ECONOMIC MODELLING OF POLICY INTERACTIONS: A CASE STUDY IN THE MURRUMBIDGEE REGION, NSW

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Abstract

This paper develops an approach for assessing the joint impacts of government policies on irrigated agriculture. The policies considered are bulk water pricing, river flow objectives and Land and Water Management Plans. The government has been considering these policy areas during recent years for the purpose of fostering ecologically sustainable agriculture. But the existing stock of knowledge on the probable impact of these policies on farm financial conditions is very limited. Similarly, economic information on the interactions between these policies is also limited.

The bulk water charges based on COAG's full cost recovery principles would be likely to increase the cost of irrigation. At the same time, the river flow objectives would probably limit the availability of water for irrigation. Moreover, implementation of Land and Water Management Plans would require financial contributions from participating irrigators. The individual and joint impacts of these policies would change the farm financial conditions of the landholders. This study models and assesses these interactions using the Murrumbidgee region of NSW as a case study. The study incorporates data from the "MIA Farm Financial Survey" and from the Department's LIAM and CEIM Models.

KEYWORDS: Modelling, Water Pricing, River Flows, Land and Water Management Plans.

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1 INTRODUCTION

During the recent decades, the concern regarding environmental degradation has been growing worldwide. Australia, being situated in a unique geographical setting, has been concentrating on its efforts to protect the uniqueness of the natural environment from degradation. To this end, the Australian governments have been formulating and subsequently implementing policy changes in almost all sectors of the economy. The vast rural area, as the most important sector, has been receiving attention throughout Australia. The State Government of NSW has been focusing on several policies options for the purpose of protecting the rural environment from further degradation and for maintaining it in a sustainable level.

This paper develops an approach for assessing the joint impacts of government policies on irrigated agriculture. The policies considered are bulk water pricing, river flow objectives and Land and Water Management Plans. The government has been considering these policy areas during recent years for the purpose of fostering ecologically sustainable agriculture. The existing stock of knowledge on the probable impact of these policies on farm financial conditions is very limited. Similarly, economic information on the interactions between these policies is also limited.

Implementation of the bulk water pricing (WP) policy based on the full cost recovery principles endorsed by the Council of Australian Governments (COAG) would presumably raise the cost of irrigation. Increased irrigation costs are likely to affect farm income and lead to some structural adjustments at the farm level.

The river flow objectives (RFOs), set out in the 1995 Water Reform Package, are designed to make more water available for the environment. Thus the RFOs would probably limit the availability of water for irrigation. Consequently the irrigated agriculture might be adversely effected.

The Land and Water Management Plans (LWMPs) are initiated by the local community of irrigators in order to achieve the twin objectives of sustainable agricultural development and environmental protection. Implementation of LWMPs would require financial contributions from the government as well as from participating irrigators. The capacity to participate in the Plan activities would depend on the financial capability of an irrigator.

The individual and joint impacts of these policies would presumably change the farm financial conditions of the landholders. The existing knowledge on such impacts appears to be limited. This study models and assesses these interactions to estimate the resulting impacts on farm financial conditions. Empirical findings would provide valuable information to the policy makers for future policy guidelines on environmental issues.

The Murrumbidgee region of NSW was used in this analysis as a case study. The study incorporates data from the "MIA Farm Financial Survey" (Naunton, Dec 1995) and from the LWMP Integrated Assessment Model (LIAM) and Catchment Economic Impact Model (CEIM) of the Department of Land and Water Conservation (DLWC).

2 OBJECTIVES

The following are the specific objectives of the study:

- To assess and model the key interactions of the policies under consideration;
- To estimate both short term and long term impacts of policy changes on farm financial conditions of large area farms in the MIA; and
- To determine the number of financially viable farms eligible to implement LWMP options under changed water pricing policy and RFOs.

3 KEY INTERACTIONS

3.1 WATER PRICING AND RFOs

The main interaction between water pricing reform and RFOs is in terms of higher water prices as well as reduced water availability for irrigation. In the short-run, the joint impact of these policies would probably push the water price further up. In the longer term, however, this higher water price would induce more efficient use of water and adjustments in cropping-mix that require less water. Thus initial depressing impact on farm financial conditions would ease out and the environment would have more water for its sustenance.

