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REVIEW

Debunking Murray-Darling Basin water trade myths

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Abstract

Australia, and particularly the Murray–Darling Basin (MDB), has the most mature and adopted water markets globally. Water trading is an important policy tool to deal with water scarcity issues, demonstrating allocative, dynamic and productive efficiency benefits. At the same time, water markets have been controversial in Australia. Markets have been blamed for a range of issues, including claims of unsustainability, inequity, farm bankruptcy, farmer distress and farm exit. This study reviews the MDB water trade literature and finds little evidence to support such myths. Arguably, the biggest misconception is that critics do not separate water markets from the meta-governance institutional structures that define them. Perceived water market failures are often due to governance issues – not water trade per se. This is not to say that market failure does not exist, it does, and indeed, there are also serious distributional issues that need addressing (e.g., water property entitlements for indigenous stakeholders). As such, water market design and governance need to adapt and evolve as problems arise and the market matures. However, in an era of increasing water scarcity, enabling water trade remains one of the most important instruments available to assist in water sharing, reallocation and farm adaptation to climate change.

KEYWORDS

adaptation, allocative efficiency, Australia, climate change, formal markets, informal markets, water markets, water trading

JEL CLASSIFICATION
Q25, Q13

1 | INTRODUCTION

Growing water scarcity and quality issues around the world have resulted in policy-makers increasingly turning to demand-management measures such as water use and behaviour regulation (e.g., metering and extraction limits), education, and various economic instruments – including water pricing, property rights, taxation and subsidies (Barbier, 2019; Grafton et al., 2022; Griffin, 2006). Water trade has been promoted since the 1960s (Hartman & Seastone, 1965); and is an example of an economic water demand management instrument that provides a flexible, voluntary and efficient allocation of a scarce resource (Easter et al., 1998; Freebairn, 2005; Howe, 2000; Randall, 1981). This study uses the terms of 'water market' and 'water trading arrangements' interchangeably, but it must be noted that a region can have water trading arrangements without a water market being formally present. Water markets have been both lauded and deplored, from many differing perspectives. Nowhere, is this more prominent than in the region that has the most sophisticated water markets in the world – the Murray–Darling Basin (MDB) in Australia.

A water market is one form of a renewable natural market, and as such may be characterized by potential issues with an incomplete assignment of property rights, pervasive externalities and limited scientific information (Barbier, 2019; Hanemann, 2006; Wheeler, Loch, Zuo, & Bjornlund, 2014a). Water markets allocate water to its highest value consumption by establishing a price signal, and prices fluctuate in response to demand and supply signals (Bauer, 1998; Easter et al., 1998; Howe, 2000; Maestu, 2013). Formal water trading involves the buying and selling of water entitlements (also called permanent water, licences or rights). Two broad types of formal water trading can be defined: (i) short-term or temporary transfers of water (known as water allocation trade); and (ii) permanent transfers of water entitlements. This includes both the ongoing property right to either a proportion or fixed quantity of the available water at a given source and water delivery entitlements – the priority right to have water delivered at a specific time (Grafton et al., 2016).

Economists have traditionally been supportive of the efficiency gains that can be derived from water trade (e.g. Crase, 2021; Crase et al., 2004; Easter et al., 1998; Freebairn, 2005;Young, 2019), which relate to both economic efficiency and equity (Dinar et al., 1997; Grafton et al., 2016). Howe (2000) highlighted the following advantages of water markets over other allocation schemes, namely: flexible reallocation over time in response to economic, demographic, and social-value changes; involves only willing sellers and buyers, therefore, provides security of tenure of property rights; and elucidates the real opportunity cost of water. These advantages lead to three distinct forms of economic efficiency: (1) *allocative*: water temporary trade improves water resource short-term decision-making by reflecting seasonal conditions (e.g., weather, commodity price adjustments, cropping choices); (2) *dynamic*: water permanent trade improves water resource structural or long-term decision-making by reflecting new investment opportunities, water regulation changes or personal strategic choices; and (3) *productive*: water price changes (both temporary and permanent) offer incentives for the efficient use of water resources as either an investment or input for productive outcomes. However, before such benefits are possible, many economists have emphasized the significant water meta-governance reforms needed for markets (e.g., Bell & Quiggin, 2008; Freebairn, 2005; Grafton et al., 2011, 2016; Young, 2019).

Given both market-efficiency benefits, and growing world water scarcity, water trade has increasingly been studied within Australia and worldwide. Figure 1 illustrates the annual

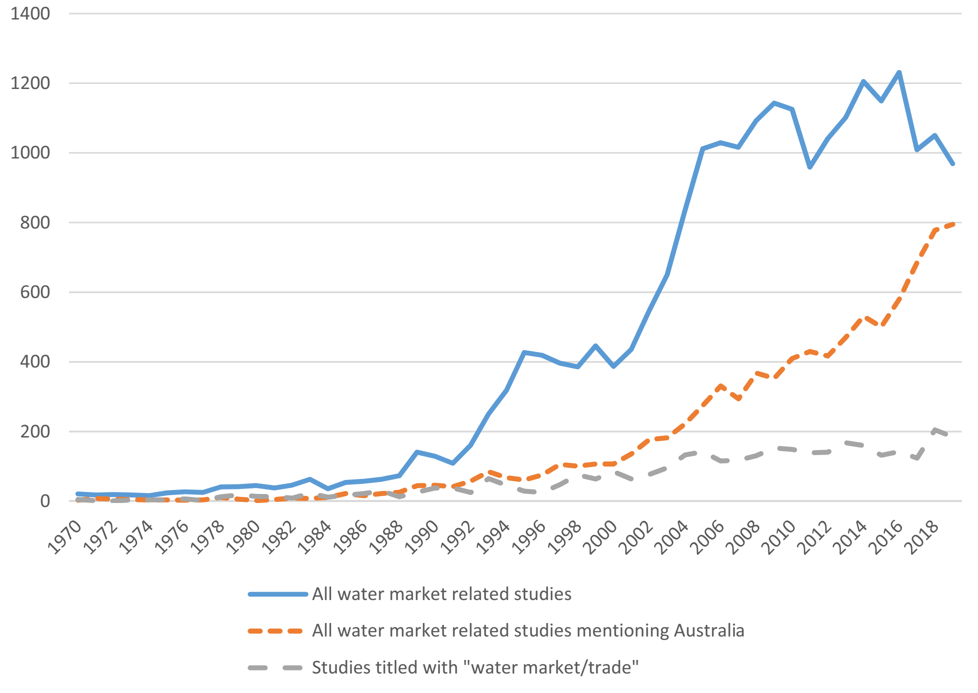

FIGURE 1 Published water trade related literature, 1970–2019. *Source*: Adapted and added to from original analysis in Wheeler and Xu (2021).

number of water market/trade-related studies over time, with Australia receiving the greatest focus, followed by the United States (mostly the western states), China and other countries that have faced significant water constraints (e.g., Chile, Spain, Middle East and North Africa, Canada, South Africa, India, UK). Topics studied include institutional conditions and frameworks; privatization and marketization issues; policy evaluation; farmers' willingness to pay; transaction costs; price and volume drivers; water use efficiency; environmental impacts; cultural issues; water quality; uncertainty; risk; theft and informal trade (Wheeler & Xu, 2021).

Despite the benefits water trade offers, given the significant meta-governance needs there has been limited practical implementation (Chong & Sunding, 2006; Crase et al., 2004; Grafton et al., 2022; Wheeler, 2021). Water trade arrangements are complex economic instruments to design, develop, implement, sustain and adapt over time. Several studies have provided frameworks or guidelines for implementation of water markets (e.g., Freebairn, 2005; Grafton et al., 2011; Wheeler et al., 2017). Wheeler (2021) analysed the extent of water trade adoption across 20 countries (and 28 regions), finding that formal water markets have been slow to develop in most regions – with only regions in the US and Australia rated as being at a highly developed market stage. Informal water trade (where water users share a resource and can include arrangements between neighbours or other forms) were found to be more common and indeed could be greater utilized as a water sharing tool in the future. Within Australia, the MDB is commonly recognized as the most sophisticated, and adopted, surface-water market in the world (Grafton et al., 2016; Grafton et al., 2022).

