Estimation of the Economic Surplus in a Water Trading Market: The case of Northern Victoria, Australia

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Abstract

The size of the economic surplus of a water trading market was estimated using the CVM-trigonometric method for the first time in the world.

A study area of about 68,000 square kilometers in the north of the State of Victoria, Australia was selected. This is one of the centers of the irrigation agriculture of Australia and is managed by a water distribution, Government-owned corporation called G-MW. The investigation period covered was an irrigation season from August, 2009 to May, 2010, and was the fiscal year of a prolonged period of drought. The questionnaire survey was carried out from September, 2010 to December through the cooperation of three farmhouse organizations. The questionnaire was distributed to 1000 households involved in irrigation farming. There were 112 effective replies.

According to the estimated result, total dealings amount to A$8,114,610 (amount-of-water traded 54,368.5ML) carried out in the study area, a buyer surplus was estimated at A$468,634, a seller surplus was estimated at A$802,811 and the total surplus was estimated at A$1,271,446 in that irrigation season. That is, when considered as the ratio to the total dealings, the buyer surplus was 5.8%, the seller surplus was 9.9% and the total economic surplus was 15.7%. Although this result is no more than a tentative estimate because of low response rate and thus sample size, it is the interesting result for the fundamental evaluation of a water trading market for both sides (buyers and sellers) to generate an economical surplus when under drought. That is, a water trading market provides a transaction participant with a flexible adjustment means by which it can respond to unusual circumstances, such as drought, and it is working sufficient well as a risk reduction measure.

Keywords: economic surplus analysis, water trading market, CVM-trigonometric method, water price, Northern Victoria of Australia

INTRODUCTION

A water trading or market has existed in Australia for 30 years and is growing in both a qualitative and quantitative sense. In June, 2010, the National Water Commission (NWC) published its assessment of the economic, social and environmental impacts of water trading, and gave the following synthetic evaluations as the conclusion.

> "*This study demonstrates unequivocally that water markets and trading are making a major contribution to the achievement of the NWI (National Water Initiative) objective of optimizing the economic, social and environmental value of water. The overwhelming conclusion of the study is that water trading has significantly benefited individuals and communities across the southern Murray-Darling Basin (sMDB)."* (NWC (2010a), p.v.)

The NWC especially focused on economic impacts of water trading. Thus:.

> *"Finding 27: The modeling estimated that water trading in the sMDB increased Australia's gross domestic product by more than A$ 220 million in 2008-09. The total benefits were even greater within the sMDB, where water trading increased gross regional product by over A$ 370 million in that year, indicating that water trading maintained productive capacity within the sMDB (rather than seeing it move to other areas of Australia). Water trading provides benefits during periods of increasing water scarcity and when water availability is improving."* (NWC (2010a), p.84)

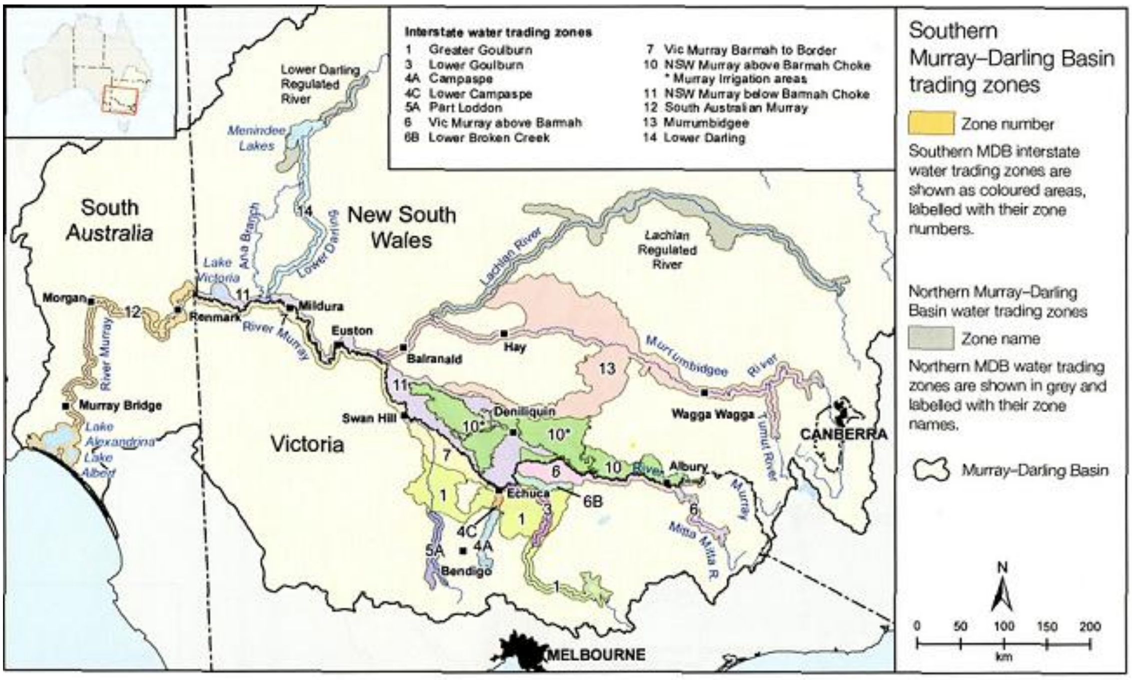
In today's Australia, the economic impacts of water trading are gaining more attention.

The NWC uses a CGE model to estimate the economic effect of water trading.[1] This model compared two cases, that is, the case *with* the water market and the case *without* the water market, and calculated how much the reduction of production levels by a drought could be stopped by using a model with certain assumptions. This is a method of building the model which can reproduce the economic effect of a water market, and can be said to be an "objective valuation" method. However, whether an irrigation farmer actually takes action which a model assumes is debatable. For example, according to our questionnaire survey, only 40% of questionnaire respondents have participated in water trading at present. Although the water market is economically attractive as seen later, the majority of farms that use irrigation do not use it. A CGE model is only what estimated any economic effect of which there is, supposing an irrigation farmhouse acts rationally. It is problematic whether an irrigation farmer will actually participates in a water market, and factors other than economic, such as age and knowledge of the Internet etc., have had big influence on their action. Thus, we need another new approach. That is, we must assess the size of the economic value which those who have participated in the water market feel. When performing overall assessment of the economic effect of a water market, I think that the "subjective valuation" of such a participant is an important part which cannot be avoided. There is no example which measured the economic surplus of the water market until now.

BACKGROUND

The principal water systems in Australia and trading zones of southern Murray-Darling Basin (sMDB) are shown in Figure 1. The sMDB is not only a center of the irrigated agriculture of Australia, but a center of a water market. The sMDB consists of part of three states, that is, NSW, Victoria and SA, and whole area of ACT.

Figure 1 Southern Murray-Darling Basin trading zone

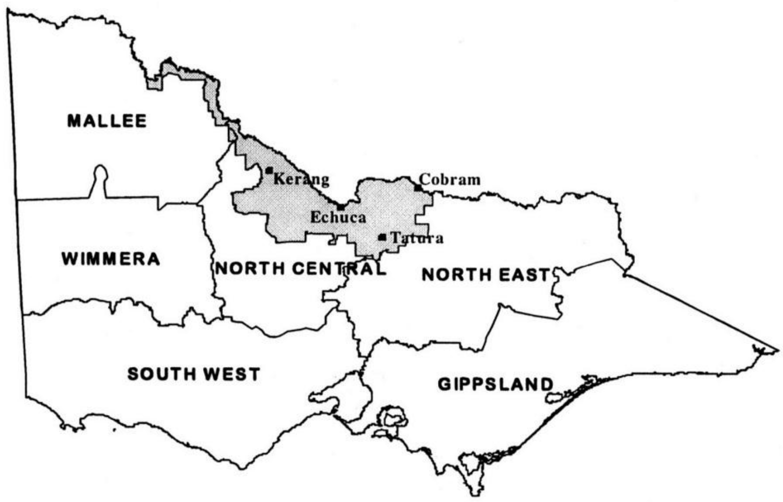


(Source) NWC (2010b), Figure 2.5, p.21.

