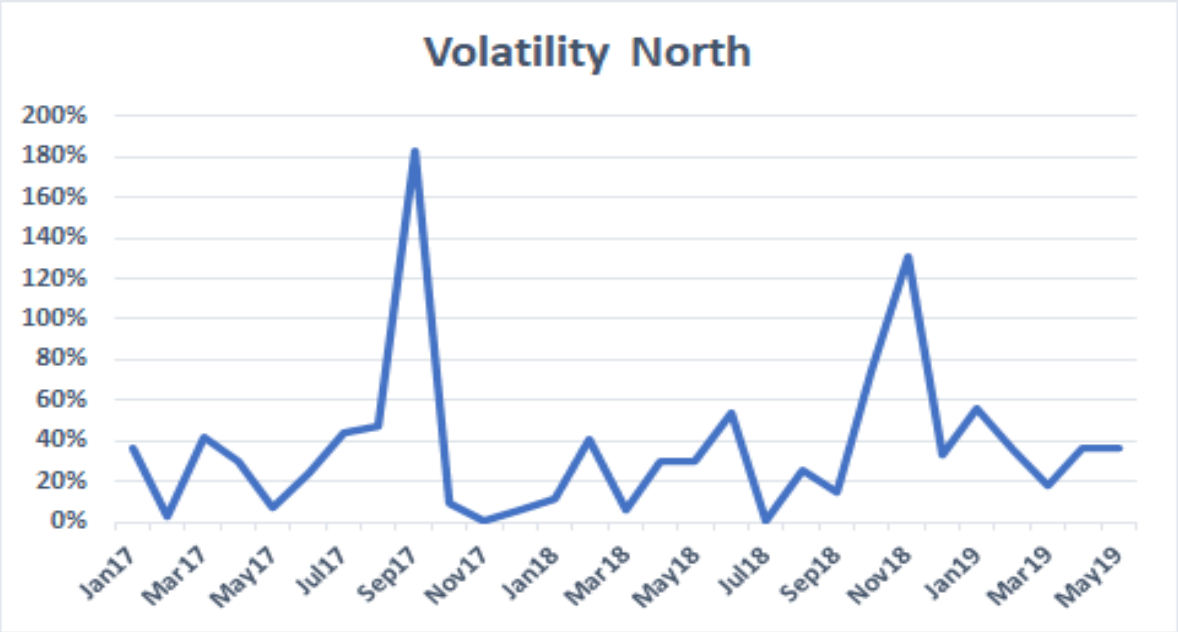


Figure 6: Volatility North (Data from Department of Agriculture, 2019).

As figure 6 shows, the volatility in the North subregion is generally at a higher level and reaches a peak level of around 180% in September 2017. In November 2018 the volatility reaches up to around 130%. These extreme levels of volatility are an indication of a less well-functioning market. A reason for the high spikes in volatility could be the drought in the respective months. In September 2017 some areas in MDB experienced one of the driest months measured in 118 years. A similar incident occurred in November 2018 (Bureau of Meteorology, 2019). The effect of the drought is most likely what causes the extreme volatility, although conclusions like that can not be based on this data only.

Another point regarding the volatility in the North district is the fact that about 22% of the entitlements in the North is controlled by foreign owners (Australian Taxation Office, 2018). As stated earlier the foreigners only own 10% of the overall water entitlements in MDB, so their share of the market in the North are relatively higher than expected. Since the foreigners are relatively more invested in the most volatile region of the MDB, most of them are assumed to be profit and risk-seeking speculators. This implies that the volatility level in the North region makes it attractive for speculators to invest in this subregion.

Over the studied period of 3 years, the average volatility in the North subregion was 53%. This level may seem high but compared with other commodities this level is not very unusual. Over a ten-year period from 2006 till 2016, the volatility in the natural gas market was almost 45%, and for the same period in the crude oil market 35% (Investing, 2019).

Commodities with low storage possibilities tend to be the most volatile, and the storage possibilities for water can be compared to that of crude oil.

Another interesting part regarding the volatility, is if it correlates with higher volumes being traded. That is, if periods with high volatility corresponds with higher liquidity in the market. It would be interesting if higher volatility led to higher volumes being traded, or if higher volatility led to lower volumes being traded. The correlation between volatility and volume for MDB is illustrated in figure 7.