However, there are many critics of water markets (e.g., Bakker, 2007; Dellapenna, 2000; Hamilton & Kells, 2021). Concerns centre around the idea that water is too unique and important to trade; that trade disadvantages many farms (especially smaller farms); and that water markets create an environment for unethical behaviour and the development of water barons (Hamilton & Kells, 2021). Critics argue that because water – as a basic human need – is fundamentally different to other tradeable commodities, allowing water markets is fundamentally wrong and immoral (Bakker, 2007; Dellapenna, 2000). Within Australia in particular – despite the decades of success of water markets in reallocating water in times of scarcity – there is still a view by some that water markets are an experiment that has turned into a 'casino' and a 'catastrophic error' (Hamilton & Kells, 2021). Water market issues have also been embroiled in controversies associated with the MDB Plan, given that buying back water entitlements has been the largest – and most successful – cost-effective strategy to recover consumptive water entitlements for the environment (Grafton & Wheeler, 2018). The extent to which there is any actual evidence for these claims of negative water market impacts is reviewed in this study.

Climate change issues, and especially increases in temperature and increased rainfall variability, along with water overallocation issues in the MDB (Grafton, 2019; Wheeler, Xu, & Zuo, 2020b), mean that water scarcity will only worsen. Australia will need all its water-sharing policy tools it has available, and hence understanding the role that water markets have played – and can further play – is critical for future policy, especially for regions where water trading arrangements are premature. Hence, it is important to judge the validity of the many MDB water trade myths that exist, and to ask whether water markets do represent a net cost for society. Similar to the five MDB myths identified in Wittwer (2019), this study identifies the four most popular water trade myths that persist in Australia – and critically examines the evidence for and against these beliefs. Given that the MDB has the largest water markets in the world, this makes it an apt case study to review the evidence for popular water trade myths. The article concludes with a summary of lessons learned, and insights on how to further improve water-trading arrangements and governance issues.

2 | AUSTRALIAN WATER MARKETS

2.1 | Background and history

Many economists have written about the history of water policy and markets in Australia, particularly, within the MDB (e.g., Crase, 2021; Cummins & Watson, 2012; Freebairn, 2005; Grafton, 2019; Grafton et al., 2016; Heaney et al., 2006; Lee & Ancev, 2009; NWC, 2011; Tisdell, 2011; Young, 2014; Young et al., 2000). All the MDB states have their own water registers, and often different water terminologies. Water trading is arranged within and between various water trading zones, with varying rules applying to carry-over of unused water allocations, tagged trade and inter-valley trade restrictions across regions (Holley & Sinclair, 2016). Within the MDB, the southern Basin is the largest water market in Australia in terms of geographic area and volumes/numbers of water entitlements. Northern MDB water markets observe lower water-trading volumes, which has been attributed to relative illiquidity, lower public storage, less hydrological connectivity, less regulated entitlements and more homogenous agricultural production – coupled with far greater on-farm water storage and groundwater extraction. There are also significant water governance differences between the southern and northern parts of the Basin – with the northern Basin needing significant institutional reform before greater water trading is allowed (Wheeler & Garrick, 2020).

Informal water markets existed in the MDB for many decades prior to the introduction of formal market rules and regulations (Wheeler, 2014). The 1980s saw increasing water scarcity and quality problems which hastened formal water trade introduction. Various states began separating water entitlements from land, from the early 1980s onwards (Tisdell, 2011). Irrigators became more favourably disposed to water trading from the 1990s to the 2000s, with temporary trading far more accepted than permanent trading (Bjornlund et al., 2011). A cap on overall water diversions introduced in 1995 and the National Water Initiative reforms in 2004 (which introduced further intergovernmental reforms to reduce trade barriers) hastened the adoption of surface-water trade (Crase et al., 2004; Wheeler et al., 2008). In the past decade,

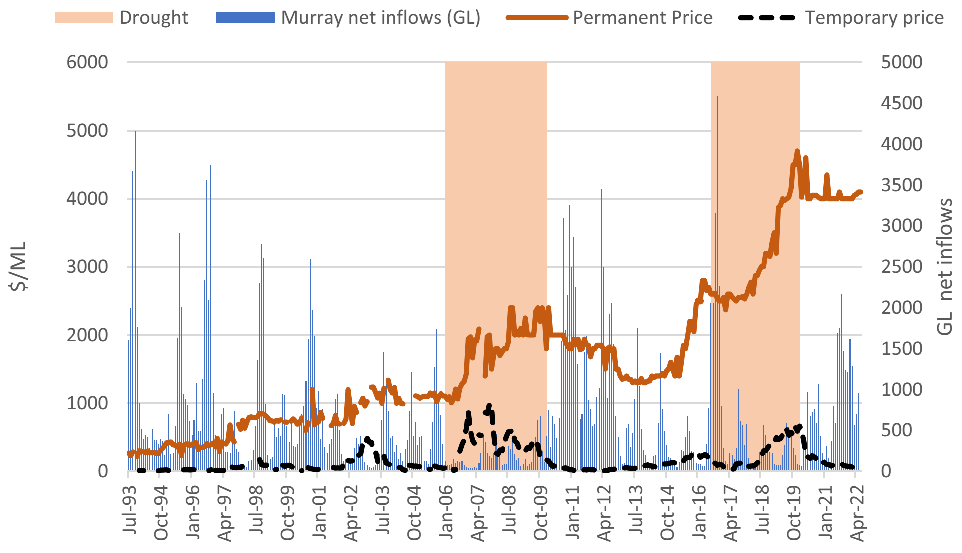

FIGURE 2 Monthly permanent and temporary nominal Goulburn water market prices and Murray net inflows, 1993–2022. *Sources*: Victorian water registers; permanent prices are for median monthly Goulburn 1A high security water entitlements, Murray net inflows sourced from MDBA (James Fuller personal communication, 27/6/2022). The most serious drought timeframes are only shown in Figure 2, though it should be noted that moderate droughts in 1998 and 2002–03 also occurred.

groundwater trade has also increased, along with conjunctive management of both surface- and groundwater resources (Wheeler et al., 2021).

By the year 2000, despite water formal trading arrangements being in operation for almost two decades, less than 10% of irrigators in the southern MDB had conducted a water market trade. By 2015–16, adoption had increased considerably and around half of all irrigators in the southern MDB had made at least one permanent trade, while 78% had conducted at least one temporary trade (Grafton & Wheeler, 2018). As at 2019–20, the Australian Competition and Consumer Commission (ACCC) estimated the value of water entitlements on issue across Australia was AUD$26.3 billion, with an average annual trade turnover (estimated from 2012–13 to 2019–20) of around AUD$1.8 billion (ACCC, 2021).

The separation of land from water allowed for new water trade participants, namely, environmental groups; non-landholder financial investors (e.g., superannuation companies and trade speculators); urban water authorities; and industry (e.g., manufacturing or mining industries) (Ancev, 2015; Connor et al., 2013; Seidl et al., 2020b). Water market reforms also drove changes in financial investment funds and other innovations. Governments in Australia began using formal water markets as a method to recover water from consumptive use (namely, from irrigators willing to sell water) and return it to environmental use from the 2000s onwards (Grafton et al., 2022).