Our target area is called northern Victoria which is located in the inside of sMDB and acts as one of the main water markets in Australia. There is about 1.5 million ha (15,000 square kilometers) of the irrigated land in northern Victoria and it is in the area which met the River Murray between Mildura and Cobram. (refer to Figure 2)

In northern Victoria, dairy, horticulture and mixed farming are mainly performed all the year round, and especially the dairy industry serves as the center of export of Australia.[2] The Internet market called “Watermove” was established by the Department of Sustainability and Environment (DSE) in 2002 to support the development of water trading across Victoria. It has been managed by Goulburn-Murray Water (G-MW). The area (68,000 square kilometers) which G-MW has managed is greater than the irrigated land region in northern Victoria, and includes basin systems, such as Goulburn River, Broken River, Campaspe River, Loddon River, and Oven River, dams, reservoirs, etc.

Figure 2 Irrigated Areas in Northern Victoria

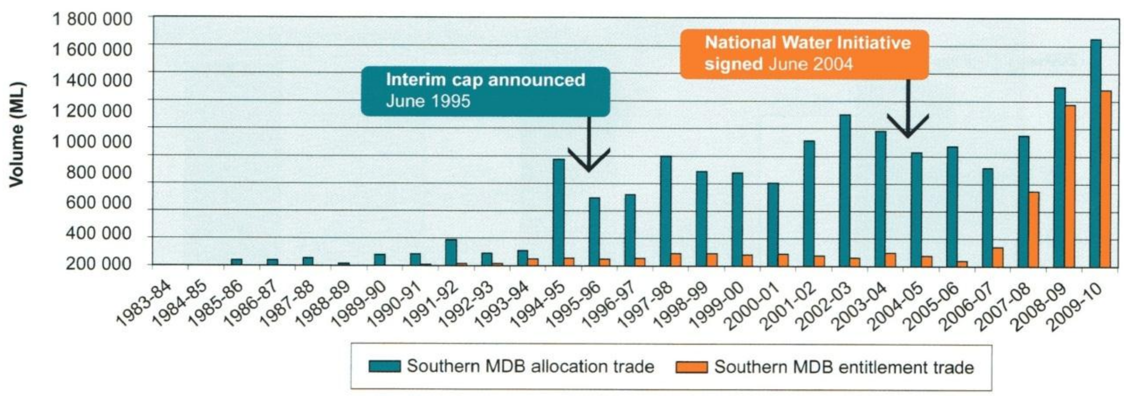


(Source) DSE & DPI (2010), Figure 1, p.1.

Moreover, although the 15 trading zones are set up in the area, the Greater Goulburn area (a zone number is 1A) serves as the center of price formation in Victoria. (refer to Figure 1)

Australia has two kinds of water trading. These are called "entitlement trading" and "allocation trading". Entitlement trading is accompanied not only by movement of water but by the transfer of the right of private property of water. Allocation trading is not accompanied by transfer of the right of private property of water, but transfers only the right to use water. Previously allocations trading has been the most popular, but recently entitlement trading have has been increasing rapidly. (refer to Figure 3)

Figure 3 Volume of allocation and entitlement trades in the southern MDB, 1983-84 to 2009-10 (ML)



(Source) NWC (2011), Figure 1.5, p.13

The turnover of water market of Australia was about A$3 billion in the 2009-10 fiscal year, and it is thought that the scale is the largest in the world. (refer to Table 1)

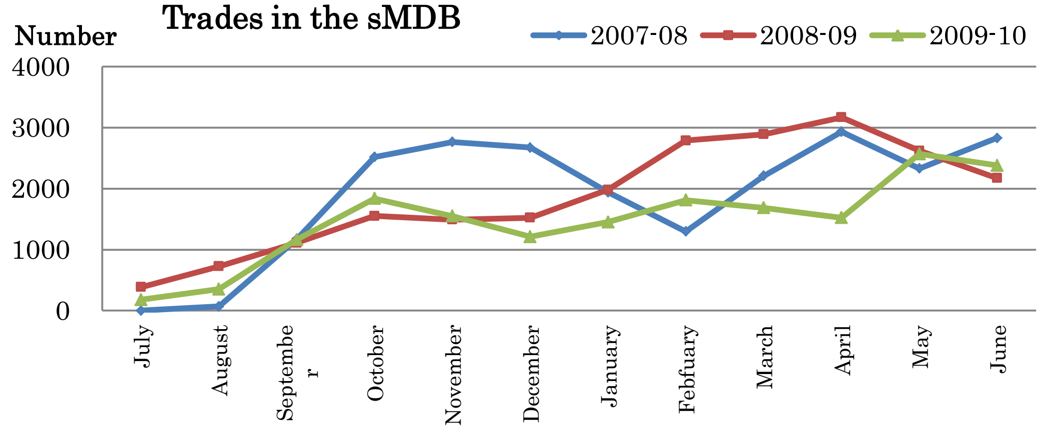
Table 1 Turnover of Water Market of Australia (unit: A$ million)

	2007-08	2008-09	2009-10
Turnover of Entitlements	844.9	2214.6	2595.6
Sales of Water Allocations	836.1	605.9	366.3
Total (A)	1499.4	2787.2	2961.9
Nominal GDP (current price) (B)	1185740	1255241	1284777
A/B (%)	0.126	0.222	0.231

(Source) NWC (2010b), Table 3.5, p.34.

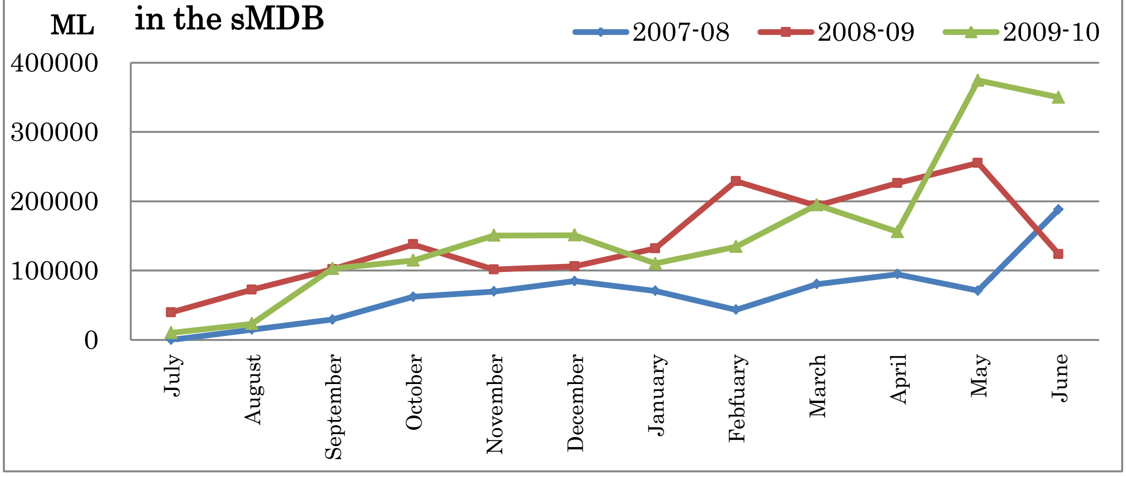
Below, the dealings amount of water and the trend of an allocations average price are shown for the past three years in the sMDB. (refer to Figure 4 to Figure 6) When the storage-of-water situation for the past three years was seen, the 2007-08 was 18% and the 2008-09 was 18% and 2009-10 was 32%.[3] Although the influence of a drought still remained in 2009-10, the water availability was greatly improved in 2009-10. In the past three years, although the dealings number decreased in the 2009-10, dealings in the amount of water increased, therefore the trading volume per affair gradually increased. (refer to Figure 4 and Figure 5) Moreover, the water average price fell greatly and was relatively stable in 2009-10. (refer to Figure 6)

