Chapter 7

Towards more sustainable irrigation: Factors influencing allocation and entitlement prices and demand in the Goulburn Murray Irrigation District of Australia

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Abstract

For well over a decade, water markets have been used in Australia to reallocate water to more efficient, productive and sustainable irrigators. In the Goulburn Murray Irrigation District, records have been kept since 1992, and trading in both water allocations (seasonal trading) and water entitlements (permanent trading) is permitted. This chapter discusses the published quantitative estimates of farmers’ responses to changes in prices, focusing particularly on two periods of drought (2002–03 and post 2006). Changes in the farmers’ demand and supply of water during drought provide insights into their behaviour in the future when it is anticipated water will be increasingly scarce. We conclude that we can predict some of the likely effects, and the likely sustainability of farm production, in a future with less available water for farm production, by learning from the responses of farmers to past periods of scarcity.

\textit{Keywords:} Allocations; Drought; Entitlements; Water markets

1 Introduction

This chapter explores water markets’ ability to facilitate sustainable irrigation by examining some of the major influences on allocation and entitlement prices and the demand and supply of water in the water markets in Australia’s largest irrigation district, the Goulburn Murray Irrigation District (GMID). Using information from the buying and selling of water entitlements (the long-term right to access water) and water allocations (the right to short-term use of water) since the early 1990s, we examine some of the factors that impact on the demand, supply
and price of these goods. The insights gained from studies that cover periods of severe drought (2002–03 and post 2006) and periods of reasonable supply (1993–02) allow us to comment on the likely market impact of long-term reductions in water supply to cope with climate change, and the policies that lead to more sustainable water management and irrigation. These insights also allow us to speculate on the likely economic and social consequences of efforts to meet competing objectives: the ability to achieve viable and enhanced ecosystem outcomes while also achieving a sustainable irrigation industry and viable irrigation communities.

2 The study region and water trading background

The GMID is located in Northern Victoria along the River Murray which itself forms the border with New South Wales (Figure 1). Irrigation within the district is mainly supplied by two major sources: the Goulburn and the Murray rivers.

Irrigation began in the district in the 1880s, and in the century that followed, population settlement, agricultural development and irrigation were inextricably

Figure 1: The Goulburn Murray Irrigation District.
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Linked. Rapid expansion occurred in the district between the world wars, promoted by government policies of closer settlement. Seen as a major region of agricultural production, during the 60 years following the River Murray Agreement of 1915, water regulation was dominated by supply management. Most effort was placed into constructing dams, locks, weirs, pumping stations and distribution networks so as to control, allocate and regulate flows and expand the storage capacity of the river system. Little consideration was given to any natural “limit” imposed by nature until in the 1960s, environmental constraints such as rising water tables and increased salinity began to be viewed as reasons for concern (Langford et al., 1999; Shanahan & Hughes, 2008). Despite state and local efforts to alter governance arrangements and an increase in the number of scientific studies demonstrating a system under strain, response to these issues was slow. It was not until 1992 that a new Murray–Darling Basin Agreement was signed – the first whole of system response since 1915. Around the same time, water management began to change with the partial introduction of water markets. While trade in water was initiated in the early 1980s, early markets were only partially successful. It was not until the real limitation to overall water supplies was appreciated, and farmers began to learn the value of water, that the market became more sophisticated (Langford et al., 1999).

Australia has promoted markets as an integral part of agricultural water management since 1994, although several states began experimenting with markets slightly earlier. Initially water entitlements were bundled with land ownership. Since 1994, they have been separately tradable, and under the National Water Initiative (NWI), they can now be owned separately from land and their worth “unbundled” from land. Each irrigator prior to the NWI owned a volumetric entitlement, but this is now defined as a share of the consumptive pool of water within the relevant water resource.