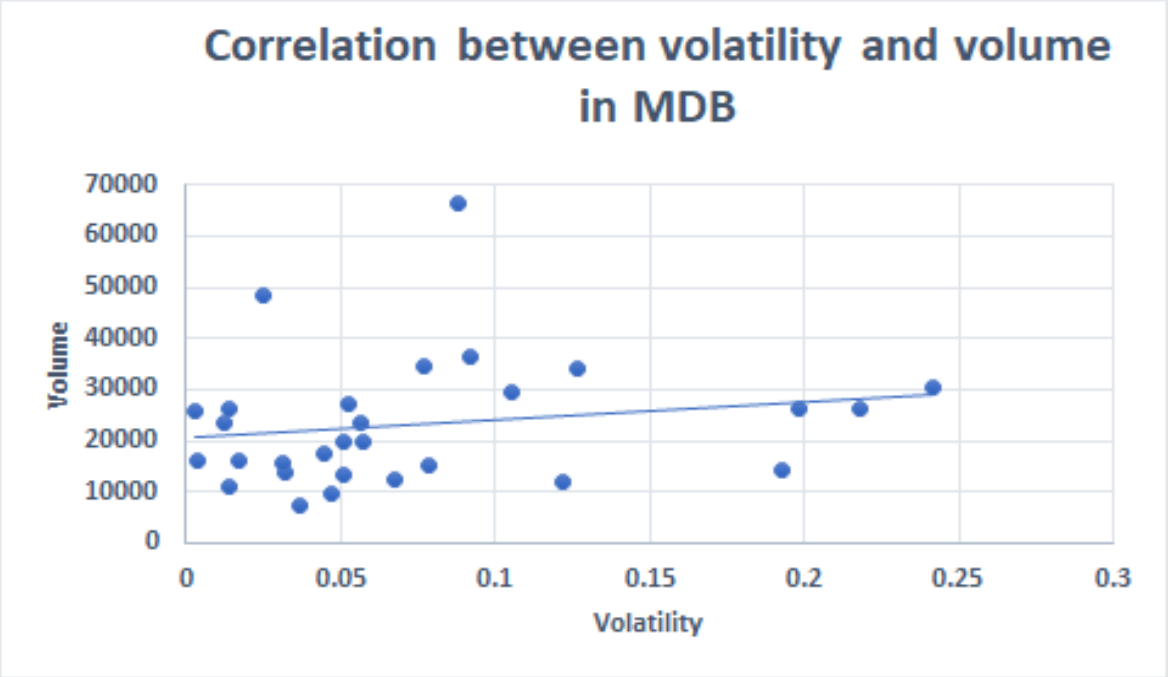


Figure 7: Correlation between volatility and volume in MDB (Data from Department of Agriculture, 2019).

It appears to be no clear correlation between volatility and volumes traded, in either of the directions. There is some trading being done for volatility levels of 20-25%, but the volume is equal to the volumes traded at lower levels of liquidity and there is no clear pattern in terms of correlation for our data. There was also no clear correlation between volume and volatility in the North-subregion, shown in figure 8. It looks like there is a correlation, but it is mostly driven by the extreme point occurring at the volatility peak, where the volume also reached a significant peak. Interestingly, the second time the volatility reached an extreme level the volume traded were close to zero. Furthermore, there is no correlation between volume and volatility for the lower/normal levels of volatility.