Figure 4 Monthly Change of Number of Allocation Trades in the sMDB



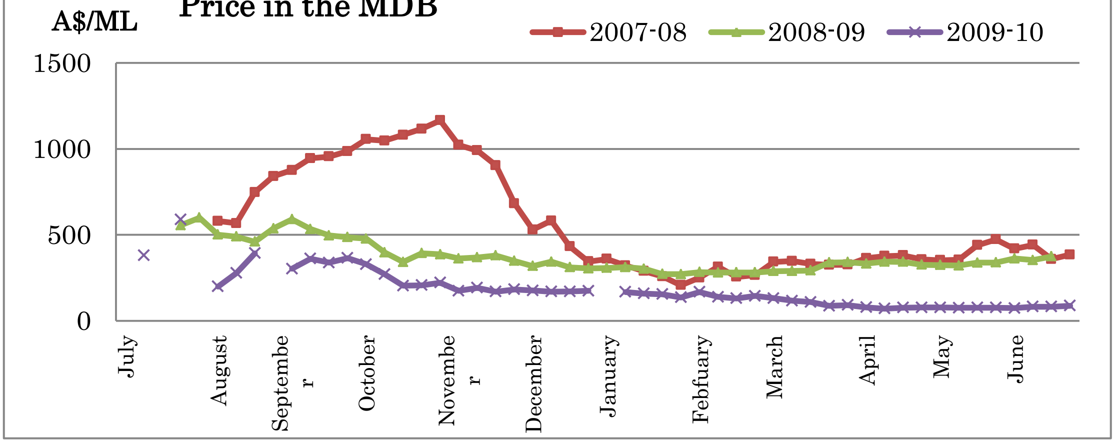
(Source) Created from NWC (2011), Table A.9, p. 65.

Figure 5 Monthly Change of Volume of Allocation Trades in the sMDB



(Source) Created from NWC (2011), Table A.9, p. 65.

Figure 6 Weekly Change of the Average Allocation Trade Price in the MDB



(Source) Created from NWC (2011), Table A.8, p.63-64.

The features of the water market of Australia are as follows:

- water rights has spread even on the individual level
- irrigation farmers are playing the leading role in water market
- Internet deals are prosperous.

The irrigation farmers of the following four types are the main participants in Australian water market.[4]

(1) Horticulture farmers

The highest concentration of horticulture is in the Victorian Murray below Barmah, Lower Darling, Murrumbidgee and SA Murray trading zones. Horticultural demand for water can be inelastic in the short term, as there is a high cost in losing established plantings. This means that allocation water is often purchased and imported during times of low local water allocations to ensure the survival of permanent plantings. (refer to NWC (2011), p.22)

Table 2 Wine grape production, wine grape prices and water allocation prices, SA Murray, 2005-06 to 2009-10

	2005-06	2006-07	2007-08	2008-09	2009-10
Wine grapes average price (A$/tone)	616	881	787	527	520
Wine grapes production (kilotonnes)	1873	1410	1837	1684	1617
Water allocation price (A$/ML)	45	202	682	347	160

(Source) NWC (2011), p. 67.

(2) Rice grower

The NSW Murray and Murrumbidgee zones have a high concentration of irrigated annual cropping, which includes rice growing. Demand for water for rice growing is relatively elastic, in that it changes significantly from year to year depending on water availability and prices (for both water and crops). Because rice is an annual crop, rice growers can sell water allocations and reduce the area under production in a relatively dry year. During a water season, they can respond to low water allocations by delaying their plantings until they get a more accurate indication of available water. They can also source additional water through the allocation market to support planting decisions, or they can sell their water allocation if planting does not proceed (providing a return on their water entitlement). (NWC (2011), p.22)

The gross margin (i.e., excluding the variable costs from sales) of rice production is presumed to be about A$100 - 200/ML. (NWC (2010a), p.60)

Table 3 Rice production, rice prices and water allocation prices, Murrumidgee, 2005-06 to 2009-10

	2005-06	2006-07	2007-08	2008-09	2009-10
Rice average price (A$/tone)	283	346	414	582	528
Rice production (kilotonnes)	1003	163	18	61	205
Water allocation price (A$/ML)	37	194	524	382	155

(Source) NWC (2011), p,67.

(3) Dairy farmers

Dairying is highly concentrated in the Goulburn, Victorian Murray above Barmah and NSW Murray zones. Similarly to rice farmers, dairy farmers can respond to dry years in various ways, including by buying allocations to grow feed or selling allocations to assist in purchasing feed substitutes (allowing farmers to maintain their herbs for the next season). (NWC (2011), p.22)

Table 4 Milk production, hay prices and water allocation prices, Goulburn, 2005-06 to 2009-10

	2005-06	2006-07	2007-08	2008-09	2009-10
Hay (A$/tone)	144	231	282	233	199
Milk (ML)	10089	9583	9223	9388	8960
Water allocation price (A$/ML)	56	194	735	337	168

(Source) NWC (2011), p,67.

(4) Mixed farming producers

Although mixed farming is the way of the agriculture which generally pursues two or more purposes at one farm (or farm management entity), the system of combining grain and livestock is often undertaken. For example, it is the agriculture which grows edible grain, such as wheat, rye and oats, and feed crops, such as corn and root vegetables, and also aims at simultaneously breeding of domestic fowls and livestock for meat, such as sheep, cow and pig.

Mixed farming varies across the southern MDB trading zones, but is most common in the Victorian Loddon-Campaspe and Murray above Barmah zones. Water demand is highly elastic, as it is possible to substitute irrigated and dryland production depending on water availability and prices. (NWC (2011), p.22)

The interesting data about the gross margins of irrigated cropping is published by the official site of DPI of the State of Victoria. This is quoted for reference. (refer to Table 5)

Table 5 Northern Victoria Irrigated Cropping: Gross Margins 2009-10

2009-10	Wheat	Barley	Canola	Faba Bean	Lucerne	Maize (Grain)
Gross Margin/ha	680	688	845	689	2893	1528
Gross Margin/ ML	194	197	241	230	289	180

2009-10	Maize (Silage)	Oats (Milling)	Oats (Hay)	Sorgham (Hay)	Soybean	Triticale
Gross Margin/ha	1269	358	1327	661	730	607
Gross Margin/ ML	159	119	442	88	97	173

(Source) DSE & DPI (2010), pp.8-31.

It is ranged from A$88 to A$442 by the price of the gross margins per 1ML of water.

EQUILIBRIUM POINT IN WATER MARKET

I will explain pricing of the water market of Australia.

In Watermove, the water market was opened from August 6 to June 3 in 2009-10. In the meantime, except for two times in the Christmas holidays, 42 dealings were fundamentally conducted on Thursday every week. A pricing system is called a double bids system and will apply for the combination of a price and trading volume for which a seller and a buyer nominate through the Internet by every Thursday. We call this combination of a price and trading volume as "order" or "order set".

For example, each order set of a seller and a buyer presupposes that it is as follows.