In the GMID prior to 1998, the water authorities announced the seasonal allocation as a percentage of the underlying entitlement at the beginning of the season, taking historical inflows into account. In 1998, the authorities announced an opening allocation at the beginning of the season influenced by what was in reservoirs, and then each month through the season, the authority revised the allocation, dependent on weather conditions, current water storage levels and anticipated demand. Hence, for the past 6 years, the opening allocation in the Goulburn system has been 0%, and for 5 years before then, below 55% (Bjornlund & Rossini, 2008). This approach, while properly acknowledging the scarcity of water in the system, has significantly increased farmers need to manage the risk associated with the uncertainty of supply and has been a significant driver behind the increased trading in water allocations (Bjornlund, 2006).

The rationale for water markets is simple. Farmers who are prepared to pay can purchase water in the market and produce a crop, while those who are prepared to sell can earn income. In this way, water will be reallocated from areas where it is used to produce low-value crops (e.g. cereals and some grazing and mixed farming) to high-value crops (dairy, fruit and wine) and from less efficient to more efficient irrigators. Trade in water allows some farmers to earn an income when using their own water for irrigation is unviable and, in the longer term, provides...
them with additional income should they wish to leave the industry (Bjornlund, 2002a). It also allows other irrigators with permanent plantings or dairy herds to buy water to stay in business during drought, assisting both individual irrigators and their communities to overcome severe water shortages. Trading thus helps “soften the blow” caused by water scarcity and partially alleviates the social and economic consequences otherwise caused by a rapid loss in income. It can also facilitate the movement of agricultural water from poor soils (where irrigation has a negative impact on river water quality) to better soils in more suitable locations and so support the process towards more sustainable irrigation.

Under the first trading rules, there were restrictions on trading of water out of certain districts, with some transfers being prohibited entirely and others being limited to 2% of the total entitlement base at the beginning of each season. Under the NWI, the cap has been increased to 4% and is likely to eventually be removed entirely.

Initially, water trade in the GMID in both the markets for water allocations and entitlements was low (Turral et al., 2005; Bjornlund, 2004). Since then, and in contrast to many other countries, markets in allocations have developed to a high level of maturity. The market for entitlements remained more subdued until water scarcity really took hold in 2007 and 2008 (Bjornlund & Rossini, 2008). This is partly because irrigators perceive water entitlements to be an integral part of the value of the farm and partly due to the uncertainty associated with the long-term level of seasonal allocations yielded by these entitlements (Tisdell & Ward, 2003; Bjornlund, 2003a; 2005). Despite this, trade in both forms of water has increased over time and irrigators have increasingly adopted water trading and especially allocation trading as the market, and its support processes have become more sophisticated (Bjornlund & Rossini, 2008; Bjornlund, 2006). For example, in 1998, a weekly water exchange was introduced to ease the administrative pressure on the authority and facilitate faster and cheaper transactions (Bjornlund, 2003b). In 2003, the exchange was extended to cover all of Victoria and the Murray region of New South Wales. These multiple exchanges were gathered under the umbrella of WaterMove (www.watermove.com.au).

Of the many regions covered by WaterMove, this chapter reports on work that concentrates on the largest and most active zone; the Greater Goulburn trading zone within the Northern Victoria regulated region. The exchange facilitates transactions in a number of different water products. This chapter focuses on trade in water allocations, which occur 10–11 months in every year (with the exception of July, generally the wettest month) and water entitlements, which can occur all year round.

WaterMove conducts water exchanges within specified trading zones. In the allocation market, buyers and sellers submit their bids to buy (sell). The bids must include the amount that they are prepared to buy (sell) and the price at which they are willing to buy (sell) the water. The exchanges are held every Thursday and the rules stipulate that the buyers’ bids be stacked in descending price order with the highest bidder eligible to buy first. The sellers’ bids are stacked in ascending order, with the lowest bidder eligible to sell first. The pool price is set at the level where the maximum volume is traded while no buyer pays more than their bid and no seller receives less than their bid. The pool price is the same for all successful
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buyers and sellers, with some buyers paying less and some sellers receiving more than their bids (Bjornlund, 2003b). The market for water entitlements has been greatly simplified following the NWI; buyers and sellers agree on a price and then complete the transaction. Until entitlements were unbundled from land ownership under the NWI, the transfer process was cumbersome and one of the main impediments to the slow uptake of entitlement trading (Bjornlund, 2003a).