3.2 RFOs AND LWMP

The main source of interaction between RFO policy and the LWMP is in terms of the reduced supply of water due to environmental flows policy and the reduction in water demand due to implementation of the LWMP options. It is anticipated that the reduction in the supply of water would probably outweigh the reduction in water demand. However, the increase in water use efficiency due to the LWMP would be useful during the dry years'. These efficiencies would partly offset the reduced intake of water at the dethridge wheel (due to RFO policies). Perhaps in wet years, both RFO policy and LWMP would have a relatively smaller effect.

3.3 WATER PRICING AND LWMP

There are two primary sources of interaction between water pricing and the LWMP. Firstly, the LWMP will be partly financed by a charge on water sales (levied within the community). Thus both the LWMP and water pricing would be likely to increase water prices. Secondly, the LWMP and water pricing will both have negative impacts on farm profits in the short term. This is primarily because several of the LWMP options will involve large capital outlays to farmers. Also, it may take several years before farmers can lower their water use through efficiency improvement and/or through restructuring their crop-mix and hence minimise the adverse financial impacts of water price increases.

3.4 All Three Policies

It is mentioned above that water pricing reform would presumably raise the cost of irrigation, that implementing RFOs would reduce availability of water for irrigation, and that implementation of LWMPs would cost the participating irrigators but eventually would reduce the demand for irrigation water. Thus the interactions of all three policies would be higher water prices, more water for the environment and less demand for irrigation water. Although in the short run, there would be an overall negative impact on financial conditions of the irrigators, eventually these policies would result in an overall improvement of water use efficiency, and positive impact on the environment.

Figure 1 shows these interactions in a schematic model. It is worth noting that estimation of environmental benefits and the questions of structural adjustments in crop-mix are out of the scope of this study. These vital issues need to be taken into account in any future attempt for estimation of economic impacts of policy interactions.