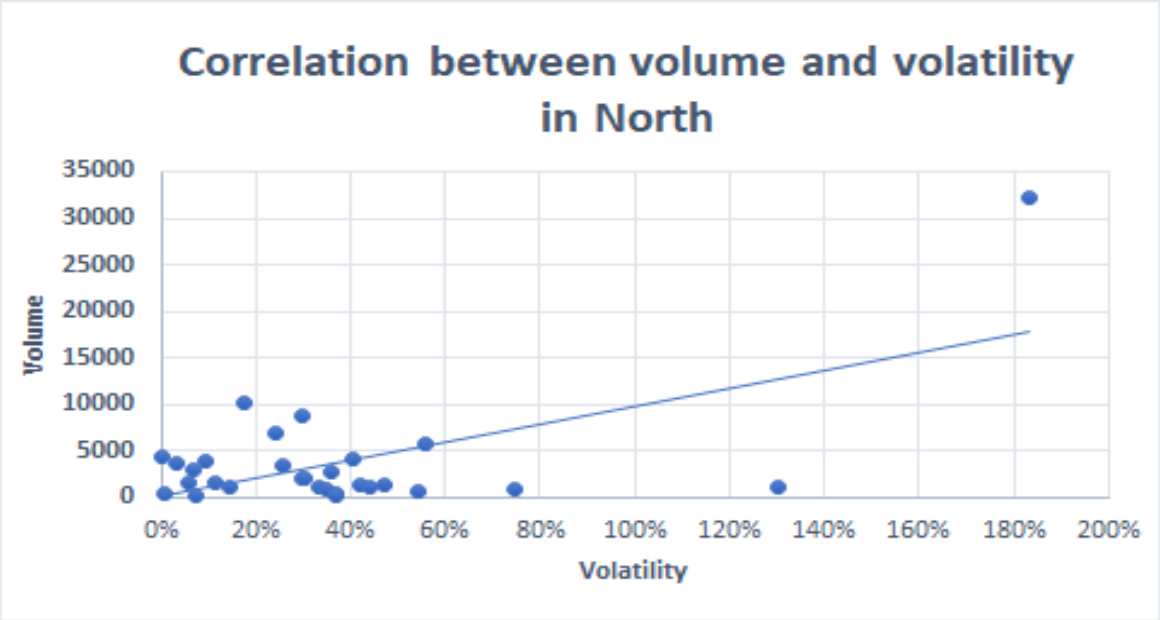


Figure 8: Correlation between volatility and volume in North (Data from Department of Agriculture, 2019).

Overall, the volatility for MDB is low enough to attract utilitarian traders. In regards of speculators, some might find the volatility in MDB too low, but they can invest in volatile subregions like the North-subregion where the volatility is far higher than the average. The highest levels of volatility in the North-subregion can be problematic in terms of a well-functioning market, but since such levels seldomly occur it is not too problematic. Based on this analysis, the volatility in the MDB is sufficient enough for profit motivated traders to be able to make money by speculating in the market, and stable enough for utilitarian traders to participate in the market.

7.5 Theory - Transaction cost

Transaction costs are what people pay to move money from one point in time to another (Harris, 2003). In this case it is the expenses which occurs when buying or selling financial instruments; explicit costs, implicit costs and missed trade opportunity costs. Explicit costs can be commissions, taxes to the government and fees to the exchanges. In general, it is everything that can be accounted for. Implicit costs are the cost of paying the spread or the cost of moving and impacting the price. Missed trade opportunity costs can be the cost of missing out of a trade because the trader placed a limit order that was not executed. Time being spent searching for information about the market is also considered as a transaction cost.

Transaction costs are low in liquid markets, which is one of the main reasons liquid markets are preferred by traders (Gomber & Schweickert, 2002). Therefore, lower transaction costs tend to make markets more liquid, because it attracts more types of traders. In a well-functioning market, the liquidity is high and the transaction costs low in a correlated manner.

7.6 Analysis - Transactions costs

Because the data used in this paper do not contain information on the implicit and missed traded opportunity cost, this part will focus on the explicit transaction costs in the market.

In water trading markets, it is important to have established the infrastructure required to transport water from seller to buyer. The transportation of water can involve pipelines and canals and are costly investments. This may be an obstacle and barrier for developing water markets. In Australia, billions of dollars have been invested to develop infrastructure. Trading of water moves it to where it is most needed, and sometimes where the infrastructure is not developed. As a result of this, some of the established infrastructure has been idle, because the water has been needed elsewhere (Milke & Raffernsperger, 2017). Because the infrastructure is not fully developed, the transaction time varies a lot between the districts. In Victoria the transaction is completed instantly, while for New South Wales it could take up to 5 days and for South Australia the delivery of water takes around 2 weeks. This force irrigators to plan weeks in advance, which takes time and could make the market inefficient to some extent (Feuerherdt, 2019).

In the MDB region, water rights are kept to areas where the infrastructure is already established. The owners of the water rights are already covering their fixed cost of transportation because the infrastructure has been developed. If the owners would like to sell the water rights to someone outside the area, they charge a fee of 15-20% and sometimes as high as 80% of the selling price (Rayl, 2016). This is a huge transaction cost and can prevent the market to allocate the water to where it is most needed.

One of the obstacles for the water market is the complexity. The different trading platforms are not easily understood by regular investors without any special experiences from the water trading industry. Investors can buy a variety of different security types from the trading platforms, such as high security water or general security. The price between these two vary a

lot and depend on demand and geography. Additionally, the market has several different prices on water. Because of this it could be a large spread in prices. As a result, the traders have to spend time trying to gather information about the price, which is inefficient (Feuerherdt, 2019). Figure 9 illustrates the difference between high security and general security water prices.