Table 6 Example of Seller's and Buyer's Schedule

Seller's schedule				Buyer's schedule			
No.	Price	volume	volume accumulated	No.	Price	volume	volume accumulated
S1	80	20	20	B1	250	10	10
S2	100	30	50	B2	200	20	30
S3	150	30	80	B3	180	30	60
S4	180	50	130	B4	150	50	110
S5	200	50	180	B5	100	30	140
S6	250	50	230	B6	80	10	150
S7	300	10	240				

This schedule is made as follows. (refer to DNRE (2001), p.27)

A seller's schedule is arranged in order of the small order of a price. A buyer's schedule is arranged in order of the large order of a price. "Volume Accumulated" accumulates the volume of order. In addition, it is assumed that all orders of the same price are summarized.

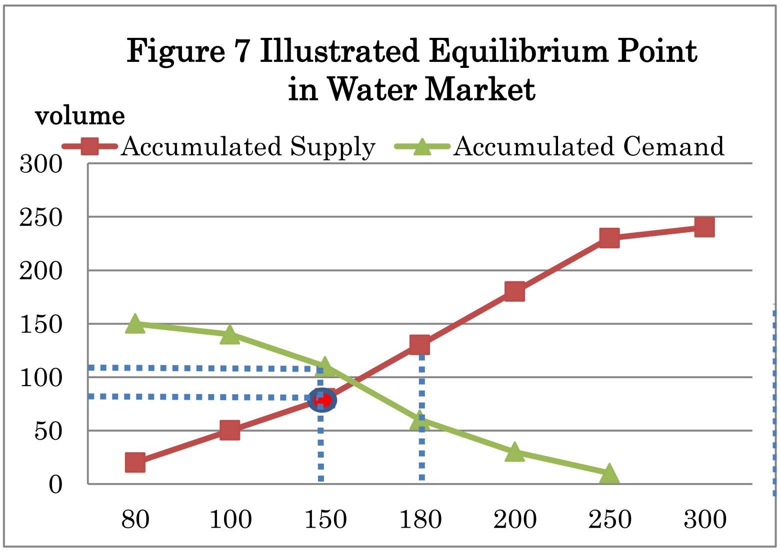
Now, since the order of S7 has a too high suggested price, and its counterpart of the selling order cannot be found, this order is unfilled. If the price is set to 80, the supply volume accumulated is 20 and the demand volume accumulated is 150, and therefore the excess demand volume accumulated become 130. If a price is raised to 100, the excess demand accumulated will be set to 90. If a price is raised to 150, the excess demand volume accumulated will be set to 30. Furthermore, if a price is raised to 180, the excess demand volume accumulated will serve as minus 70. Since the excess demand volume accumulated changed from plus to minus when a price was moved to 180 from 150, an equilibrium price becomes either 150 or 180. Since the absolute value of difference is small in case a price is 150, an equilibrium price is set to 150.

When an equilibrium price is set to 150, since supply volume accumulated becomes 80 and demand volume accumulated becomes 110, the supply volume accumulated is smaller than demand volume accumulated. Then, equilibrium volume is decided as 80 in this case. In addition, although the B4 took out the buying order of 50, since the seller corresponding to it is not found in 30 of them, 30 is cut among 50.

As a result, in this dealing, the seller of S1, S2, and S3 can sell off as desired amount of water. On the other hand, although the buyer of B1, B2, and B3 can purchase as desired amount of water, only 20 can be purchased among B4's orders of 50.

In other words, in this dealing, the seller of S4, S5, S6, and S7 cannot sell water. Also the buyer of B6 and B5 cannot buy water and 30 of B4's orders of 50 cannot be purchased.

This dealings can be explained using an accumulated supply curve and an accumulated demand curve. (refer to Figure 7)



A price level is taken along a horizontal axis on account of drawing, and volume of water is taken along the vertical axis. According to the Figure 7, an equilibrium point is seen on the price axis of between 150 and 180, and is seen on the volume axis of between 80 and 110.

An equilibrium price will be determined at a price with a smaller absolute value of a difference between supply volume accumulated and demand volume accumulated. An equilibrium volume will be determined under the same equilibrium price at a smaller volume between supply volume accumulated and demand volume accumulated. It can be said that a market equilibrium point will be decided by the intersection of an accumulated demand curve and an accumulated supply curve supposing it can assume that an order exists innumerably. This equilibrium price is called "pool price".

CVM-TRIGONOMETRIC METHOD

An economic surplus is a total of a seller surplus and a buyer surplus. With a seller surplus, [(market equilibrium price) minus (the minimum price considered that seller may sell water)] is multiplied by dealings volume.

Similarly, with a buyer surplus, [(the maximum price considered that a buyer may purchase water) minus (market equilibrium price)] is multiplied by dealings volume.

The minimum price considered that a seller may sell water is called WTSmin (the minimum Willingness-To-Sell price) for convenience. Similarly, the maximum price considered that a buyer may purchase water is called WTBmax (the maximum Willingness-To-Buy price) for convenience. Clearly, the key point in the case of measuring an economic surplus is how to grasp this WTSmin price and WTBmax price.

Supposing that the prices which were shown in the water market can assume that these were exactly same as WTSmin of a seller and WTBmax of a buyer, an economic surplus is easily calculable. It can be shown as follows when it calculates using a former example. (refer to Table 7)

Table 7 Example of Surplus Calculation (Direct Method)

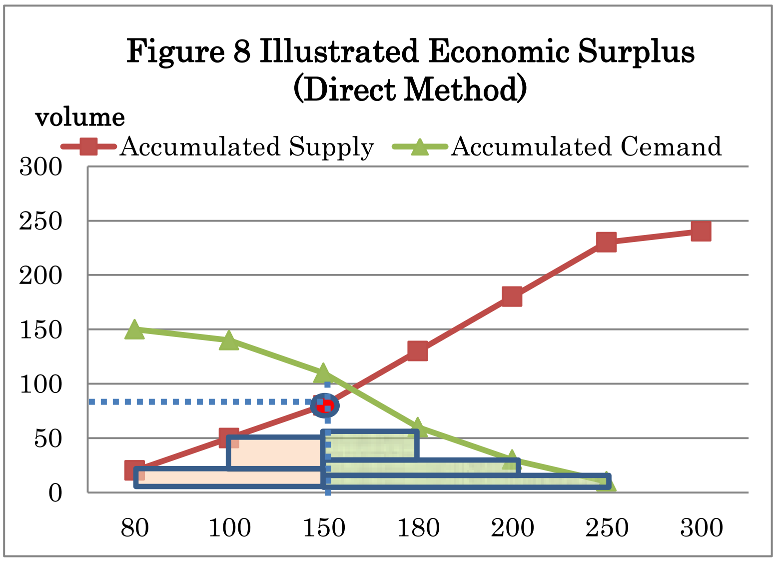
Seller's surplus				Buyer's surplus			
No.	price	volume	seller's surplus	No.	price	volume	buyer's surplus
S1	80	20	1400†	B1	250	10	1000
S2	100	30	1500	B2	200	20	1000
S3	150	30	0	B3	180	30	900
				B4	150	20	0
Seller's surplus in total			2900	Buyer's surplus in total			2900

† (150 – 80) × 20 = 1400. Hereafter, it is calculable similarly.

Therefore, in the case of this example, as for the % occupied in the gross transaction amount of money of A$12,000, a seller surplus and a buyer surplus become 24.1%, and it will be said that the ratio to the amount of money for dealings of the total surplus is 48.3%.

The following figure illustrated the above calculation intelligibly. (refer to Figure 8)

We will call this method of calculating an economic surplus directly from the observed data as "direct method".