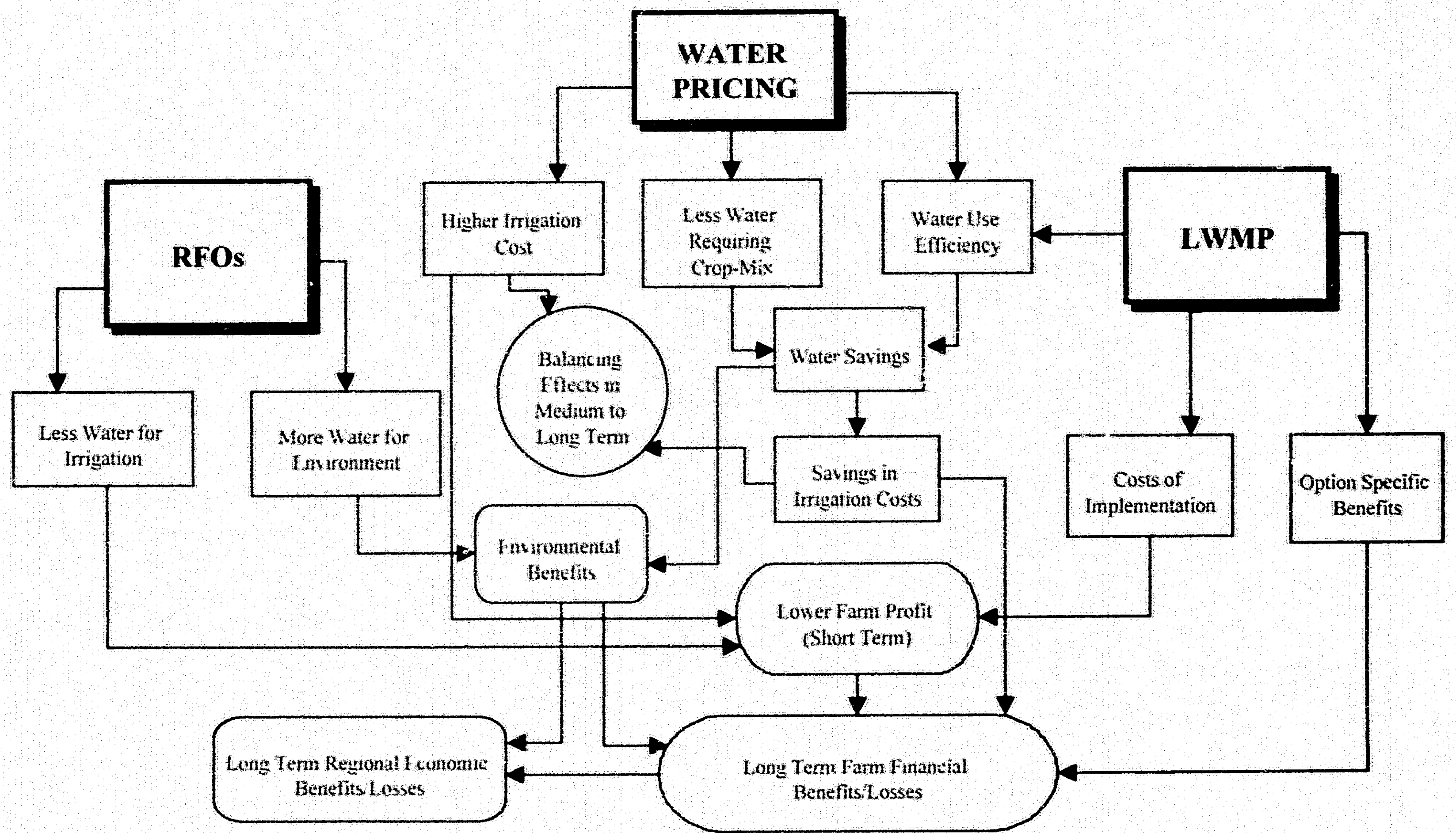
4 METHODOLOGY

It is mentioned above that this study incorporates data from the "MIA Farm Financial Survey" (Naunton, Dec 1995); and from the DLWC's LWMP Integrated Assessment Model (LIAM) and Catchment Economic Impact Model (CEIM). The LIAM was used to evaluate the MIA&D Land and Water Management Plan options (DLWC, Jul 1996). The water savings and option specific benefits for the LWMP options were generated through this model.

The CEIM was used, among other studies, to analyse the impact of interim river flow objectives on the regional economy in the Murrumbidgee Valley (Assim, Aug 1996). The water availabilities under different RFOs were derived by the DLWC Hydrology Unit and were used in the CEIM. For purpose of this study the base case and other scenarios were chosen (for more details, see *ibid*, pp11-12). The RFO scenarios assumed higher level of water for the environment and thus less water available for irrigation. For example, Scenario 5 has the largest negative effect on the amount of water available for irrigation. The Murrumbidgee Valley hydrology data for the RFOs were adjusted according to the relative diversions to the Valley and the MIA.

The water price change scenarios were considered from the Independent Pricing and Regulatory Tribunal Interim Report (IPART, Oct 1996). Scenario 1 is based on CPI increases only and assumes continuation of the status quo. This assumption has been built into other scenarios as well. The main focus in Scenario 2 is substantial efficiency improvements (8%) within the DLWC. Scenario 3 focussed on large increase in resource management and environmental management costs due to externalities. It has been assumed that these costs would increase by 25% of the current costs each year. Cost escalations in other areas were assumed to be 1 to 2 % per annum. A gain in efficiency within DLWC's expenditures at 5% per annum has also been incorporated in this scenario. In this study Scenario 1 and Scenario 3 were taken into account.

FIGURE 1 FLOW MODEL SHOWING KEY INTERACTIONS AMONG POLICIES



The increases in water bills per large area farm (LAF) were estimated based on these scenarios. Irrigation intensity for LAF was derived through weighted average of irrigation usage for a bundle of crops in the MIA. To estimate the impact of water price change on farm profits, other necessary data were taken from Naunton 1995 and from NSW Department of Agriculture Report (Pagan, Curthoys, Marshall & Jones, Apr 1996).

The information derived from the LIAM and the CFIM models were supplemented by input data from other sources mentioned above to model the interactions of policy changes and to estimate the resulting impacts.

The modelling of impacts of the three policies was done in steps. First, the impacts of water price changes under different scenarios per MIA large area farms were estimated. Second, the changes in water availability under different RFOs were derived. Subsequently, the joint impacts of water price change and RFOs per LAF were derived for alternative scenarios. Finally, short term and long term impacts on farm profit situations against each of the MIA&D Land & Water Management Plan (Upstream) options were estimated. The short term impacts incorporated the project costs of the options but did not take into account the option specific benefits or the water saving benefits. On the other hand, the long term impacts took into account the recurrent costs and both the option specific and water saving benefits.

The model simulated the number of large area farms eligible to implement different options, taking into account the impacts of all three policies. The simulation was based on the unit project cost of the options. The model generated normal cumulative distribution around the unit project cost for mean profits under different water pricing and RFO scenarios, and their standard deviations.