Even though water trade is now a common adaptation water management tool used by irrigators, it remains controversial. One of the main reasons for this is the fact that water markets allow prices of water to vary according to water scarcity and demand. Prices of water, especially temporary water, consequently can – and have – varied considerably. For example, Figure 2 illustrates net inflows to the Murray River and nominal temporary and permanent nominal water market prices in the Goulburn, Victoria, the largest water market in the MDB, from the early 1990s to 2022. Such variability in prices, and the associated hardship this can cause in times of high prices for those irrigators who do not have sufficient permanent water and hence need to buy temporary water, can cause significant stress and financial pain. Wheeler et al. (2018) highlight the association between MDB irrigators' poor mental

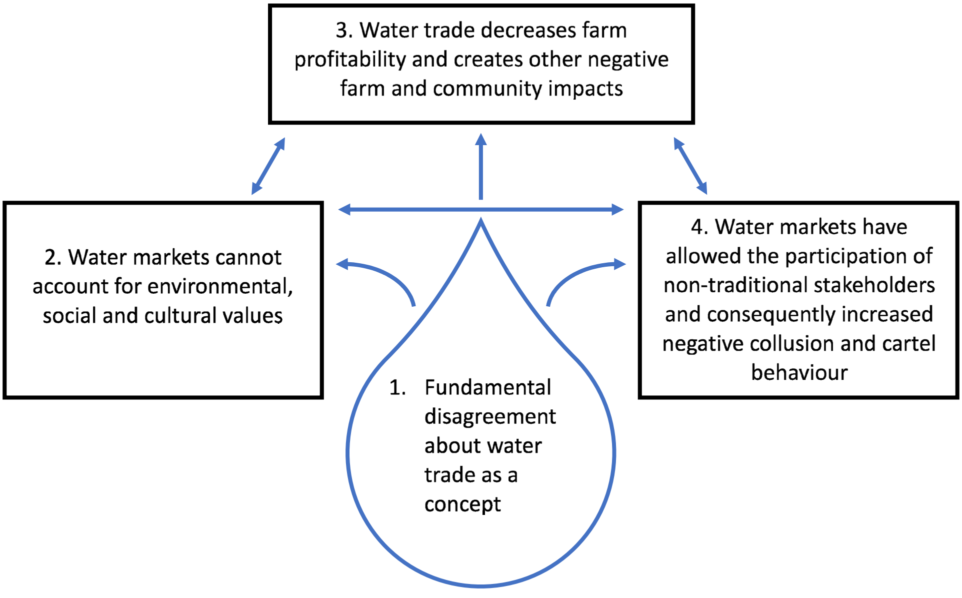

FIGURE 3 Water trade myths in Australia.

health and financial hardship. As such, in times of drought and low-water allocations, water markets are often singled out as an easy blame for irrigator hardship. For example, irrigator concerns raised about both water market prices in the south-eastern drought from 2016/17 to 2019/20 (e.g., Goulburn temporary prices reached the median monthly price of $665/ML in January 2020) and increased corporate investor water market participation, led the government to commission a wide-ranging report by the national economic regulator (the ACCC) in 2021. By June 2022, median monthly temporary water prices had fallen to $18/ML (Figure 2). The critics of water markets are often silent during times of low prices, but much louder in times of higher prices.

Although water markets, like many other markets, have their share of market failure issues in Australia, it is worth first reviewing the actual evidence for and against four broad Australian water market myths.

2.2 | Australian water market myths

Figure 3 and Table 1 provide an overview of the top water market 'myths' that exist in Australia. The following groups these myths into four main categories: (i) fundamental disagreement about water entitlements as a concept; (ii) water trade and its perceived environmental, social and cultural impacts and (iii) water trade and perceived negative farm impacts; and (iv) water trade and perceived cartel or collusion behaviour.

2.2.1 | Fundamental disagreement about water trade as a concept

The water trade myth most often cited is that assigning water entitlements to private individuals is immoral because everyone has a right to water (Bakker, 2007; Barlow & Clarke, 2003; Wockner, 2017). Such an argument is often predicated on not understanding the public and private nature of water as a good, and does not distinguish between all the different uses of water. Griffin et al. (2013) argue the 'water-is-different' view exaggerates biological requirements for

TABLE 1 Summary of the evidence for and against the four main water trade myths in the MDB.

Water trade 'myths'	***Reality***
1. Assigning water rights to private irrigators is immoral because everyone has a right to water	• *Confuses the differing uses of water and usually mistakes markets with privatization issues*. Water as a whole is not a traditional public good, many uses of water are private and people can be excluded. The argument that creating water trade arrangements conflicts with other approaches such as "river rights" or legal enforcement approaches is a fallacy – both can (and should) exist together.
2. Water trade fails to account for community, environmental or other social values, hence are detrimental for society	• *Critics usually fail to distinguish between governance issues and water trade operation*. Also, there is generally no recognition of the issues of original property rights allocation (which is not a market outcome – but a political/social one). Markets can be designed to account for greater social, environmental and cultural values, and where there are serious social welfare issues, usually there are many better ways to address this, whilst maintaining markets. • The evidence regarding water trading causing environmental degradation is mixed – both positive and negative externalities exist. Many so-called environmental impacts from water trading are associated with other factors or river operations.
3. Water trade decreases farm profitability and creates other negative farm and community impacts, disproportionately impacting smaller farms.	• *There is a lack of evidence linking water trade with farm exit; lower farm profitability; and worsening farmer mental health*. Studies consistently find seasonal factors, climate, water availability, commodity prices and locational factors as the main influences on farm profitability. Although financial hardship is usually the main reason why irrigators sell permanent water, it is not the sole reason, and it does not necessarily become a causal factor for poorer future profitability. Indeed, there is evidence it can be a positive influence. Other reasons irrigators sell water include to increase farm viability; facilitate on-farm investment; and meet other family objectives. • *Financial stress is the main reason for farmer psychological distress, and this occurs separate to water trade issues*. Financial stress is impacted by many influences, but climate and drought stress are often major drivers. Indeed, selling permanent water can help address this financial stress. Empirical surveys consistently find that the majority of irrigators state selling permanent water was positive for their farm. • *Most arguments of small farmer disadvantage are common to all agricultural markets*. However, some evidence exists of information asymmetry, especially in terms of asset capital valuation and borrowing.
4. Water trade has allowed the participation of non-traditional stakeholders and consequently increased negative collusion and cartel behaviour.	• *Empirical evidence consistently finds water market movements are predominantly driven by seasonal conditions, with limited to no evidence from a recent ACCC review of collusion and cartel behaviour*. Although the size of external investors and ability to influence market is currently small and limited, there is the need for further research.

water; confuses privatization with marketization; confuses capital scarcity with water scarcity; exaggerates the need to preserve agrarian economies; and exaggerates public entitlements to water. The arguments about the right to water often confuses the role of water as part of fundamental basic need for living (e.g., clean drinking water and other essential household uses); with its role as a production input to other goods and services. For example, drinking water (along with other semi-essential households uses) represent one of the smallest water uses in Australia. Indeed, within the home, around one-third of the average use is consumed outdoors in gardens, lawns and pools. In 2019/20, Australian households used less than 20% of the physical water supply, with agriculture using more than 50% and electricity, gas, water and waste services, industry and mining the remainder (ABS, 2021).