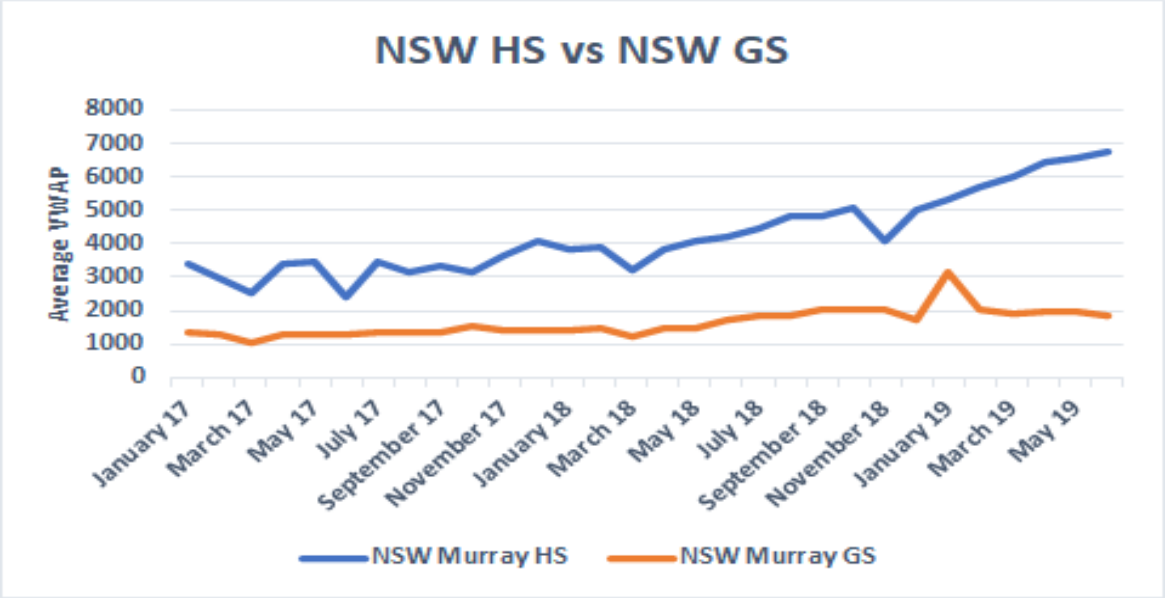


Figure 9: Average VWAP in NSW HS vs NSW GS (Data from Department of Agriculture, 2019).

Kim Morison, former managing director of Blue Sky Water Fund, who has invested in water since 2012, says: "You have to know what commodities that water supports, what are the drivers of climate in any particular region, what's supply and availability in the area" (Courtenay, 2017). The time it takes for an investor to gather information about the market may serve as a barrier from investing in the water market. For farmers this information is much more likely to be available and is based on many years experience supporting the objective of the market regulation - to make a more efficient allocation of water for agricultural purposes.

To sum up - the transaction costs of water trading in Australia is relatively high. The major cost driver is the building of infrastructure and the cost of lack of utilization because water demand varies from season to season and from year to year. In addition, it is no single market price on water. The time it takes for an investor to gather the different prices from the exchanges and brokers could be a barrier from investing in the market.

7.7 Theory - Informative prices

The efficient market hypothesis states that the price of a financial instrument should reflect all relevant and available information about the instrument at a given time (Harris, 2003), i.e. an informative price. The hypothesis uses three levels of efficiency; strong-form efficiency, semi strong-form efficiency and weak strong-form efficiency as illustrated in figure 10.

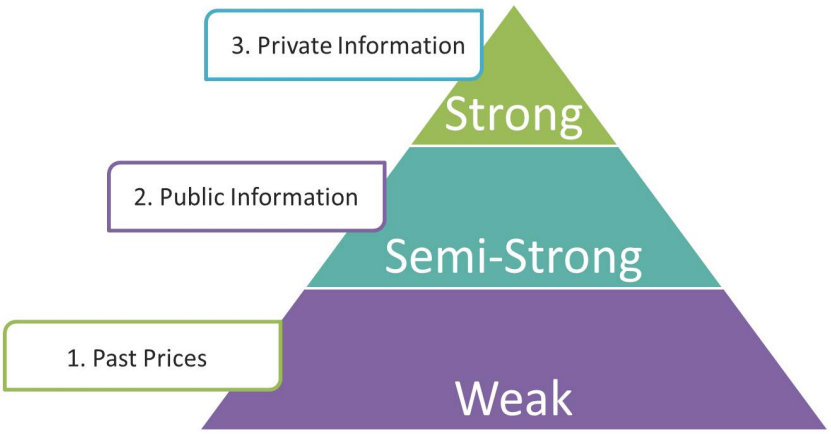


Figure 10: The three levels of efficiency (Smith, 2019).

Markets are weak-form efficient if the current price reflects the information in the past prices, so no one can predict the future price by looking at the past price. Empirical studies show that most markets have this form of efficiency (Harris, 2003).

Semi-strong efficiency occurs when the prices reflects not only past prices but also all the public information available at that given time (Malkiel, 1989). In this case informed traders can make a profit based on information not known to the public. A lot of markets are semi-strong efficient (Harris, 2013).