By July 2004, more than four-out-of-five farm businesses within the GMID had traded water at some time, and in many areas, the figure was higher than nine in ten. During the very dry seasons of 2002–03 and 2003–04, 60% of all farm businesses were active in the water market (Bjornlund, 2006). Water purchased in the allocation market, as a percentage of total water use within the GMID, has increased from approximately 3% during periods of high supply in the mid 1990s, to more than a third by 2006–07. These are clear signs of increased market adoption among water users.

In most years, irrigators within the Goulburn system have received their full allocation (Table 1), with the exception of 2002–03 and 2006–07, 2007–08 and 2008–09 where allocation as at 1 March 2009 was 31% for the Goulburn and 35%

<table>
<thead>
<tr>
<th>Season</th>
<th>Goulburn system</th>
<th>Murray system</th>
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<tbody>
<tr>
<td></td>
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<td>2007–08</td>
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1Maximum seasonal allocation; 2Total water trade for season as percentage of total water use.

Source: Authors’ calculations. Based on Goulburn–Murray Water’s Records.
for the Murray system. During the drought year of 2006–07, opening allocations were 0%, and by December, had only increased to 24% within the Goulburn system. To use water beyond their allocation, irrigators can purchase water allocations from other irrigators. In general, the volume of water traded has been increasing over time.

The annual volume of water allocations traded has increased from less than 50,000 ML (megalitres) in 1989 to almost 350,000 ML by 2006. While the quantity of water traded has steadily increased, prices have been much more influenced by seasonal conditions, such as the drought in 2002–03. Before 2001–02, average monthly pool prices ranged from $10 to $100 ML$^{-1}$ (except for 1 month where it reached $170$ ML$^{-1}$), and increased to $480$ ML$^{-1}$ in 2002–03, and then falling again during the seasons of 2003–04 to 2005–06 (allocation prices, Figure 2). Large variations are also reflected in the weekly pool price and quantity traded. For example, in 2002–03, the weekly pool price varied between $500$ and $105$ ML$^{-1}$; the maximum quantity traded in a week was over 2500 ML and the minimum under 200 ML. In contrast, in 2004–05, the weekly price ranged between $103$ and $26$ ML$^{-1}$ while the quantity traded each week ranged from over 4000 to only 10 ML. During the drought season of 2006–07, prices reached in excess of $900$ ML$^{-1}$ by December while the accumulated volume traded at that time exceeded any other year and the volume traded in one single exchange was 13,856 ML (Bjornlund & Rossini, 2008).

Since 1993, there has been a mean annual growth in allocation prices of 20.2% and 12.3% in entitlement prices. As Figure 2 shows, there is also clear evidence that the two prices are closely linked, following the same cyclical pat-

![Figure 2: Monthly average prices paid for water allocations and entitlements in the Greater Goulburn from 1993 to 2007 (Periods of drought are shaded).](image)
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tern but with allocation prices fluctuating more than twice as much as entitlement prices (Bjornlund & Rossini, 2008; Wheeler et al., 2008c). Although allocation and entitlement prices have increased steadily since water trading began, they have been very variable, and appear strongly influenced by seasonal conditions such as the drought in 2002–03 and 2006–07.

Understanding the factors influencing price determination in water markets is important. While prices are determined by the interaction between supply and demand of water, these are themselves influenced by a range of other policy and market factors. Generally, economic analysis of agricultural prices frequently considers factors such as stocks, imports, production, usage and exports; however, modelling water prices is more complex and there have been few attempts to estimate the factors impacting on prices paid for water in the markets for water allocations and entitlements (Bjornlund & Rossini, 2005; 2007a). Still fewer studies have examined changes to water demand in the market over an extended period that includes drought. A close examination of the factors that impact on water demand in the entitlement and allocation market both in “normal” periods of supply and in drought should provide insight into what may occur as water supplies lessen in the future, either because of climate change or because of government policy to increase the allocation to environmental flows.