Hence, very few water uses represent a traditional public good (e.g., non-excludable and non-rivalrous, such as abating lake pollution) and an essential basic need for living (Hanemann, 2006), while many uses of water are private (e.g., irrigation water consumption). Indeed, water characteristics make it both a private and public goods at the same time. As White (2015) outlined, water can also be classified as a common-pool good (non-excludable and rivalrous – e.g., aquifer); and as a club good (excludable and non-rivalrous – e.g., a district's irrigation infrastructure). Hence, it is important to recognize that establishing *private entitlements* in water does not necessarily conflict with *public entitlements*. Both types can be created at the same time. Society has traditionally managed many important resources (e.g., food, land) by creating private property entitlements to give individuals incentives to produce effectively and efficiently (Griffin et al., 2013). In particular, private water entitlements, and both basic human rights and ecological 'river rights' can – and indeed should – exist together. Young (2019) outlines how 'hands off' water and minimum flows in a river can work with private individual entitlements. Creation of private water entitlements does not exclude public entitlements to water – part of a resource can always be partitioned for the public domain (such as conveyance and critical water needs), as well as making sure that overall water infrastructure is publicly owned and governed by a set of institutional rules. Indeed, the assumption that private water entitlements equates to privatization of infrastructure is incorrect – the two issues are fundamentally different (Grafton et al., 2016; Griffin et al., 2013). Grafton et al. (2016) furthered this argument by outlining a variety of concepts falsely attributed to water markets, including, privatization; deregulation; decentralization; corporatisation; commercialization; marketization and resource commodification. While there may be examples of water privatization leading to appropriation – which is a concern of many critics – the more salient issue is whether this is a consequence of water trade itself, or whether it is a result of institutional failure. Indeed, Dellapenna's (2000) argument that the changes needed in the public property rights systems for water markets to be socially beneficial were too costly to justify the benefits. Developments in institutions and other innovations twenty years later suggest that this argument no longer holds for many countries. While some countries may be unable to implement formal water trade arrangements, increasingly more countries are doing (and can do) so, and it is possible to implement water sharing and more informal water trade, plus redesign existing water institutions, rights and allocations (Wheeler, 2021).

2.2.2 | Water trade and its perceived environmental, social and cultural impacts

Another key water trade myth propounded is that water markets fail to account for community, environmental or other social values, hence are detrimental and inequitable for society (Barlow & Clarke, 2003; Hartwig et al., 2020; Kiem, 2013). Interrelated to this is that trade causes environmental problems (e.g., RMCG, 2019). It is possible that differences in environmental, social and cultural outcomes may arise where: (a) externalities or other market failures exist; or (b) there are problems with the initial allocation of property entitlements and hence various stakeholders were excluded from the market or the allocation of entitlements.

Cultural and social impacts

Hartwig et al. (2020); 10) claimed that the water market in the state of New South Wales (NSW) does not promote equity, and instead 'reflects and reproduces structural inequalities stemming from colonial dispossession'. Hartwig et al. (2020) reported that the volume of water entitlements owned by Aboriginal organizations fell 17% from 2009 to 2018, arguing that water trade facilitated this dispossession trend. Marshall (2017) elaborates on the concept of 'aqua nullius', and how Aboriginal water rights and interests have been traditionally ignored. Marshall (2017) and Nelson et al. (2018) argue that further legal recognition of First Nation water rights as property rights is needed, and that doing so will play an important part in economic development in Aboriginal communities. Jackson et al. (2019) provide evidence that the Australian public is supportive of increased water rights for First Nations. Indeed, along with providing more property rights to water entitlements for First Nation communities, Australia also needs to seek the most effective ways to empower Aboriginal organizations (both financially, institutionally and via personal skills) and to maximize the cultural benefits from water. We return to this property rights distributional issue later.

Others have argued that water markets increase the gap between the 'haves' and 'have nots' (Colloff & Pittock, 2022; 9), while others cite cases of individual farmers that have been disadvantaged by the market (e.g. Kiem, 2013). However, the distributional issues from voluntary trade choices is fundamentally different from assessing both social welfare and market failure issues (discussed later). The concept of equity can be defined in many ways, but if we define it similar to Dinar et al. (1997) as the equal opportunity to utilize a resource (or participate in water trade), then setting up water trade arrangements can increase equity – especially in times of drought – as it allows increased water sharing over various regions – by irrigators who otherwise would not be able to utilize that water. Another social value rarely discussed is how the unbundling of water from land allowed for farm assets to be split more equally among farm children. The passing down of the farm and questions of successors have long been vexing issues for farmers. Daughters have often traditionally been disadvantaged in succession. However, there are indications that unbundling water licences from land allows for a more equitable – and gender diverse – split (Wheeler, Bjornlund, et al., 2012a). Although the issues on equity and disadvantage of trade in general has little support in the literature (see Section 2.2.3), to date there has also been no study that has sought to understand the long-term issues of participating in water markets, both on individuals or on communities. Further research would be required.

Environmental impacts

As noted, there are many ways that water property rights can be distributed to assist in meeting societal objectives. One such example includes portions held aside for public use, such as a 'river rights' or 'cultural rights'. Other portions of the river can then be reserved for consumptive uses with entitlements correspondingly allowed to trade. Indeed, there have been many instances where community interests and environmental values have been incorporated into water trading (Young, 2019). The large-scale buyback of water entitlements from consumptive to environmental use is one such example in Australia, and the provision of some funds in 2018 to buy back water for cultural purposes another (Grafton & Wheeler, 2018). Water markets provide a tool for reallocation purposes. As at the end of 2021, over 2106GL of water entitlements have been recovered (the majority through buy-back from voluntary tenders) for environmental purposes (MDBA, 2022), making this one of the largest reallocations of water from consumptive use in the world. Indeed, the existence of water markets to recover water has proved to be the most cost-efficient, effective and equitable method of recovery (Grafton & Wheeler, 2018) – albeit not the most politically favoured (although again, water trade cannot be blamed for this).

Arguments regarding trade's environmental negative impacts often centre around salinity impacts (Haensch et al., 2016; Khan et al., 2009); changed water consumption patterns; environmental watering impacts; increased use of sleeper/dozer entitlements (NWC, 2012); and Barmah Choke water bank degradation issues (see submissions to Productivity Commission, 2018 or ACCC, 2021). Arguments claiming water consumption have changed (due to water trade or environmental water movements) ignore the fact that water has environmental benefits moving from upstream to downstream (NWC, 2012).

It is true that water trading can cause both positive and negative externalities. Movement of permanent water away from highly saline zones in the 1990s may have increased salinity when irrigation stopped (Khan et al., 2009), while others suggest the opposite (e.g., Lee et al. 2012). Where there is poor integration of groundwater and surface-water entitlements (and differing meta-governance for both), then there is the potential that increased substitution and consumption of groundwater for surface-water entitlements could increase salinity (Wheeler et al., 2021). Reviewing all the evidence, the NWC (2012) concluded that the impacts of increased water trade on salinity was inconsequential – as both negative and positive externalities existed.

Another potential negative externality impact of increased use of carry-over trade is that it can lead to less 'socialization' of existing water resources. Previously, irrigators who did not use/trade all their water allocations forfeited the water, which increased available water in storage (and correspondingly river flows for some extractors) and allowed an increase in water allocations the following season. The increase in irrigation efficiency across the Basin (private and subsidized) and the reduction of return flows over time has also led to reduced storage capacity. Such a result can mean that owners of lower securities can be more affected by reduced allocations. However, the flip side of carry-over is that it reduces risk for irrigators (who tend to be risk-adverse in general), while also reducing variability of within-season water temporary prices and hence can represent a positive impact.

In terms of other adverse environmental impacts, NWC (2012) found that water trade led to higher flow scores for assessed river systems, hence improving ecological impacts under dry conditions compared with wet. Regarding recent arguments surrounding the impact of trade on Barmah Choke bank erosion issues, in early 2021 it was found that a large sand slug (suggested to be caused from decades of mining and land-clearing upstream) was slowly making its way down the river and accumulating in the Choke – hence causing the problem and reducing capacity in general (MDBA, 2021). This highlights that water trade and environmental water are too often easy targets to blame for any identified problem. There are also issues regarding the management of general water flows within the river, which is a far broader issue than the presence of water trade causing environmental problems.