Markets are strong-form efficient if the prices reflect all available information, both known and unknown to the public. In these markets, trading based on inside information is not profitable and informed traders cannot profit from trading. Only a few markets are strong-form efficient (Harris, 2013).

How informative prices are depends on the costs of acquiring information and how much liquidity is available. If the information is expensive or the market is illiquid, the prices will not be very informative. Fully informative prices seem to follow “random walks” because no

one can predict future price changes from past information when the prices fully reflect the available information (Harris, 2003).

7.8 Analysis - Informative prices

The fundamental value of water is rather unclear and not very well defined, as it depends on circumstances such as season, place and meteorological conditions – i.e. varying demand. Inside information in the water market is also by definition difficult to measure and analyse. Because of this, it is complicated to identify the type of efficiency dominating this market. The weather forecast can represent a source of information which can be relevant for the market and the demand. It is relevant because rain is a source of supply to the water market. If the price is informative, and at least semi-strong efficient, it should contain this public information about the variation in supply.

In order to test the assumption that the water market is semi-strong efficient, the price of water over a period is compared to the amount of rainfall in the same period. Figure 11 illustrates the actual amount of rain fallen, the expected amount of rain and the water price during the studied period. Expected rain is historic data from Bureau of Meteorology (1980-2016) of average rain in the respective months.

However, there are some assumptions that need to be made in order to conduct this analysis. One of the assumptions are that the weather forecast is predicting the development in rainfall one month beforehand. The second assumption is that the precision of the weather forecast is high for the same period (i.e. the amount of rain). If these two assumptions are true, the weather forecast predicting rainfall would be the same as the line for actual rain in figure 11, but the information would come a month earlier than what is shown in the figure. In other words, the weather forecast in the figure is represented by the line of actual rain, only a month in beforehand.

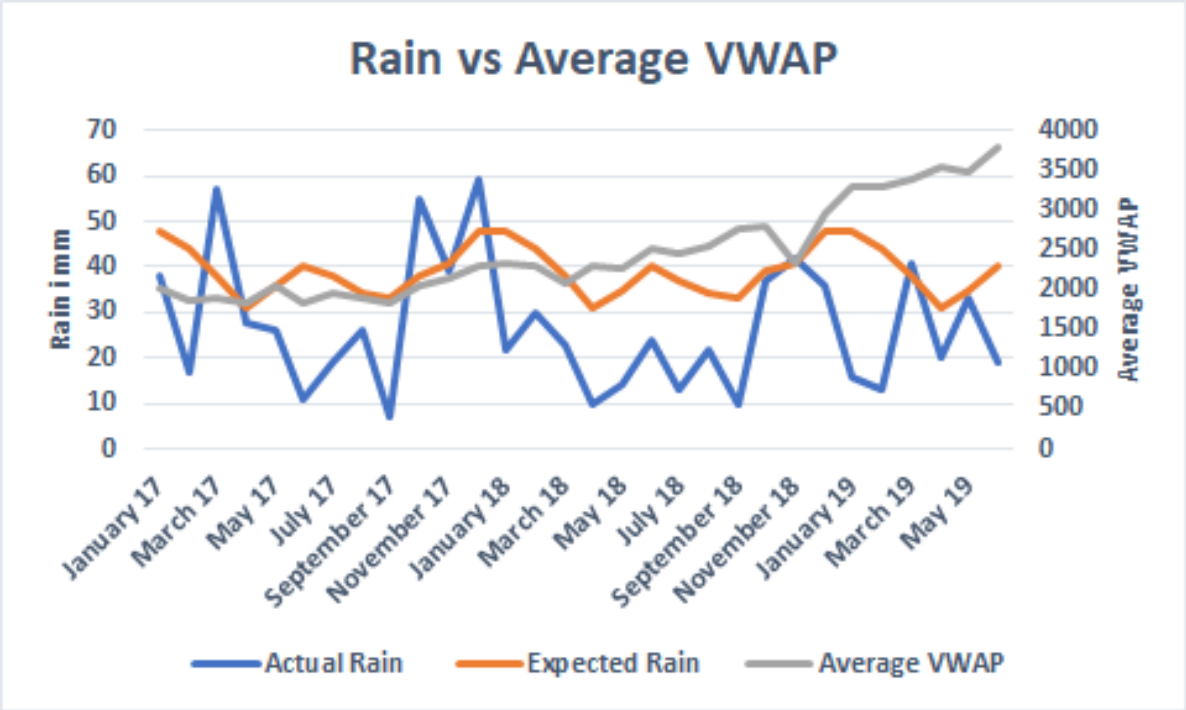


Figure 11: Actual and expected rain vs average VWAP (Data from Department of Agriculture & Bureau of Meteorology, 2019)