Theoretically there should be a price expressed in the market equally to a marginal net return. However, the difficulty of this direct method, in the first place, is it has a high possibility that the special factor for successful making dealings have entered in the price expressed in the market. Although I wanted to discuss the details separately, with regard to the dealing strike (or successful) rate of the participants of 1A zone in the whole 2009-10, the seller's strike rate was 38.2% and buyer's strike rate is 51.8%, respectively. In order that a seller may make sale successful from such a low strike rate certainly, the way which set up the price which is less than the equilibrium price expected becomes advantageous. Similarly, the way which the buyer set up the price which is more than the equilibrium price exceeded becomes advantageous. For this reason, generally the economic surplus based on direct method has the problem of being overestimated.

Moreover, as the second problem, in direct method, no matter what price a market equilibrium price may turn into, the negative economical surplus to the both sides of the participants who succeeded in market dealings is not produced. For example, in the case of the rice farm where it is considered as marginal net revenue proceeds of about A$100-200/ML means never purchasing water, when a water price exceeds the A$200/ML. However, when the availability of water is in early stages of a season, it is thought that a certain amount of loss is prepared and sometimes actually produced, i.e. the negative surplus could happen. It is a difficulty of direct method that such a point cannot be reflected.

We propose the use of the Contingent Valuation Method (CVM)-trigonometric method instead of this direct method.[5]

An outline of CVM-trigonometric method is as follows although another paper about the details of this analysis method will be produced.

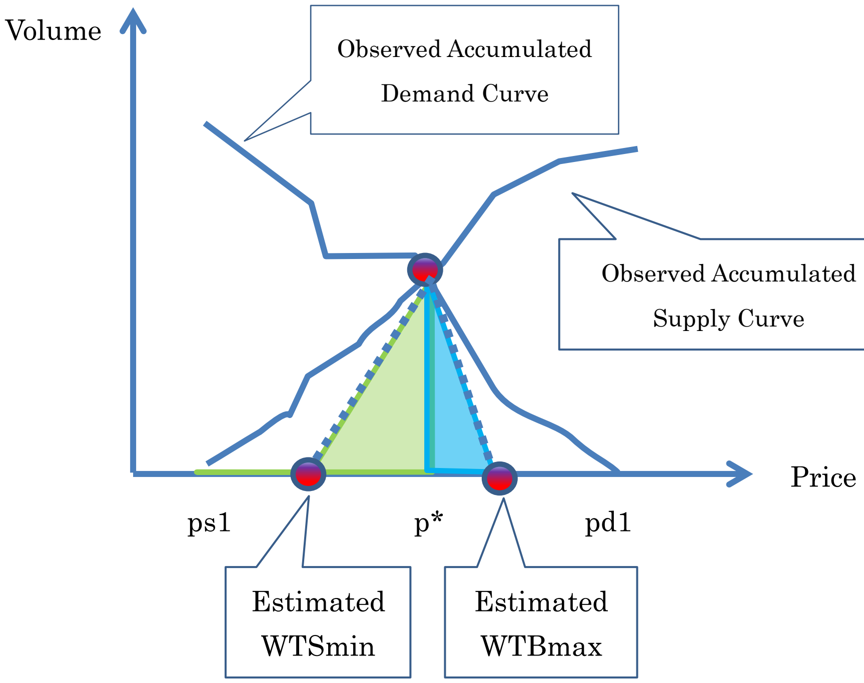
By using questionnaire survey, it finds out about WTSmin price and WTBmax price of each person of every month. These data are weight averaged and average WTSmin price and average WTBmax price of every month are calculated. An approximated curve is presumed to these data and a WTSmin Curve and a WTBmax Curve are presumed.

Furthermore, the data basing monthly unit are changed into the data basing daily unit, and the estimated WTSmin Curve and estimated WTBmax Curve which can correspond to actual weekly unit time dealing are computed. (refer to Figure 10)

If the assumption that an Accumulated Supply Curve and Accumulated Demand Curve are linear is made, the both seller and buyer surplus for every week dealing are calculable basing only four information sets: a market equilibrium price, equilibrium volume, estimated WTSmin price, and estimated WTBmax price. We call this method as CVM-trigonometric method. (refer to Figure 9 and Appendix A and B)

In Figure 9, ps1 is the minimum price of an Accumulated Supply Curve, and pd1 is a maximum price of an Accumulated Demand Curve. p* is a market equilibrium price. WTSmin is the minimum Willingness-To-Sell price (or the minimum permissible seller's price) obtained by the CVM method. Similarly WTBmax is the maximum Willingness-To-Buy price (or the maximum permissible purchasers' price) obtained by the CVM method.

Figure 9 Illustrated CVM-Trigonometric Method



RESULTS

The investigation period covered was an irrigation season from August, 2009 to May, 2010, and was a year which is recovering a long drought at last. The questionnaire survey was carried out from September, 2010 to December through the cooperation of three farmhouse organizations: Fruit Growers Victoria (FGV), Victorian Farmers

Federation (VFF), and United Dairy Farmers (UDF). The questionnaire was distributed to 1000 households involved in irrigation farming. There were 114 completed surveys that were received (112 effective replies). Distribution of farm type was as follows. (refer to Table 8 and Appendix C)

Table 8 Distribution of Recovery person's Farmhouse Type

Dairy farm	Annual horticulture	Perennial horticulture	Mixed farm	Cropping farm	Others
84	7	11	5	0	2
77.1%	6.4%	10.1%	4.6%	0%	1.8%

The ratio occupied to the operating area of G-MW of the respondent total is as follows. (refer to Table 9)

Table 9 The Ratio Occupied to the Operating Area of G-MW of the Respondent Total

	Volume managed or owned (ML)	Volume allocated in 2009-10
G-MW(A) †	2,011,195	1,510,892
Respondent total(B)	86,191	33,090
Ratio (A/B)	4.3%	2.2%

† The data concerning G-MW is obtained from NWC (2010b), p.19, and p.87.

Information on the minimum permissible seller’s price (WTSmin) was received from 31 questionnaires. Similarly, the number of the maximum permissible purchasers' price (WTBmax) was 133. Moreover, it was 41% which actually sold and bought among respondents in the water market (46/112).

In the result of the question item which incidentally asked whether the respondent would agree or not to water trading, ‘support’ was 67 (59.8%), ‘opposition’ was 30 (26.8%), ‘unsure’ was 3 (2.6%), and ‘no-answer’ was 12 (10.7%). When this answer was limited to those who actually conducted water trading, ‘support’ was 33 (71.7%), ‘opposition’ was 9 (19.6%), ‘unsure’ was 1 (2.2%), and ‘no-answer’ was 3 (6.5%). It is thought that those who actually participated in water trading regarded water trading very positively.

Estimated WTSmin Curve, estimated WTBmax Curve, actual pool price and economic surplus are calculated and shown below. (refer to Figure 10 to Figure 12.)