2.2.3 | Water trade and its perceived negative farm and community impacts

Other popular myths that exist in Australia is that water trade has significant negative farm impacts, often leading to farm exit (e.g., Hamilton & Kells, 2021; Kiem, 2013; RMCG, 2019). It also said to result in water moving aware from annual towards permanent agriculture; the loss of the dairy industry in Victoria (Foote, 2021; Hamilton & Kells, 2021; RMCG, 2019); and a 'swiss cheese' impact on existing regional irrigation infrastructure. The actual evidence for and against whether water trade causes negative farm and community impacts is broken down into permanent and temporary trade impacts.

Temporary trade impacts on farm profitability

In the literature, there is clear evidence of significant economic benefit (both from allocative and productive efficiencies) from the existence of water temporary trade (e.g., ABARES, 2021). Traditionally, MDB irrigators and communities have been quite accepting of temporary water trading, whilst less enthusiastic about water entitlement trade (Bjornlund et al., 2011). Numerous studies have found that MDB farm viability is improved with the existence of temporary trading: Wheeler, Zuo, and Hughes (2014b) found that selling a larger volume of water allocations improved farm viability; Kirby et al. (2014) found water markets allowed dairy farms to sell allocations and buy fodder in the Millennium drought; while Rafey (2020) estimated that realized gains from annual water allocation trade increased output by 4–6%, and that shutting down the market would be comparable to an 11% uniform decline in surface-water allocations in terms of farm profits.

Important findings have also been made in the literature regarding farmers' risk management, with water allocation trade a risk management strategy for many farmers. Zuo et al. (2015) found farmers' experiencing higher profit variability and more downside risk purchased greater volumes of temporary water. Nauges et al. (2016) established horticultural irrigators used temporary water trading because they were averse to the risk of large losses (downside risk), while broadacre irrigators used water temporary trading as they were averse to profit variability (variance). Haensch et al. (2021) found no statistically significant association of poorer socio-economic areas with water allocation trade. They suggested water allocation trading was more significantly associated with water scarcity, confirming that markets provide an important adaptive tool for irrigators in response to unfavourable conditions. Furthermore, Wheeler et al. (2010) suggested that farmers who participated in the early water allocation market had larger farms; less off-farm income; higher farm-operating surpluses and higher farm productivity.

Permanent trade impacts on farm profitability

Permanent water trading has been found to be driven by planning or implementing farm structural changes to control long-term risk exposure, e.g., to secure a particular level of water availability, or change farm location or type – sometimes followed by adjustments using the temporary market (Bjornlund, 2006; Turral et al., 2005; Wheeler et al., 2010). There are two broad potential impacts that can arise from selling water entitlements: a positive impact (reduction in debt, farm restructure and reinvestment to make it more productive or efficient) and a negative impact (less water for production and/or higher costs in buying water allocations or feed). No significant impact on current year profitability from selling water entitlements has been found (although a negative effect from buying water entitlements was found) (Wheeler, Zuo, & Hughes, 2014b); while another study only found weak to no significant evidence of a delayed impact from selling water entitlements within farms that remained farming (Wheeler, Zuo, & Bjornlund, 2014c). Path dependency in farming strategy does appear to exist, in that once a farmer implements a strategy, they are more likely to continue doing so over the next five years – which has been found to be the case for selling permanent water (e.g. Seidl et al., 2021; Wheeler et al., 2013). This finding indicates that, at some point, selling more permanent water entitlements may be a negative financial strategy for an individual farm if the desire is to continue irrigation, and more research is needed in this area using longitudinal panel datasets.

Haensch et al. (2021) investigated the drivers of permanent water trade and found that key influences on the volumes of entitlements sold included net rainfall, groundwater use and dryland salinity – while water entitlement purchase volumes were far more likely to be associated with water market prices, location and soil productivity. No significant association between socio-economic status and amount of water entitlements sold was found, although there did seem to be a significant association between more disadvantaged areas and higher volumes of water entitlements purchased (which is the opposite of the belief that selling water entitlements disadvantages local areas).

Although it is true that financial hardship is often the main reason why farmers sell permanent water (Bjornlund et al., 2011; Thampapillai, 2009; Wheeler & Cheesman, 2013; Wheeler, Zuo, et al., 2012b); it is not the sole reason. Dominant reasons identified in Wheeler and Cheesman (2013) within their survey of 589 irrigators who had sold permanent water, included debt (30%); support farm income and increase viability (22%); farm exit (15%); surplus water (9%); on-farm investment (8%); and other (age, death/divorce, environmental reasons, family support, frustration with local irrigation districts or the government, channel upgrades, unbundling of land and water as well as decreased water quality levels). 80% of those surveyed said their decision to sell water had been a positive decision, while only 13% said it was not a positive decision. Similarly, Schirmer (2016) found many irrigators reported a positive farm impact after they sold permanent water, particularly in relation to reducing debt, stress levels, and improving their life, finances and farm enterprise as a whole. NWC (2012) also found that 91% of irrigators who had traded water in the past three years believed the ability to trade entitlements had been beneficial to their business – while only 9% considered it not beneficial.

From a macro point of view, unbundling water from land has changed the value of water as a farm asset. Wheeler et al. (2016) compared the returns of water markets in the Goulburn with the stock market and found that capital growth was the major source of return until 2008. The return then stabilized, and fell post-2012, increasing again after 2015. Holley and Sinclair (2016) highlight the benefits of water as a financial asset that has increased in value over time – namely, that a significant portion of farmers are now using water title as loan security. The ability to undertake water market trades (e.g., time involved, reduced transaction costs and increased functionality and access) has also significantly improved over time – indicating positive impacts on viability (Holley & Sinclair, 2016; Loch et al., 2018). Overall, there is a need for more work in this space, using longer timeseries of data, and particularly trying to examine causality issues between land and water values in more depth.

Trade impacts on farm exit, especially within the dairy industry in Victoria

Following on from these claims about negative farm profitability impacts, critics often argue this leads to farm exit. This is usually associated with the trend in falling irrigation farm numbers and the presence of water markets and/or the MDB Plan; and that the impact is causal (Hamilton & Kells, 2021). It goes without saying that the varied, longitudinal impacts on farm outcomes are rarely discussed, or if modelling by such critics is performed, overemphasis is given to simplistic, linear input–output modelling or analysis that is of dubious quality and not peer-reviewed (e.g., RMCG, 2019). This contrasts with whole-of-economy dynamic computable general-equilibrium modelling, that has consistently shown major shocks such as drought (rather than buybacks of water entitlements) have caused the largest impact on MDB farming communities (Wittwer, 2019). In addition, the most detailed long-term timeseries study on farmer exit in the MDB found that the direct drivers of exit were climatic (e.g., increases in maximum temperature and increased drought risk) and socio-economic (e.g., decreases in commodity output prices, increased urbanization and higher unemployment). Conversely, absolute rainfall, changes in irrigation water diversions and water trade movements had no significant association with MDB farmer exit (Wheeler, Xu, & Zuo, 2020b). Other studies have suggested that although the outward trading of water may have had a minor impact on declining farm productivity – such an impact was small in comparison to the drought (NWC, 2012). Other cross-sectional studies examining farmer exit intentions have revealed financial pressure predominantly drives farm exit, exacerbated by drought conditions (Wheeler & Zuo, 2017).