The figure shows a slow and increasing trend for the price during the whole period. For the last part of the figure, from October 2018 to present, the price increase correlates with a decrease in the actual rain. At some points the increase in price comes a month before a significant drop in rainfall, as could be expected if our assumptions are true and the price is informative regarding weather forecasts. The lowest period of actual rainfall is from January 2018 to September 2018. During this period the rainfall was never higher than 30mm per month. The price of water increases slowly during this period, and also here the price rise sometimes occurs a month before a sudden drop in rainfall. Similarly, it could be expected that the price would decrease a month before an increase in rain, but there is no evidence from the figure that this happens during the period. Generally, it is no clear and strong pattern regarding the price movement set up against actual (forecasted) rain, even if it sometimes fits the predicted pattern.

An obvious reason for this could be that rainfall is not the only factor that determines the price of water. Additionally the VWAP in the figure contains both spot prices and prices on derivatives bought several months before the weather forecast is presented. It is likely that such derivatives get bought based on the amount of expected rain in a given month. This may

contribute to smoothen the price changes when unexpected patterns in rainfall occurs. Therefore it is difficult to draw any conclusions based on the figure, but if any were to be drawn, the price is not very informative regarding the weather forecast.

To further examine the price and whether it is informative, Craig Feuerherdt gives some insight on his thoughts on the subject, as a long-time participant in the market; *"... there is no single price in the market which makes price and depth discovery very difficult... This means people need to spend time to determine the price of water which is very inefficient. This inefficiency means that those with the resources are able to find arbitrage opportunities… This can create significant shifts in market prices for no apparent reason."* (Feuerherdt, 2019)

Since some traders have arbitrage opportunities, the price certainly not reflect every information available and by definition the price is not strong-form efficient. Based on the information received by Craig Feuerherdt and figure 11, the price is not semi-strong efficient either. A trader can not predict the future price by looking at the past price, so it is at the very least weak-form efficient.

8 Conclusion

The aim of this paper has been to supply insight into the Australian water market and conclude if it is well-functioning, through an analysis based on four important factors. The findings of the analysis are presented chronologically below.

The variances in volumes and trades in the different regions in the market is a concern to the liquidity. Many subregions have days without any trading activity, indicating that these subregions are illiquid. For MDB in total, the liquidity is better off than these single subregions, but it is generally not satisfactory enough for a well-functioning market. Further, the volatility analysis discovered that the North region peaks at high volatility-levels, but it occurs rarely. Besides that, the volatility for MDB averaged below 10%. Because of this, the volatility in MDB is considered stable enough to make the market functional for utilitarian traders. It is also considered sufficient enough to be lucrative for certain profit-motivated traders, and by this attracts speculators and foreign traders. The volatility is considered to be satisfactory for a well-functioning market.

Transaction costs are discovered as high, which argues against it being a well-functioning market. A major price driver is the cost of developing infrastructure to transfer the water, as well as the transferring time is very various. The market can also appear advanced for traders to understand as well as having a spread in prices, which can create a substantial transaction cost in means of time. Informative prices are the last prerequisite for a well-functioning market. The analysis concludes that the weather data is not reflected in the price. Including the fact that the price varies greatly, making arbitrage opportunities, the conclusion is that the prices are weak-form efficient at most.

Because of the liquidity, transaction costs and weak-form efficient prices, the water market in Australia is not well-functioning based on the analysis of regular standards for financial markets. Liquidity impacts every other factor and is perhaps the most determinant factor for a market to be well-functioning. Based on this, a top priority to improve the market would be to enhance the liquidity by lowering the transaction costs.

As the electronic trading platforms are relatively new, it is also possible that the market is evolving in the direction of a well-functioning market because of the features these platforms brings to the market attracts traders. This may contribute to lower the transaction costs. The inquiry from H2OX to the ACCC to regulate the market may result in a higher level of price efficiency as well. These are possible ways of improving the market, however this could be the topic of another paper and is outside the scope of this paper. Further discussion of this is therefore omitted.

A final and important reflection on this market, is that the nature of water is different from other commodities and financial instruments. Water is needed for people to survive, and for farmers to generate food. For many purposes, it is impossible to substitute this commodity. Compared to other water markets, which may be the most relevant comparison, the Australian water market is quite liquid and Australia is widely recognised as a front runner for the water markets (Buiter, 2017). Transaction costs are also lower than in several other comparable water markets such as the Californian water market (Johnson, 2015). Craig Feuerherdt from H2OX believes that the market is relatively efficient as well. As a water market, the Australian water market is therefore considered well-functioning, and perhaps even the most well-functioning water market there is.