Figure 10 Estimated WTSmin Curve, Estimated WTBmax Curve and Actual Pool Price

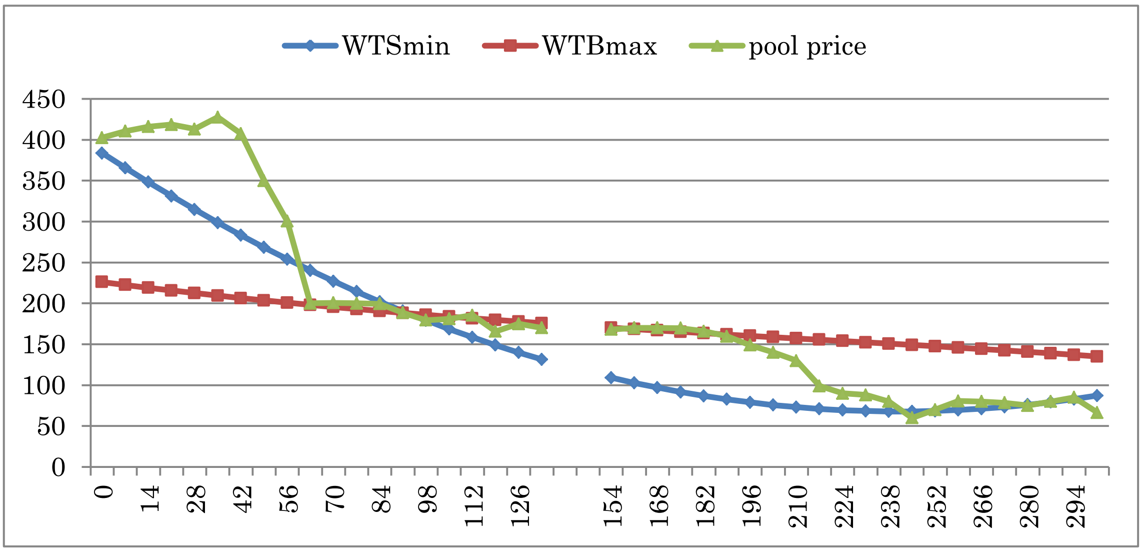


Figure 11 Seller's Surplus and Buyer's Surplus in Zone 1A of 2009-10

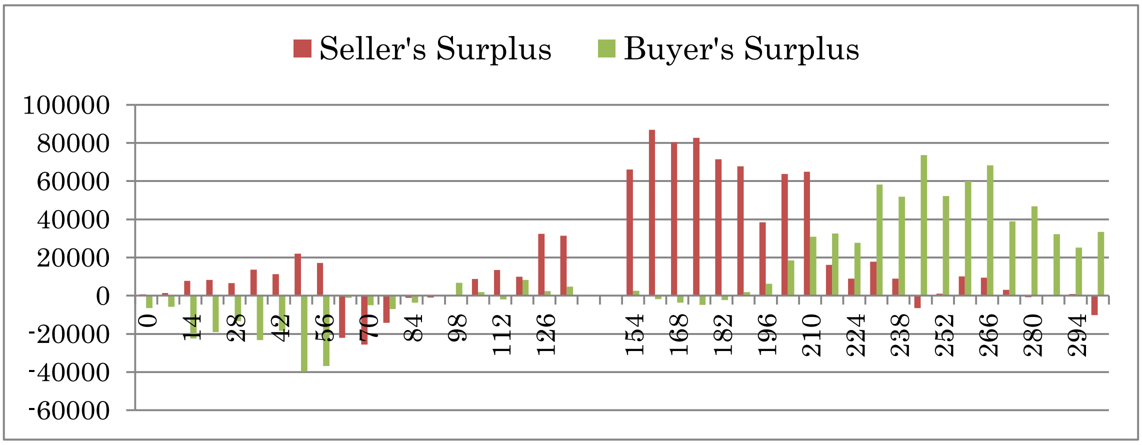
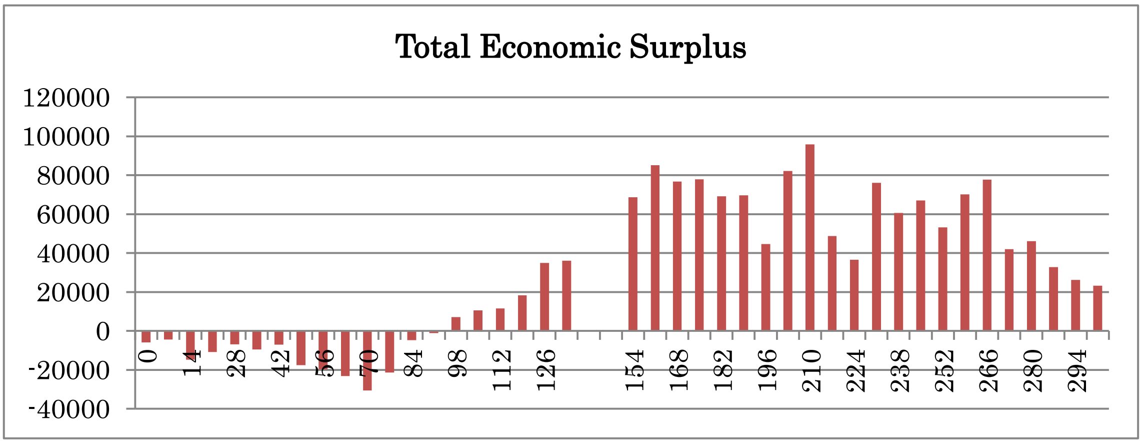


Figure 12 Total Economic Surplus in Zone 1A of 2009-10



The followings can be pointed out from these figures.

(1) The total surplus is A$1,271,446 and the ratio occupied in the gross transaction

amount of money (A$8,114,610) became 15.7%. Among the total surplus, the seller's surplus was 9.9% and the buyer's surplus is 5.8%.

(2) From the viewpoint of surplus analysis, the irrigation season in the 2009-10 fiscal year is classifiable at three time period. The first, it was the time from August 6 to November 5, and the total surplus was negative. The second was the time from November 12 to March 4, and was time when the total surplus was positive and a seller's surplus was superior. The third was the time from March 11 to June 3, and was time when the total surplus was positive and a buyer's surplus was superior. This can be interpreted as follows.

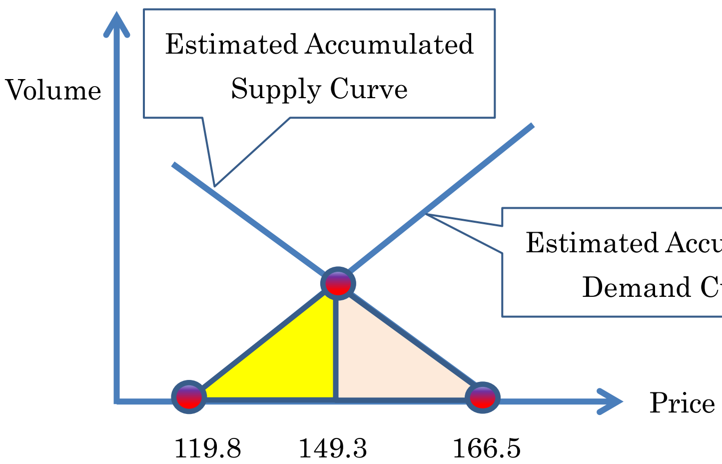
Many buyers purchased water in order to continue production in spite of the loss by operation under the influence of a drought in the early stage of the irrigation season. However, they change to the seller of water during the second half, and it is thought that the loss of the first half was covered.

(3) Both seller's surplus and buyer's surpluses became negative only during the dealings between October 8 (time distance 63) and November 5 (time distance 91).

Seeing through the irrigation season, it is possible that the marginal net return (or average net return) of a seller and a buyer is in agreement with WTSmin and WTBmax, respectively. The average equilibrium price of the water market in the 2009-10 was A$149.3/ML, equilibrium quantity was 54,368.5ML, the seller's surplus was 9.9%, and the buyer's surplus was 5.8%. Using these results, the maximum and minimum of a marginal net return of the seller and buyer of a water market can be presumed.

The average water price for 2009-10 in the area concerned is calculable with A$149.3/ML (A$8,114,610/54,368.5ML). It will be set to A$29.5/ML (A$802,811×2/54,368.5ML), if the size of a seller’s surplus is doubled and this is expressed with per 1ML. That is, although it thought that the seller just sold water for A$119.8/ML, they were able to sell for A$149.3/ML in practice. Thus, a seller's minimum permissible selling prices will be A$119.8/ML.

Figure 13 Illustration of Maximum and Minimum of a Marginal Net Return



Similarly, it will be set to A$17.2 /ML (A$468,634×2/54,368.5ML), if the size of a buyer's surplus is doubled and this is expressed as per 1ML. That is, although it thought that the buyer just purchased water for A$166.5/ML, they were actually able to purchase for A$149.3/ML. Thus, a buyer's maximum permissible purchase price will be A$166.5/ML.