Many suggest the water market has facilitated/encouraged the movement of water towards permanent agriculture and away from annual agriculture (or peri-annual such as dairying) – consequently making the MDB less resilient in times of drought (as there is less annual agriculture to 'give up' water to permanent crops) (Foote, 2021; Hamilton & Kells, 2021; RMCG, 2019). It is true that adaptive capacity of the irrigation industry is enhanced by diversity of different types of agricultural production in the MDB, and – in particular – by the presence of opportunistic annual crops (e.g., cotton and rice). There is an important role that these crops play in providing water to more permanent crop irrigators in times of drought. Indeed, there is strong evidence that water markets encourage the movement of water from low-to-high value uses (Wittwer, 2019). This water movement can occur at many levels: (a) within an agricultural industry (e.g., one dairy farmer to another); (b) between different agricultural industries (e.g., dairy to almonds) and (c) between different sectors (e.g., from agriculture to environment or mining to urban). It is also important to note that value is not always determined by dollars or economic return – other motives can, and do, drive individual choices. Water trade has allowed the movement of water across all these various levels, while at the same time facilitated movement of water between surface and groundwater consumption (Wheeler et al., 2021). In the literature, early studies have often concluded that permanent water buyers were more likely to be cultivating permanent crops (e.g., citrus, grapes) to secure long-term water security (Bjornlund & McKay, 1995, 1996; Young et al., 2000). Early studies also show that water trade occurrs within industries, and is driven by socio-economics, farmer and productivity characteristics (Wheeler et al., 2009, 2010). What is also true is that the water market provides different risk management strategies for various irrigation industries, and is particularly used more in horticultural industries to reduce risk (Nauges et al., 2016; Zuo et al., 2015). Although there has been a significant reduction in dairy farming and increases in perennial activities such as nuts within the MDB over the past decade, the real reasons for such transitions need careful scrutiny.[1]

Examining permanent water trade movements in particular, a time-series analysis from 2000–2011 by Haensch et al. (2016) found that movement of water entitlements away from northern Victoria was highly associated with increased dryland salinity and surface-water salinity, as well as reduced rainfall patterns – with farm productivity ramifications. However, it also revealed that water entitlements were far less likely to be sold in areas with more dairy and grazing production (Haensch et al., 2016). Another time-series analysis by Xu et al. (2021) found that MDB dairy farm exit was significantly positively influenced by hotter temperatures and reduced rainfall. Other cross-sectional studies seeking to understand future farmer strategies have found that dairy farmers (as compared with broadacre and horticulture farmers in the MDB in the mid 2010s) were not more likely to be planning on exiting or transitioning out of farming (Zuo et al., 2022). Hence, although water trade may facilitate changes in industry positions over time, those changes are usually driven by overall profitability and locational/productivity influences, and hence, water market existence cannot be blamed for changes in industry structure. In addition, broader issues regarding planning, subsidization, regulation and allowance for irrigation activity in new green sites across the MDB must be focussed upon before the presence of water trade is allocated blame for agricultural industry composition changes. Overall, any arguments over how to manage a changing agricultural landscape and control farmers' land choices, need careful scrutiny – especially given Australian agriculture's open, trade-exposed economy.

Trade impacts on irrigation districts and communities

Following the impacts of farm exit (after selling permanent water), critics often cite that this leaves land dormant, a haven for pests and weeds, and increases future irrigation infrastructure system delivery costs for those remaining (Australian Parliament, 2011). Certainly, during the Millennium drought in the 2000s there was land left dormant and abandoned – much of this driven by the small irrigator farm-exit schemes that were implemented – albeit much of that land since has been sold and returned to farming (dryland or irrigation). From the irrigation side, empirical evidence from Wheeler and Cheesman (2013) found that 70% of farmers who sold permanent water to government continued farming (and nearly all of these kept their delivery rights). However, irrigation infrastructure operator areas now impose termination or exit fees to cover ongoing costs associated with stranded assets.

[1]Dairy farm profitability is driven predominantly by milk prices, seasonal conditions and feeding costs. A dry season increases both irrigation water and fodder costs, but also water needs. From the late 1980s, the Murray region (NSW and Northern Victoria areas) consistently had the most variable average annual rate of return across Australia (Weragoda & Frilay, 2020), hence making it the most vulnerable to a changing climate. Exit and expansion intentions across all dairy regions vary, with the Murray region rated as in the middle.

These are a charge imposed on entitlement trades and subsequent loss of a water access entitlement out of an irrigation district or area. These fees are set by the ACCC and charged to maintain the delivery infrastructure or any stranded assets that remain after the water access entitlement has left the area. The ACCC (2019) highlights that the largest price increases occur in modernized irrigation schemes (e.g., pressurized systems in particular), where infrastructure modernisation impacts upon irrigators' future delivery charges and energy costs. Other issues exist with the 'gifted' nature of irrigation infrastructure, with MJA (2019) concluding that irrigation infrastructure subsidization is currently hiding the real ongoing cost of irrigation upgrades from irrigators. Again, blaming the presence of water markets (or the Basin Plan) for causing farm exit to occur is avoiding the more difficult issues surrounding stranded assets in areas with looming climate change. There needs to be recognition that a severe rationalization of irrigation areas should be considered, with perhaps large amounts of area removed from the system – but with the proper structural adjustment and regional community packages put in place.

Trade impacts on farmer welfare, and on smaller farms

Finally, critics have argued that because water markets allow permanent water sales and variability in temporary water prices, this causes serious mental health and wellbeing issues for farmers – with smaller farms at a particular disadvantage (Foote, 2021; Hamilton & Kells, 2021; Kiem, 2013). One argument made is that prior to formal markets, water used to be a lot cheaper and could be traded informally for a 'slab of beer' (Hamilton & Kells, 2021), while others blame water markets for increasing the complexity and uncertainty of water management (Kiem, 2013). Whilst it is true to some extent that the creation of formal water markets did displace informal markets in the MDB, not all informal water trade has been displaced. For example, Wheeler, Zuo, and Bjornlund (2014d) illustrated that many irrigators are willing – and often do – donate water allocations for environmental purposes. The argument that water used to be 'much cheaper' also requires scrutiny. Such arguments ignore the reality of what drives water market prices, namely, the influence of water scarcity. For example, in June 2022, temporary water traded in the southern MDB at a median monthly price of $18/ML – well under the price of a 'slab of beer'! Such is the advantage of water trade in reallocating water more effectively over time, and prices moving up and down to reflect scarcity (as shown in Figure 2). Just like rising land and house prices, there are winners and losers in such a scenario, but what is known is that market efficiencies exist for all farm sizes who participate (Wheeler et al., 2010).

When water trade is blamed as increasing uncertainty and water management costs (Kiem, 2013), commentators often ignore the bigger picture. The existence of water trade is not the primary reason of reduced water allocations over time – that can be traced to climate change and the overallocation of consumptive water entitlements. Eliminating water markets will not magically 'improve' water or farm management for irrigators – in an era of climate change this will only result in less flexibility, less income and most likely more stress and bankruptcy.

In addition, the evidence for linking mental health problems to the existence of water markets (e.g., Hamilton & Kells, 2021) is lacking. While it is true, as outlined previously, that the main reason for permanent water sales is debt – what is also true is that the sale of that water often provides positive farm results. Wheeler et al. (2018) analysed the mental health of 1000 MDB irrigators in the mid-2010s and found that higher psychological distress was most related to finances; drought; water availability; commodity prices and time. Horticultural irrigators had higher distress, followed by broadacre, dairy and then livestock irrigators. Both Wheeler et al. (2018) and Zuo et al. (2022) showed that there was a strong association between farmers citing financial stress and worse psychological distress and consequently then planning on leaving the farm. Wheeler et al. (2018) also established a strong positive association between psychological distress, and farmers acting very negatively towards issues such as water trading; government; the environment; the Basin Plan; and optimism about the future. In particular, farmers were more likely to disagree that water trading had been a good thing for farming, if they were suffering moderate to very high levels of psychological distress. Obviously, causality issues are important, and those who link serious mental health issues to the presence of water markets, without a thorough consideration of what causes poor mental health problems in farmers, are not providing helpful or useful policy advice.