3 Influences on allocation and entitlement prices

Previous work by Wheeler et al. (2008c) demonstrates that the price of allocations in the GMID is significantly and positively influenced by a yearly trend and the change to government policy introduced in 1998 to facilitate allocation trading. Other potential influences, such as commodity prices, are virtually insignificant (Bjornlund & Rossini, 2005). In any particular month, however, the price of water allocations is negatively and significantly related to the current allocation level. Even allowing for lagged effects (such as the previous month’s allocation), current allocation levels are still significant, while the net water deficit (the gap between rainfall and evaporation) also becomes significant. Thus, unsurprisingly, in the short term, the price of water allocations is heavily dependent on the weather (and particularly the size of the net water deficit) and the amount of water available from storages and released by the authorities.

By way of contrast, the price of water entitlements is significantly and positively influenced by several factors including allocation prices (reflecting weather and storage conditions), the month of the year, a yearly trend and the 1998 policy change. Overall, more of the variation in entitlement prices can be explained by the economic models than the variation in allocation prices. The single most significant influence on entitlement prices has been the yearly trend, highlighting the increasing acceptance of trading entitlements, and that over time, investing in such entitlements has proved profitable. The other most significant influence on entitlement prices is allocation prices (Bjornlund & Rossini, 2007a). As allocations
become more expensive, it follows that irrigators are willing to pay higher prices for water entitlements, both to reduce the need to buy future allocations and to attempt to ensure a more secure supply during periods of scarcity.

In summary, over the period 1993–2007, fluctuations in the price of water allocations have been mostly influenced by short-term factors (such as the drought, the current allocation of water received and the net deficit of water) rather than the longer-term prices of water entitlements. Permanent plantings of grapes (and the long-term losses associated with a single drought season) also seem to have influenced entitlement prices in the GMID, but not so much water allocations. Government policy changes had a positive influence on both allocation and entitlement prices, indicating that administrative policy changes can make a significant difference to water prices. Finally, the increasing acceptance of a market approach to water allocation is revealed in long-run increases in entitlement prices as the demand and prices paid for entitlements have increased as irrigators recognise the need to secure long-term water rights.

4 Influences on the elasticity of water demand and supply

4.1 Water allocations

While the price of water can provide information about its relative scarcity, estimates of the elasticity of demand and supply provide information about how farmers respond to changes in prices. In periods of increasing water scarcity, how farmers and their communities respond to increasing prices becomes an important element that affects their overall sustainability.

Elasticity is measured by the percentage change in quantity divided by the percentage change in price. A good that is “inelastic” is one where the quantity does not change a great deal in response to a price change, while an “elastic” response is one where the quantity responds strongly to a change in price. A positive elasticity means that the quantity supplied (or demanded) moves in the same direction as the price change and a negative figure represents a change in quantity in the opposite direction of the price change. For example, a value of 0.5 means that for every 1% increase in price, there is a 0.5% increase in quantity, while a −0.7 means that for every 1% rise in price, there is a 0.7% fall in quantity.

There has been comparatively little work estimating the elasticity of water allocations. Estimates tend to be more elastic if they are based on econometric studies or using mathematical programming and less elastic if derived from models based on field experiments. A recent review of 24 studies on irrigation water in the United States reveals a mean price elasticity of 0.48 and a median of 0.16 (in absolute terms), with larger elasticities in the longer run (Scheierling et al., 2006). They also reveal a large variation in the results, with elasticities ranging from 0.001 to 1.97. Overall, the demand for irrigation water appears to be more elastic than the demand for residential water, a result that is consistent with Australian studies on water price elasticities (Appels et al., 2004).
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Over the period 1997–2006, and based on bids registered with WaterMove, Wheeler et al. (2008a) found the elasticity of monthly demand in the GMID ranged from –1.32 to –7.82. Using supplier’s bids from the same source, the elasticity of monthly demand was estimated to range from 1.13 to 6.88.