As a result, a seller's marginal net returns was A$119.8/ML, and the buyer's marginal net return was calculated with A$166.5/ML. In other words, it can be said that the differences of the marginal net return of a seller and a buyer were about A$50/ ML in the 2009-10 water market of 1A zone. (refer to Figure 13)

DISCUSSION

The recovery rate of our questionnaire is 11.2%, and it is clear that this recovery rate is insufficient. However, it is thought that the collected reply covers 2 to 4% of the farmer of the region in general (refer to Table 9), and the reply price of questionnaire reflects the level of an actual market price well. Therefore, it is thought that the result of a questionnaire is reflecting reality to some extent from these facts although the recovery rate was low. I believe at least that it can have the meaning as trial calculation.

Our analysis result can explain the trading conditions of an actual irrigation farmer well. When a water price exceeded A$200/ML, probably it has exceeded the marginal net return per water 1ML of some dairy farmers or majority of mixed farmers, and they had to prepare for the loss by operation, but in early stages of the season (winter), it was still going to continue production, water was purchased, and the buyer surplus became negative.

On the other hand, many of them become a seller and they secure a management income in the second half of the irrigation season (summer and autumn). In this way, the scenario that some dairy farmers and majority of mixed farmers could have stabilized their management through the whole season by using water market can be seen from our analysis result. I think that this is the point which is beneficial in surplus analysis.

The residual problems are as follows.

The first is to raise a response rate. However, since this problem is connected also with problems, such as funding ability and credibility for residents, we must be realistic in what can be achieved.

Second, analysis of the water entitlement market which has increased recently was not fully treated in this paper.

CONCLUSIONS

The economic surplus of the water market was estimated for the first time in the world.

Simultaneously, CVM-trigonometric method was developed as the analysis method. As a result, the economic surplus in the water market of northern Victoria for 2009-10 was estimated at about 15% of the amount of money for dealings.

In order to consider the meaning of this result, I will compare with the result of other economic effects.

In the NWC report, the trial calculation is made as making GDP of Australia increased by A$220 million, and is made as making GDP of sMDB increased by A$370 million, in the 2008-09 as an economic effect of a water trading.[6]

The total amount of dealing of the water market of Australia was A$1499.4 million in the 2007-08, A$2787.2 million in the 2008-09 and A$2961.9 million in the 2009-10. (refer to Table 1)

Supposing that an economic surplus is about 15% of the total dealing amount and this size is applicable between 2007-08 and 2009-10, a water market participant's total surplus will be calculated with A$224 million, A$418 million, and A$444 million, respectively. Therefore, the economic surplus effect of water dealings becomes the conclusion that it was larger than the ratchet effect by a drought, except 2007-08. (refer to Table 10.)

Table 10 Trial Calculation of Economic Effect of the Water Trading between 2007-08 and 2009-10 (unit: A$ million)

	2007-08	2008-09	2009-10
The ratchet effect which eases the production reduction by a drought (A) †	191.5～274.8	223.6～370.9	107.2～237.3
Economic surplus effect (B) ‡	224	418	444
Total economic effects (= A+B)	416～499	641～788	551～681
The ratio occupied to nominal GDP of the total economic effect	0.035%～0.042%	0.051%～0.062%	0.042%～0.053%

† The data (A) was cited from NWC (2010a), p.84.

‡ The economic surplus effects (B) are assumed to be 15% of the volumes of trading of a water market.

It is one interesting result of this paper in the economic effect of a water market that the economic surplus effect may be larger than a ratchet effect. Therefore, when discussing an economic effect, it is important not to neglect analysis of the economic surplus effect. It is also possible that the basis which water market is utilized and develops just because this economic surplus effect is large exists. That is, the economic surplus effect also just shows simultaneously the size of the impelling force (driving force) of a water market, or the size of the charm of the water market for market participants. It is also the proof of having sufficient charm for the participants that the water market of Australia has no less than 15% of economic surplus, and can be judged that the Australian water market has the possibility of further development.

Next, if our analysis result is seen from a political viewpoint, it can say as follows.

If a water price is in within the limits about A$166.5/ML from A$119.8/ML, the influence which both a seller and a buyer have on the community will be small because the economic surplus is positive. However, when a water price exceeds A$166.5/ML constantly, management of some dairy farmers and majority of mixed farmers and rice growers becomes severe. Water entitlement trading increases instead of allocation trading and a structural change of irrigation agriculture may take place. These changes will have a potential impact on not only community but also agricultural structure. In order to control this, it will be necessary to guide change of a water price to within the limits about A$166.5/ML from A$119.8/ML.

Although the research which clarifies the economic effect of water trading is still in its infancy, both the comparative analysis (objective valuation) by a model and the economic surplus analysis (subjective valuation) are methodologically required. Among these, since it cannot ask for economic surplus analysis with the data observed directly, its questionnaire by the CVM method is indispensable. Although our analysis has a low recovery rate and the further improvement is required, we think it was able to be shown that the economic surplus analysis by using CVM-trigonometric method can be performed into a water market.

ACKNOWLEDGEMENT

This research received financial support of the Shiga University Education and Research Project Center of the 2010 fiscal year. The questionnaires were distributed by a cooperation of the following three farmhouse organizations: Fruit Growers Victoria (FGV), Victorian Farmers Federation (VFF) and United Dairy Farmers (UDF).

NOTES

1. Refer to NWC (2010a), Appendix C for the details of a CGE model.
2. Refer to NWC (2011), p.21 and DSE & DPI (2010).
3. Refer to NWC (2011), Table A.3, p.61.
4. Refer to NWC (2011), p.22.
5. Refer to Liu & Kondo (2008) for the detail of CVM method.
6. Refer to NWC (2010a), p.85.

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APPENDICES

Appendix A: Estimated WTSmin Price Function and Estimated WTBmax Price Function

$$Y = 4.8883 \cdot \{(z+21)/30\}^2 - 85.442 \cdot \{(z+21)/30\} + 441.19$$
$$= 0.005431 \cdot z - 2.61995 \cdot z + 383.7756, \quad R^2 = 0.9681$$

Y : WTSmin price, z : time distance from August 6 (=0,1,2,---,301).

$$Y = -0.0581 \cdot \{(z+21)/30\}^3 + 1.3717 \cdot \{(z+21)/30\}^2 - 17.6 \cdot \{(z+21)/30\} + 237.82$$
$$= -0.00000215185 \cdot z^3 + 0.001389 \cdot z^2 - 0.5255 \cdot z + 2261522, \quad R^2 = 0.942$$

Y : WTBmax price, z : time distance from August 6 (=0,1,2,---,301).