2.2.4 | Water markets and perceived cartel and collusion behaviour

In recent years, there have been continual claims that there is huge collusion by some external stakeholders (in particular brokers, financial institutions, and corporate investors) in water markets. This collusion and illegal behaviour include scraping, driving arbitrage, spoofing, underreporting, unethical practices, backdoor deals and large-scale insider trading (Hamilton & Kells, 2021; RMCG, 2019). To some extent this is also tied with corporate behaviour in general (Edwards et al., 2009). To investigate such claims, we need to consider drivers of water market prices and volumes; and if there is evidence that prices have been manipulated. Like any market across the world, there is no doubt that some water market transactions have probably not been entirely legal or ethical, but the question remains as to if the practice is widespread? Indeed, the literature on non-landholders in commodity markets sheds some light on this question, with most finding that speculators do not destabilize the commodity market, but instead contribute to lower volatility levels and enhanced market quality by improving short-run price efficiency and liquidity (e.g., Brunetti et al., 2016; Kim, 2015).

Water trade drivers

The main drivers of temporary water prices have been found to be seasonal factors, such as water allocations, drought and low-water storages, but also that policy factors such as carryover have significant influence within the season (ABARES, 2021; Brooks & Harris, 2008; de Bonviller et al., 2019; Plummer & Schreider, 2015; Wheeler et al., 2008; Zhao et al., 2022; Zuo et al., 2016, 2019). Similarly, the water market has been found to provide for risk and uncertainty adjustments – within and between seasons (Brennan, 2006; Loch et al., 2012; Wheeler et al., 2008; Zuo et al., 2015). Other studies have applied financial stock market techniques to water markets and identified similar characteristics. For example, market depth (Brooks et al., 2009); price clustering (Brooks et al., 2013; Zuo et al., 2014); and price leadership (Brooks & Harris, 2014). Overall, little evidence of hoarding and speculation in MDB water markets has been found (Loch et al., 2021).

In a detailed analysis of the entire southern MDB water market, Zhao et al. (2022) found strong seasonality drivers, and suggested financial investors had increased market liquidity, as well as reduced potential uncertainty. de Bonviller et al. (2019) investigated insider trading in water markets and found that although there was evidence of abnormal price movements (indicating potential for insider trading) prior to insider trading rules being introduced in 2014, there was only very weak evidence of abnormal price movements post-2014. It was suggested that temporary water traders are becoming more sophisticated and speculative, and that implementation of insider trading rules seem to have been effective. However, this does not negate the need for additional intermediary regulation to provide minimum quality standards and address conflicts of interest (such as intermediaries owning and principally trading water, and unethical handling of customer accounts, being open and transparent with all information) (Seidl et al., 2020b).

The impact of investors and non-users in water markets

Because information on ownership of water entitlements is not easily publicly available, there is only scant evidence on the size of the "non-user" (particularly in terms of investors) stakeholder group in water markets. A crude approximation is the "non-user" group in the Victorian water register (DELWP, 2019), defined as water entitlements not "associated" with land (note this is not describing unbundling, user owned entitlements are fully unbundled). Entitlements not "associated" with land may still be owned and traded by irrigators who own multiple water allocation accounts or have their entitlements as part of their self-managed superannuation accounts. However, as non-landholder stakeholders, by definition, do not irrigate themselves, they also would have their entitlements listed in the "non-user" group, enabling crude approximation. Non-user ownership of high-reliability water entitlements increased from 5% in 2009 to 12% in 2018 in northern Victoria (DELWP, 2019). The interim report by ACCC (2020) also found very similar ownership of investor holdings in 2019–20 (investor high security entitlements as a proportion of total entitlements varied from 3.3% in SA (zone 12) to 19.8% in Victoria (1B), with an average of 7–8% across zones). ACCC (2021) reported that from 2017–2019, institutional investors made up 11% of all transactions on six water market exchange platforms. Hence, this illustrates that the scale of such non-user activity is still small (albeit growing), and hence limits their ability to influence market prices and volumes.

On the topic of market manipulation, a significant amount of the 210 submissions made to the ACCC water market review (to the interim report and to the issues paper) expressed concerns regarding market power issues. ACCC (2021) requested a large amount of information and water trade records on the 20 largest investors and traders. The ACCC found no evidence of such investors' influence over water prices in the short-term, nor any evidence that water was being withheld from the market in order to increase prices. In addition, no findings concerning squeezing, spoofing, ramping, anomalous price movements, insider trading or collusion were found, most specifically for the time-period 2017–2019. Overall, the report concluded that the increase in water prices was much more likely due to reduced inflows and increasing water scarcity, which is the common finding of the academic literature.

Seidl et al. (2020b) found that the reasons non-landholders became involved in water markets included the long-term rise in water asset values; the diversification against other assets; and the fact that variability in water market prices presents significant opportunities for investment trade returns. It was also found that non-landholders provide a variety of benefits such as new water market trade innovations. Seidl et al. (2020b) suggested that although the current small number of water market financial investors probably have limited market impact, the impact was dependent upon: (a) the liquidity of the local water market they operate within and imperfect competition factors; (b) their trade volume and (c) information asymmetry (e.g., insider information knowledge). Growth in non-stakeholder investment within water markets was also likely to be limited by opportunity cost with financial stock markets and the substantial financial investment and trading skills required. However, further research is required in this space.

3 | DISCUSSION

3.1 | The key adaptation benefits of Australian water markets

The previous section has provided evidence for and against the four broad water market myths that exist in Australia. This brings us to the overall question of would Australian society be better off without water markets? The answer, in an era of growing and devastating climate change, is a resounding 'no'. Well-designed marketplace rules and infrastructure will encourage participation, reduce strategic gaming, aggregate information – and improve efficiency, liquidity, and equity – which will facilitate more efficient and equitable allocation. The most important benefit that water markets bring is the ability to adapt to changing circumstances

(Crase et al. 2020; Holley & Sinclair, 2016; Rafey, 2020; Wheeler, 2014; Zhao et al., 2022). This adaptation comes in three main efficiency forms: (1) allocative; (2) dynamic and (3) productive. Crase et al. (2020) emphasized the need for Australian policy to support efficient adaptive resilience, arguing that some aspects of Australian water policy have allowed this (such as setting caps and establishing water markets), while other aspects (such as subsidizing on-farm irrigation infrastructure and expensive augmentation of urban water supplies) have not. Equity issues are met through water trade arrangements allowing more irrigators to share water in times of water scarcity (as compared with the situation they would be in otherwise).

A substantial number of theoretical and empirical models have demonstrated the major economic and financial benefits from Australian water markets. The economics literature on Australian water markets has outlined the overall net welfare gain to society from water markets, using a variety of different modelling approaches (e.g., computable general equilibrium, partial equilibrium models; hydro-economic models; econometrics; water demand optimisation models – both from theoretical and applied perspectives [e.g., ABARES, 2021; Brennan, 2006; Rafey, 2020; Wittwer & Young, 2020]).

As noted previously, Rafey (2020) estimated that shutting down water markets would be comparable to a 11% uniform decline in surface-water allocations in terms of farm profits. ABARES (2021) estimated that southern MDB water trade generated average annual total benefits of AUD$117 million to irrigators. Indeed, the ability to trade water will become increasingly important as climate change continues to worsen water scarcity and/or increases variability. The issues surrounding climate change and necessary adaptation are generally ignored by critics of water markets (e.g., Hamilton & Kells, 2021 barely mention climate change in their water market book) – but it is the critical issue for the future.

3.2 | The market failures of Australian water markets

Although clearly water markets have brought benefits to Australian society, as with other markets, this does not mean that they are free of market failure. As Cummins and Watson (2012) argued, it is unlikely that policy can ever 'get it right', and Young (2014) outlined mistakes in the sequencing of historical water reform. Australia's water policy experiment will continue for many years yet, and there are considerable issues of decades of government policy distorting farmer behaviour that need reform (subsidization of on-farm irrigation infrastructure being one – see Wheeler et al., 2020a). Similarly, it is important to focus on first-best policies, and not blame water trade for problems of market failure elsewhere in rural communities. For example, the argument made by critics that, due to issues around technology availability, internet infrastructure and skills, smaller farms are at a disadvantage in water markets is unfortunately the same argument regarding information asymmetry in all agricultural and finance markets. Blaming water trade is not effective policy in addressing these problems, as Wittwer and Young (2020) have argued in terms of the need to target relevant regional social investment. Crase (2021) similarly argued the need for synergies in drought and Basin planning with water policy.