Demand for water is closely related to seasonal requirements. The figures reveal that the elasticity of demand for water is relatively low early in the season peaking mid season and declining again towards the end of the season. Such a pattern is consistent with the view that farmers are most keen to purchase water early in the season – newly growing crops require water to survive – but as the growing period unfolds and they are either committed to developing the crop or not, the elasticity of demand increases (Wheeler et al., 2008a).

It is also possible that there are particular price ranges within which farmers (in aggregate) behave differently. Underlying this observation is the idea that as the price of water varies from season to season (being higher or lower on average in some years), so different crops become viable and the farmers then active in the market (i.e. those growing viable crops) may have different responses to price changes. An examination of elasticity by price range reveals that elasticity of demand ranged from –0.90 to –7.03 and the elasticity of supply ranged from 0.11 to 4.09 from the lowest to the highest price range. The elasticity of demand and supply for water depends on the time of the season and market prices. Demand elasticity is higher and varies more during the season than supply elasticity. Demand therefore appears to be dominated by active irrigators responding to fluctuating weather and market conditions, while water sellers and lower value producing irrigators deciding to sell all or a large proportion of their water early in the season dominate the supply side (Wheeler et al., 2008a).

Examining actual water traded against actual prices paid (rather than bid prices) between 1997 and 2006, demand elasticity was estimated between 0.51 in the short run and 0.82 in the long run. Statistically, however, these estimates were insignificant, so that in the aggregate, factors other than just price were found to also influence water demand.

As Figure 2 starkly reveals, drought has a major influence on water prices. Unsurprisingly, in periods of drought, prices rise. Wheeler et al. (2008a) also suggest that in periods of drought, the elasticity of demand decreases (the elasticities are lowest in drought years). This is consistent with the response that as water becomes scarcer, those farmers who continue to produce continue to purchase it to maintain production irrespective of price increases. Indeed, depending on the anticipated severity of the drought, and the farmer’s financial and personal situation prior to the drought, some continue to purchase water even when it is uneconomic to do so. The decision to continue to purchase water, even when product prices for farm output are below the water price, is consistent with the realisation that where permanent plantings exist, a failure to provide minimal water may mean a permanent cessation of production. This also suggests that the longer a drought continues, the more pressing this issue becomes for farmers with permanent plantings and the more the decision to purchase allocation water becomes, in effect, a decision whether to continue farming. This also has implications for the entitlement price.
4.2 Water entitlements

Whereas work on prices and elasticity of allocation water reveals farmers’ short-term responses to variations in water markets, seasonal factors, weather conditions, etc., the entitlement market provides insights on farmers’ longer-term responses to change. Responses in the entitlement market therefore provide insights into the possible direction of change in irrigation and the sustainability of this sector. In Australia, however, this market has been comparatively slow to develop, and any insights from previous research should be considered preliminary.

There has been surprisingly little quantitative work on the factors affecting the price of water entitlements. Analyses of individual transfers in New Mexico found that the most influential factors influencing entitlement prices were urban and industrial activity, the priority of the water right that was traded and the volume of water traded (Colby et al., 1993). An analysis of mean annual prices in Colorado revealed that agricultural commodity prices were significant until urban buyers started to dominate the market after which time other non-farming factors such as the number of housing starts were important (Person & Michelsen, 1994). Within the study region, neither the priority of water rights nor competition from urban and industrial users has been an issue.

Bjornlund (2002b) analysed individual transfers of water entitlements during the early years of water trading to establish the factors influencing individual irrigators’ willingness to pay and accept prices in the market for entitlements over two time periods within two different states. He found that as trading was opened up both spatially and between different types of water users and classes of water entitlements, and as market operations became more proficient and intermediaries more active in the market, prices increased and became more consistent across space and entitlement classes. This is consistent with earlier findings in US markets (Gardner, 1985; Brown et al., 1982). He also found that efficient and higher-valued irrigators were willing to pay higher prices when buying, and were capable of demanding higher prices when selling; buyers and sellers in the strongest bargaining position paid lower prices and received higher prices; and older farmers sold at lower prices unless they sold as part of a planned retirement process. Finally, he found that price dispersion in the market in South Australia declined sharply between 1987 and 1996, from approximately 18% initially to 6% in the last year. In comparison, markets in Victoria exhibited a relatively constant dispersion during the first 9 years of trading of around 20%; a rate still within the range experienced for many other commodities (Pratt et al., 1979). These findings suggest that for individual farmers, the market for water entitlements is being impacted by normal economic factors, as would occur in any other market process.