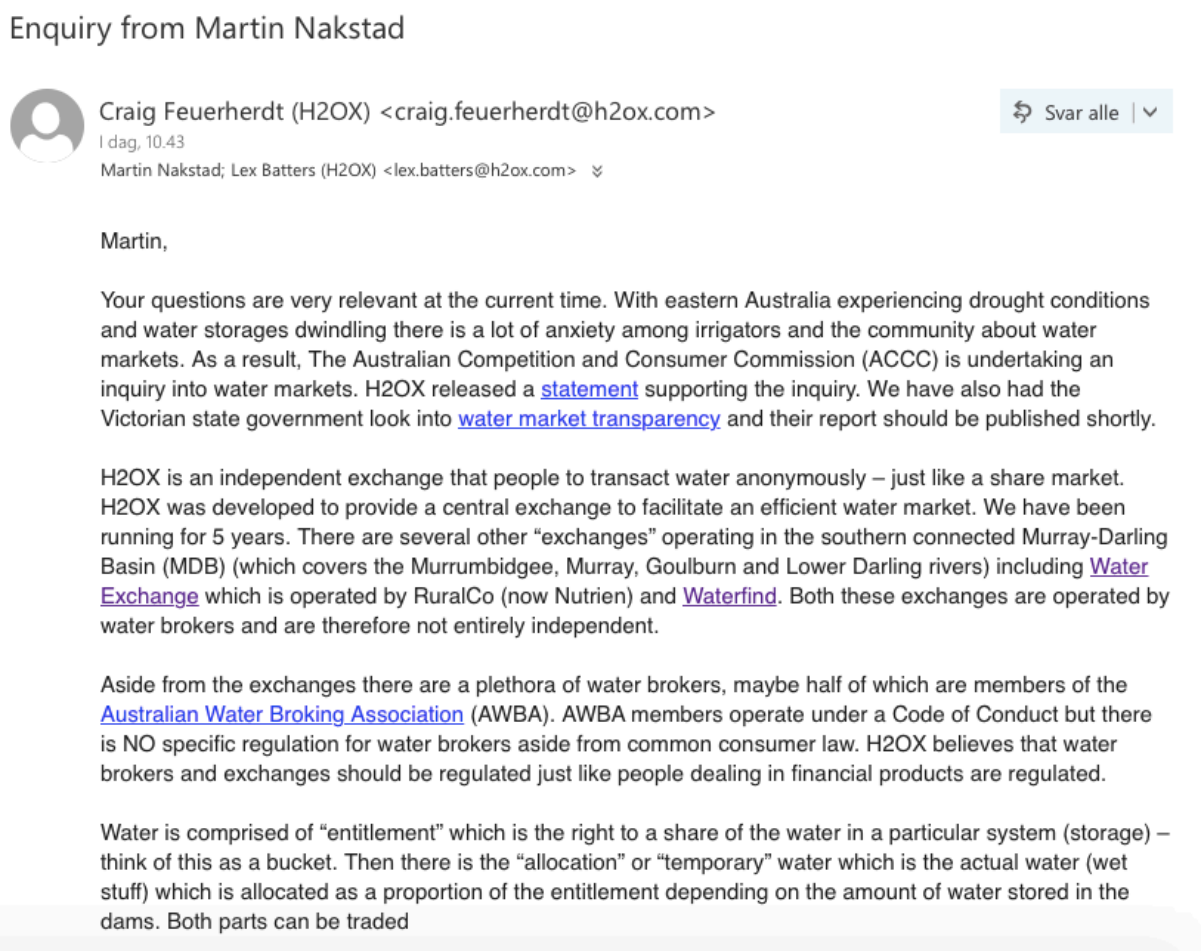
9 Limitations of the analysis

The four factors we have evaluated has been presented as key factors, but to evaluate the market more properly, the analysis could have considered other aspects as well. Examples are how prone to shocks the market is, or how innovative and dynamic the market is. This could impact how well-functioning the MDB water market is. The findings also have some other limitations which will be presented below.

The available data doesn't provide information about each trade separately. For price matters, it consists of the monthly broker spread between buy and bid, and average monthly VWAP for each region. Regarding volumes, it contains monthly total volumes and trades. The data also lacks information about if the trades are derivatives or at spot price. Furthermore, the data doesn't show if the participants in the market are speculators or farmers with land in the district. With this information we could have done a more precise and a deeper analysis about the water market in Australia, and how the participants use it. It is also worth mentioning that the information received from Craig Feuerherdt is based on his personal opinions and experiences from the market, and by that reason could be biased. This should be considered when evaluating the information contained from this dialogue.