The following sections elaborate on what we know are the identified shortcomings of water markets.

3.2.1 | MDB water market failures

Water markets, like other markets in society, need to be scrutinized for imperfect competition; externalities and information asymmetry. Any other issues that are related to distributional issues, pecuniary externalities and governance structures are not necessarily the fault of markets per se, but often related to 'meta-governance' issues and inadequate regulatory oversight (Grafton et al., 2018, 2022; Quiggin, 2019). If these institutions and structures that oversee water trade and use are corrupted or are missing, then this can result in negative impacts for society (Wheeler et al., 2017). Young (2014) highlighted that the sequencing of water reforms is crucial. Key lessons that Australia could have done better before introducing trade include a more stringent and enforced cap on water use; addressing return flow issues; understanding groundwater connectivity issues and optimizing storage.

A comparison of water trade and governance structures across the MDB highlights that greater attention needs to be focussed on ongoing attempts to reform both state water institutions in terms of monitoring and compliance, estimating historical and current water extraction (and consumption) information from satellite and thermal imaging; water pricing issues, water accounting, along with water resource plans (Wheeler & Garrick, 2020). Greater attention must also be paid to developing strong independent water and governance institutions that can limit (and highlight) rent seeking. A return to the National Water Commission (disbanded in 2014) would be a good start. Without these reforms, there are serious implications for potential market failure and allowing or encouraging greater trade may have net social costs.

In summary, there is evidence of market failure in water markets within Australia. Imperfect competition does seem to exist in some forms, especially regarding inter-valley trade issues, tagging, interstate trade issues and unregulated water broker behaviour (ACCC, 2021; Productivity Commission, 2018; Seidl et al., 2020b). There is more evidence of imperfect competition in the northern MDB than the southern MDB, due to both endowment of resources and unregulated property rights (Wheeler, Carmody, et al., 2020a). Very careful assessment needs to be given to any change in unregulated entitlements to allow trading, such as allowing trading in floodplain water harvesting rights. Negative externalities are also clearly present, mainly because of the lack of clear property rights, enforcement and monitoring, and institutional rules. Such externalities have also resulted from government policy, particularly irrigation infrastructure subsidies to recover water. Information asymmetry has also been shown to be present in water markets, in terms of availability of data and information on prices, water registers, water asset valuation and unregulated water brokers.

3.2.2 | Distributional failures

Many of the perceived costs noted by critics of Australian water markets represent pecuniary externalities (e.g., increases or decreases in market prices from various actions) – which can have different distributional issues, but are not necessarily market failure per se. The key distributional issues for Australian water markets are: (a) initial distribution of property rights can make markets inequitable – which is especially the case for First Nations communities; and (b) legacy and gifted asset issues – the increased sale of permanent water out of districts (along with not keeping delivery rights or not paying for delivery rights). The second of these issues can increase the spread of fixed costs across less users in irrigation districts and have the potential to cause stranded assets, which may particularly impact smaller irrigation dependent rural economics. Addressing these distributional issues can be both incorporated into existing water market design (and water pricing policy) as commented upon earlier in Section 2.2.1, or it can be addressed through a direct reallocation of water rights (e.g., for cultural purposes). As noted, water trade arrangements can be designed for more equitable outcomes (Young, 2019).

3.3 | Future water market reform and research

As has been highlighted by numerous commentators, water markets are based on various institutional and hydrological rules – and requirements need to continually develop and evolve as new information, increasing adoption, changed farmer behaviour and new technology becomes available. Unsurprisingly, the ACCC (2021) water market review recommended several sweeping changes and improvements. These included: improved market integrity and conduct – especially by market intermediaries; a Water Markets Data Standards to improve market information and allow for more consistent reporting; a Water Market Information Platform; strengthened water metering and monitoring of water extractions; and the establishment of an independent Water Markets Agency to undertake market surveillance, enforcement and reporting. Seidl et al. (2020a) and Seidl et al. (2020b) also provided extensive commentary on new water market institutions that could be implemented, water accounting changes, water data information needs (improving the quality, consistency, and range of information – both pre-trade and post-trade) and suggested the need to use new insights from the economics market design literature. Looking forward, governments need to progress the ACCC reforms, and there is a need for further research around water banking (from groundwater aquifer recharge); computerized 'smart markets'; blockchains; regulating pre-trade offers; and a review of river operations.

Although ACCC (2021) and ACCC (2020) provided the most in-depth analysis of water entitlement ownership and trade activity to date given its powers of information collection, there is still a need for further quantitative longitudinal trade evaluation. For example, entitlement ownership by stakeholder-type data and trading patterns could be analysed at a catchment level to identify and address concerns of market power and monopolistic behaviour. There is also work to be done in more clearly understanding the socio-economic outcomes of, and participation in, water markets and water reform across regions. This work should specifically address causality issues; cultural water issues; path dependency; stranded asset and restructuring needs; gender equality; asymmetric information; climate change adaptation; water consumption; surface-groundwater interaction and substitution; irrigation area changes and environmental outcomes.

4 | CONCLUSION

Water markets in Australia have been blamed for, and accused of, many things: being immoral; inequitable; not accounting for environmental or social values; environmental degradation; farm exit; low profitability; decimation of the dairy industry; farm abandonment; farmer psychological distress; the displacement of informal trade; high temporary and permanent water prices; non-user stakeholder collusion and illegal behaviour and putting smaller farms at a disadvantage. Overall, this study has reviewed and provided evidence that largely debunked these widely held beliefs. The question must be asked, and repeatedly asked, what is the situation that irrigators in the MDB would be in without water markets? The counter-factual is always the most important consideration, but something that critics usually ignore.

Although some previous water trades have been unethical and immoral – an accusation that can be made in any market – there is a lack of evidence, especially in the current mature market stage, that this behaviour is occurring at scale and having a significant impact overall. An evaluation of water markets must consider their entire benefits and costs, and commentators who over-exaggerate, cherry-pick faults, conduct a few biased interviews and ignore peer-reviewed evidence represents poor research practice. The biggest advantage of water markets lies in their adaptation benefits, allowing irrigators to: (a) cope with weather uncertainties and share water in times of both scarcity and excess; and (b) retire or exit their farms with more dignity and ease when needed. Farm exit is a real phenomenon that has always existed in Australia and will only continue to exist given current and predicted climate change and other economic pressures. Whether it is recognized or not, water trade provides one way of facilitating what is a very difficult time for most farmers when they exit.

It is critical to note that water trade only exists within institutions, hydrological rules and structures, which allow and govern the transfer and use of water. Meta-governance frameworks and the sequencing of any water reform is crucial, given the feedback loops that exist between stakeholder behaviour and any resource consumption or change in policies. As such, Australia still needs reform in terms monitoring, compliance, enforcement, auditing, estimating water extraction information from satellite and thermal imaging, water accounting and improving water information in general. In addition, there is opportunity for envisioning new structures and rules for water market design, to improve social welfare. While all the available evidence suggests that non-stakeholder involvement in water trade is currently limited, there remains considerable research questions to investigate regarding the potential for monopolistic concentration of entitlement ownership and market power – particularly in illiquid or 'thin' markets or when combined with insider information and information asymmetry. Greater transparency in water market data and ownership records would facilitate such research. Furthermore, the serious negative distributional consequences of historical decisions regarding water and land need addressing – especially for First Nations. Again, instead of blaming water markets as 'the problem', it is possible that they can be part of 'the solution'. Smart design and integration of social and cultural aspects into water trade governance is possible.

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DATA AVAILABILITY STATEMENT

There is no data used in this study.

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