Regression analyses, using mean monthly prices, show very few relationships between commodity prices and prices of water entitlements, with only wine grape prices having a significant positive correlation with price. There also appears to be negative correlations between the price of water entitlements and dairy products which are the outputs from the main high-value industry within the district.
The major factors influencing the price of water entitlements are the price of water in the allocation market, the level of seasonal allocation, wine grape prices and interest rates (Bjornlund & Rossini, 2007b).

There is slightly more research available about the demand for entitlement water. In the GMID, between 1997 and 2003 for example, it was found that rainfall and evaporation, seasonality factors, the price of entitlements, the price of water allocations and the price of milk were statistically significant factors influencing the demand of water entitlements. Although useful, the study did not provide a fully specified model of water demand (Bjornlund & Rossini, 2006).

Wheeler et al. (2008b) used a region-level model to estimate the factors correlated with the demand for water entitlements purchased by farmers in the GMID. They found that average demand for water entitlements was significantly and positively influenced by the demand in the previous month and seasonality factors. Surprisingly, other variables such as farm income, rainfall and lagged demand were not significant, although the allocation variable (the percentage of the water entitlement that is available for use at that time) was “almost” statistically significant. The difference between the findings of the 2008 study by Wheeler et al. and the 2006 study by Bjornlund and Rossini is most likely caused by the continued and intensifying drought that occurred over the period.

Complicating any analysis of agricultural water markets in Australia over the past 10–15 years has been the impact of drought. This may, however, also provide important insights into long-term sustainability of agriculture in periods of climate change and lessening water. For example, for the period 1997–03, Bjornlund and Rossini (2005) found an expected negative relationship between prices of water entitlements and demand for water entitlements, the work by Wheeler et al. (2008b) suggests the price of water entitlements was positively (but weakly) related to water demand. Extending the analysis to include drought years confirms that prices were positively significant, in relation to demand for entitlements. Thus, the beginning of a major (and continuing) drought in 2003, where prices have skyrocketed, appears to have fundamentally changed the relationship between price and demand. Indeed, comparing cycle factors for entitlement and allocation prices confirms that up to 2003 the two factors moved in unison, but since then they have departed (Bjornlund & Rossini, 2007a).

That a major drought should cause a significant shift in the market is not unexpected. The positive sign of the price elasticity, although unusual, signals that buyers would be willing to pay higher prices for larger volumes. It is also consistent with some irrigators “digging in” (and paying what it takes) to maintain their farms in the longer term, while others sell. Increasing price and volumes also helps lower average costs, thus favouring larger and more efficient irrigators. It may thus reflect the shift in farmer production processes desired by policy makers. Farmers who are willing to purchase entitlement water in times of drought are also signalling a long-term commitment to irrigation production – something that is only viable for high-value crops. Comparatively “short-term” price changes are then less of a factor influencing the demand for water as farmers restructure their production process.
Between 1997 and 2007, the market has been dominated by historically low allocation levels and the price of water entitlements does not appear to play a significant role in influencing the demand of water entitlements. The regressions suggest that scarcity is the major reason. What is less understood, however, are the factors associated with individual irrigator decisions. For example, during a drought period risk-averse irrigators, in an effort to secure their production, are likely to be buyers in the market, but identifying the cluster of characteristics associated with risk aversion remains unresearched. During the 2002–03 season, there were reports of a high level of anxiety among irrigators on the day of the weekly exchange, as water was needed “instantly” (Bjornlund, 2003a). High anxiety and high prices during this season saw many people active in the entitlement market. Identifying individual farmer characteristics (such as the age of the farmer, attitude towards leaving the farm, their stress and income levels) may play a more important role in determining trade outcomes than previously thought.