When this analysis was conducted there were several months where “Broker spread buy/sell” information was omitted, because the information was not made public available. Therefore, VWAP has been used because it provides a more accurate information for the analysis.

10 Appendix



Enquiry from Martin Nakstad

Craig Feuerherdt (H2OX) <craig.feuerherdt@h2ox.com>
I dag, 10.43
Martin Nakstad; Lex Batters (H2OX) <lex.batters@h2ox.com>

Svar alle

Martin,

Your questions are very relevant at the current time. With eastern Australia experiencing drought conditions and water storages dwindling there is a lot of anxiety among irrigators and the community about water markets. As a result, The Australian Competition and Consumer Commission (ACCC) is undertaking an inquiry into water markets. H2OX released a statement supporting the inquiry. We have also had the Victorian state government look into water market transparency and their report should be published shortly.

H2OX is an independent exchange that people to transact water anonymously – just like a share market. H2OX was developed to provide a central exchange to facilitate an efficient water market. We have been running for 5 years. There are several other "exchanges" operating in the southern connected Murray-Darling Basin (MDB) (which covers the Murrumbidgee, Murray, Goulburn and Lower Darling rivers) including Water Exchange which is operated by RuralCo (now Nutrien) and Waterfind. Both these exchanges are operated by water brokers and are therefore not entirely independent.

Aside from the exchanges there are a plethora of water brokers, maybe half of which are members of the Australian Water Broking Association (AWBA). AWBA members operate under a Code of Conduct but there is NO specific regulation for water brokers aside from common consumer law. H2OX believes that water brokers and exchanges should be regulated just like people dealing in financial products are regulated.

Water is comprised of "entitlement" which is the right to a share of the water in a particular system (storage) – think of this as a bucket. Then there is the "allocation" or "temporary" water which is the actual water (wet stuff) which is allocated as a proportion of the entitlement depending on the amount of water stored in the dams. Both parts can be traded

Figure 12: Screenshot of e-mail from Craig Feuerherdt, first part

Australia's water market has been developed over the last 20 years or so as water was "unbundled" from the land. Prior to this water was associated with a parcel of land where it had to be used. It was very difficult for water to be traded. In Victoria unbundling occurred on 1 July 2007. This process allowed water owners so buy and sell water to meet their requirements. At that time water turned into a tradeable commodity. It also allowed non-landholders to own and trade water.

The Australian water market is efficient to an extent. It is always possible to trade water in the southern MDB. Unfortunately the water market is very splintered with 3 exchanges and a multitude of brokers. This means there is no single price in the market which makes price and depth discovery very difficult. As a result, there can be a large spread in the prices between intermediaries. This means people need to spend time to determine the price of water which is very inefficient. This inefficiency means that those with the resources are able to find arbitrage opportunities – buy from Broker A at $X and seel through Broker B at $X+n. This can create significant shifts in market prices for no apparent reason. A single, independent exchange would solve this inefficiency.

There has been a lot of discussion about "speculators" in the market. These are entities that don't own land but trade water. Many irrigators feel that these entities are distorting the market because they own a large percentage of the water and can manipulate prices by purchasing large volumes of water and not sell it back into the market. From our position as an exchange, we have seen this activity done by all types of market participants from large corporate investors through to smaller family farmers. Ultimately this is the basis of the ACCC inquiry. H2OX believe that a single exchange would minimise this activity. With all water being listed on a single exchange it provides one single price point. This allows everyone to speculate from a single source of truth. The reality is all market participants, including farmers are speculators. Farmers speculate on water prices coming down, (some) investors speculate on the water price going up. Naturally there are risks for both.

There are also inefficiencies in transacting the water. In the state of Victoria, transactions of allocation/temporary water (the physical wet stuff) are completed instantly. In NSW transactions are completed by a human and take 2-5 days depending on how busy they are. In South Australia transactions take around 2 weeks. All this delay mean irrigators need to plan many weeks in advance especially when trading water between states – something that is difficult when there are many other jobs to be done on a farm. These inefficiencies are slowly being improved but require government investment in the various water registers.

In terms of the delivery of water to the farmers property, the majority of the southern MDB has water delivered by gravity through open channels. This isn't the most water efficient method given evaporation and seepage, but it is energy efficient. Most water authorities allow irrigators to place orders within 24 hours of the delivery time.

In summary, the Australian water market is relatively efficient. H2OX believe the adoption of a single exchange would introduce another step change in market efficiency and remove a lot of the angst around water prices being experienced in the market today.

H2OX would be more than happy to have a discussion with you and your fellow students. Let me know if that's something you'd be interested in.

Good luck with your papers!

H2OX
AN XCHG COMPANY

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Figure 13: Screenshot of e-mail from Craig Feuerherdt, second part

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