Appendix B: Estimated Weekly Seller's Surplus and Buyer's Surplus

Date	z	pool price	WTSmin	WTBmax	volume	Sales	Seller's surplus	Buyer's surplus	Total surplus
2009/8/6	0	402.5	383.7759	226.1522	74	29785	692.7929	-6524.87	-5832.08
2009/8/13	7	410.5	365.7024	222.541	62	25451	1388.726	-5826.73	-4438
2009/8/20	14	415.98	348.1612	219.0614	228.2	94926.64	7738.127	-22468.4	-14730.3
2009/8/27	21	418.5	331.1523	215.7091	188.2	78761.7	8219.422	-19082.6	-10863.2
2009/9/3	28	413	314.6756	212.4796	133.3	55052.9	6553.319	-13364.7	-6811.37
2009/9/10	35	427.5	298.7313	209.3684	212.6	90886.5	13688.12	-23187.4	-9499.28
2009/9/17	42	407.29	283.3192	206.3711	183.4	74696.99	11368.12	-18424.3	-7056.14
2009/9/24	49	350	268.4394	203.4834	541	189350	22062.14	-39632.7	-17570.6
2009/10/1	56	300.5	254.0919	200.7007	736.2	221228.1	17082.82	-36736.1	-19653.3
2009/10/8	63	200	240.2767	198.0187	1092.1	218420	-21993.1	-1081.88	-23075
2009/10/15	70	200.6	226.9937	195.4329	1936.2	388401.7	-25551.8	-5002.25	-30554
2009/10/22	77	200	214.2431	192.9389	2000	400000	-14243.1	-7061.08	-21304.1
2009/10/29	84	199.5	202.0247	190.5323	826	164787	-1042.69	-3703.67	-4746.36
2009/11/5	91	188.44	190.3386	188.2086	1005.5	189476.4	-954.507	-116.343	-1070.85
2009/11/12	98	179.5	179.1848	185.9634	2085	374257.5	328.6466	6738.086	7066.732
2009/11/19	105	181.11	168.5632	183.7923	1396.5	252920.1	8760.795	1872.899	10633.69
2009/11/26	112	185.5	158.474	181.6908	992	184016	13404.92	-1889.36	11515.56
2009/12/3	119	165.68	148.917	179.6546	1193.8	197788.8	10005.85	8341.417	18347.26

2009/12/10	126	175	139.8923	177.6791	1845.1	322892.5	32388.62	2471.613	34860.24
2009/12/17	133	170	131.3999	175.76	1626	276420	31381.91	4682.897	36064.8
2009/12/24	140								
2009/12/31	147								
2010/1/7	154	168	109.1163	170.2967	2243.7	376941.6	66058.66	2576.503	68635.16
2010/1/14	161	170	102.753	168.5587	2585.1	439467	86920.07	-1862.9	85057.16
2010/1/21	168	170.11	96.92203	166.855	2193.9	373204.3	80283.55	-3570.53	76713.02
2010/1/28	175	169.75	91.6233	165.1811	2118.5	359615.4	82755.7	-4839.57	77916.14
2010/2/4	182	166	86.85686	163.5326	1804.8	299596.8	71418.77	-2226.58	69192.19
2010/2/11	189	159.77	82.6227	161.905	1757	280715.9	67773.9	1875.597	69649.5
2010/2/18	196	149	78.92082	160.2939	1097	163453	38438.43	6194.707	44633.14
2010/2/25	203	140	75.75122	158.6949	1982	277480	63670.54	18526.64	82197.17
2010/3/4	210	130	73.11391	157.1035	2282.9	296777	64932.63	30937.32	95869.95
2010/3/11	217	99	71.00887	155.5154	1152	114048	16122.89	32552.86	48675.75
2010/3/18	224	90	69.43612	153.926	864.5	77805	8888.737	27632.03	36520.77
2010/3/25	231	88	68.39565	152.331	1811	159368	17751.74	58251.77	76003.51
2010/4/1	238	80	67.88746	150.726	1464	117120	8866.381	51771.43	60637.81
2010/4/8	245	60	67.91155	149.1065	1651.5	99090	-6532.96	73579.66	67046.7
2010/4/15	252	70	68.46792	147.468	1348.8	94416	1033.233	52244.42	53277.65
2010/4/22	259	80.5	69.55658	145.8062	1840.4	148152.2	10070.14	60094.76	70164.9
2010/4/29	266	80	71.17751	144.1166	2130.5	170440	9398.153	68300.21	77698.37
2010/5/6	273	78.48	73.33073	142.3948	1216	95431.68	3130.755	38860.21	41990.96
2010/5/13	280	75	76.01623	140.6364	1427.2	107040	-725.183	46838.12	46112.94
2010/5/20	287	80	79.23401	138.8369	1098	87840	420.5272	32301.46	32721.98
2010/5/27	294	85	82.98408	136.9919	967.9	82271.5	975.6069	25161.49	26137.09
2010/6/3	301	66.5	87.26642	135.097	974.7	64817.55	-10120.5	33430.75	23310.24
				Total	54368.5	8114610	802811	468634.9	1271446

Appendix C: Questionnaire

Customer Survey on Water Trading of 2009/2010

Water trading in Australia is amongst the most developed in the world, trading has generated much interest globally. This questionnaire aims to estimate the economical value of water trading by carrying out direct measurements of how water trading has affected communities. Please help us in this valuable research by completing this survey.

（A questionnaire plan, implementation, cooperation and target region）

Plan and implementation: Shiga University researcher (Japan)

Cooperation: Fruit Growers Victoria, United Dairyfarmers of Victoria, Victorian Farmers Federation

Operating area of G-MW of the northern part of the State of Victoria

（Questions）

1. Respondent's attribute

1-1	Tick the type of farm. Choose one. (When you are not a farmer, write down details in Others.)	Dairy farm□, Annual horticulture□, Perennial horticulture□, Mixed farm□, Cropping farm□, Others□( )
1-2	Tick the ha of farmland which you held in 2009? Choose one.	0-99 ha□, 100-499 ha□, 500-999 ha□, 1000 ha and over□
1-3	How much water in each category did you hold as of August 2009?	High-reliability water share （ ）ML, Low-reliability water share （ ）ML
1-4	How much was the maximum allocation for year 2009/10 in your area?	Maximum Allocation （ ）ML
1-5	How much was the amount of carry over at the start of the 2009/10 irrigation season (15 August 2009) ?	Volume of water (）ML
1-6	Tick your chief crop. Choose at most two.	Grain□, Fruit□, Vegetable□, Annual grass□, Perennial grass□, Others□（ ）
1-7	What is your business structure? Tick one.	Family□, Partnership□, Corporation□, Cooperative□, Others□ ( )
1-8	What % of your operating costs was water in the 2009/10-season? Tick one.	Under 5%□, Between 5-10%□, Between 10-20%□, Between 20-30%□, Between 30-40%□, Between 40-50%□, Over 50%□

2. If you undertook **temporary trading** in the irrigation period of 2009/10-season. Please advise details below.

Date (dd/mm/yy)	Amount of purchase (ML)	Amount of sale (ML)	Market price (A$/ML)

* Fill in another sheet, if there is insufficient space.

3. If you bought **temporary water**, please let me know the maximum acceptable price that you were prepared to pay.

   If you sold **temporary water**, please let me know the minimum acceptable price that you were prepared to receive.

   Please record below on a month by month basis.

2009/10-season	Maximum acceptable price of purchase (A$/ML)	Minimum acceptable price of sale (A$/ML)
July		
August		
September		
October		
November		
December		
January		
February		
March		
April		
May		

4. Please let me know the record of your **permanent trading** in the irrigation period of 2009/10-season.

Date (dd/mm/yy)	Amount of purchase (ML)	Amount of sale (ML)	Market price (A$/ML)

＊ Fill in another sheet, if there is insufficient space.

5. If you bought **permanent water**, please let me know the maximum acceptable price that you were prepared to pay. If you sold **permanent water**, please let me know the minimum acceptable price that you were prepared to receive.
Please record below on a 2009/10-season basis.

Year	Maximum acceptable price of purchase (A$/ML)	Minimum acceptable price of sale (A$/ML)
2009/10-season		

6. Did you hold carry-over at the end of the 2009/10 irrigation season?

How much is the amount of **carry-over** at the 15th May 2010?	Volume of water（　　　　）ML

7. Do you believe the development of water trading has been advantageous for your enterprise?

8. Please write further comments you may wish to make about water trading.

Please mail this questionnaire to: Prof. Manabu Kondo, Faculty of Economics, Shiga University, 1-1-1 Banba, Hikone, Shiga 522-8522, JAPAN. Thank you for the cooperation.