There is evidence of increased market activity following seasons of very high allocation prices and difficulties in obtaining water in the allocation market (Wheeler et al., 2008a). Identifying the characteristics of the farmer likely to adjust their entitlement holdings and in which direction, particularly in periods of water scarcity, remains to be done.

To this point, we are not aware of research that has identified significant coefficients for either the short-run or long-run elasticity of entitlement water in Australia. The strongest factor associated with these elasticities has been the time of year, as water entitlements are made effective on 1 July each year and there is no dispute about who has access to the next season’s water allocation on this date (Wheeler et al., 2008b).

Drought increases the stress placed on farmers. We also suggest that the elasticity of demand for entitlement water will decrease (become more inelastic), as prices increase and remaining farmers become more determined to purchase entitlements with less regard to price. An important (and yet little researched) factor likely to be influential to this decision is the response of banks and financiers to individual farmers requests for loans. Without adequate access to finance, the ability of the market to redistribute water permanently and to areas of higher productivity is reduced. However, at the same time, the entry into the market by the Australian government as part of its “Water for the Future Plan” may also decrease the elasticity of demand for water and cause significant increases in water prices. The government anticipates spending A$3.1 billion on purchasing water from farmers to address over-allocation and achieve environmental objectives within the Murray–Darling Basin. This means, based on the trend in sales of water entitlements over the past 5 years, the government will need to purchase 100% of current volume of water traded for the next 14 years to achieve its objective of buying 1500 GL (gigaliters) of water. One consequence of this policy action is that it could potentially prevent the market from achieving the water market reform benefits experienced in the past.
5 Conclusion

From the results, it is clear that in periods of great water scarcity, farmer’s response to changes in water prices differs from periods when supply is relatively more plentiful. In periods of reasonable supply, farmers’ decisions to buy or sell water allocations are most influenced by the time of the season, the condition of their infrastructure, market prices for their production, etc. As supply decreases under increased water scarcity, the pressure on irrigators to choose between maintaining their production and ceasing production increases. This pushes more farmers into choosing whether to produce in a particular season, and hence also impacts on the supply of water available for purchase. As a drought period continues, however, more farmers are required to choose between maintaining production and permanently ceasing production – a factor that influences the entitlement market. As individual farmers make these choices both short and long term, they are influenced by a range of additional factors such as their age, whether they have a succession plan for their farm, income (and savings), the state of the market for their crop and the current policy directions of the government. Many of these factors are comparatively poorly understood – despite their importance in determining whether agricultural production will remain viable in the long term.

To date, the period of concurrence between the existence of drought conditions and actively operating water markets in the GMID has been relatively brief. The data we have to this point include the drought years before 2002–3 and after 2006. Nonetheless, we have some insight into farmers’ responses.

Current predictions suggest that there will be a permanent reduction in annual water supply in the whole of the Murray–Darling Basin (including the GMID) due to climate change. Second, there is likely to be a permanent reduction in the amount of water available for farming, as the natural environment’s needs are given higher priority and the government enters the water market in a significant way. Both of these factors will cause the price of water, in both the entitlement and the allocation markets, to rise to permanently higher levels. While farmers must adjust to these shifts, it is likely that the price of agricultural output will also rise. For policy makers attempting to facilitate a sustainable level of agricultural output, the critical issue is to ensure that water continues to be transferred to where it is most valuable and that change occurs at a rate that allows farmers time to respond (by modifying their demand for water, altering production, investing in more efficient infrastructure and leaving the sector, etc.). Which farmers have the capacity and ability to respond to increased water scarcity, and how quickly they will react to the market remain largely unanswered questions. Nevertheless, much of the future sustainability of the irrigation sector in the GMID depends on the answers.

The future sustainability of irrigation in Australia depends on achieving a long-term equilibrium between the competing demands of agriculture, the environment and the community. It is clear that over the past decade and a half, water markets have assisted irrigators in the GMID to begin to adjust to water scarcity and to move towards more sustainable irrigation.
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