5 ASSUMPTIONS

The following assumptions were made to estimate the impacts of the policies on farm financial conditions of the MIA:

- The MIA Farm Survey data were representative of the population of irrigated landholders in the Murrumbidgee region. *In statistical terminology, it was assumed that the sample mean and sample standard deviation (from the Business Survey) were unbiased estimators of the population mean and population standard deviation*
- Average farm profit was used for large area farms only.
- The profits of the farms in a given enterprise followed a normal distribution.
- The structure of fixed and variable costs (excluding water costs) remained the same, regardless of water price levels.
- The crop-mix and the external impacts remained unchanged.
- Farm size was constant. That is, even though different farms were assumed to have different profits, their areas were remained the same.
- Commodity prices would remain constant in nominal terms.
- Average water supply under different RFO scenarios was used.

6 RESULTS AND DISCUSSION

The assumed water price scenarios generated increases in water charges by 10.6% in the case of Scenario 1 and 47.3% in the case of Scenario 3 ie., from the current charge of $2.83/ML to $ 3.13/ML and $4.17/ML respectively. The resulting increases in water bill per average large area farm of 460.87 ha were estimated to be $737 and $3,292 that are about 1.4% and 6.1% of the average profit respectively. Thus change in water pricing would have only moderate impacts on farm profits.

Table 1 presents the percentage decline in water supply due to RFOs under different scenarios and the resulting impacts on farm profits. The declines in farm profits were estimated assuming economic value of one ML of irrigation water as $40 (DLWC; Jul 1996; p.A3-2). The underlying argument is that the reduction of supply of one ML of irrigation water would reduce farm profit by an amount of $40. It can be observed from Table 1 that RFO Scenario 5 would reduce the largest volume of water supply resulting in the highest decline in farm profits.

TABLE 1 PERCENTAGE DECLINE IN WATER SUPPLY AND FARM PROFITS UNDER DIFFERENT RFO SCENARIOS

	Scenario 2	Scenario 3	Scenario 4	Scenario 5
% Decline in Water Supply	6.6	1.2	2.2	36.9
% Decline in Farm Profits	4.4	0.8	1.5	24.5

The joint impact of water pricing and RFO policies on average large area farm profits are depicted in Table 2. The combined effect of water pricing Scenario 3 and RFO Scenario 5 would be the greatest, a reduction of profit of over $16,500. These average profits were being used to generate profits under each of the LWMP options and the number of large area farms eligible to implement the options.

TABLE 2 AVERAGE PROFITS UNDER DIFFERENT WATER PRICE AND RFO SCENARIOS ($/LAF)

Water Price	RFO Scenarios				
Scenarios	Base	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Current	54,161	51,777	53,734	53,376	40,873
Scenario 1	53,424	51,040	52,997	52,639	40,136
Scenario 3	50,869	48,485	50,442	50,083	37,580

The results for only three selected LWMP options are documented in this paper. Although the results for all 53 LAF Plan options are apparently different, in terms of the extent of impacts of policy changes they are similar. The main causes of the differences in the results of each of the options are the differences in option specific benefits, in water saving benefits and in project and recurrent costs (DLWC, Jul 1996). The options selected for presentation have different degrees of option specific benefits, water saving benefits, and project and recurrent costs. So the results presented would provide indications on the extent of impacts of the policy changes.

The short run profits under different LWMP options were derived by subtracting the unit project cost of the option, taking into account the expected government contribution for implementation, from average profit under alternative water pricing and RFO scenarios. In the short run, implementation of the LWMP option would cause a very substantial reduction in farm profit (Table 3). The other policies would produce further depressing effect on profitability of the farm. The extent of such effect would, however, depend on the project cost of the option. None of the other Plan benefits would be accrued in the short run.

TABLE 3 SHORT RUN PROFITS UNDER DIFFERENT POLICIES ($/LAF)

LWMP Options	LWMPs, Current WP & Base Case RFO	LWMPs, Changed WP and RFO Scenarios		
		Scenario 2	Scenario 4	Scenario 5
Reducing Accessions on Mixed Farms (M07)	2,161	-3,515	-1,917	-14,420
Drainage Recycling with 12 mm Runoff Storage (M20)	32,381	26,705	28,303	15,800
Mole Drainage & On-Farm Recirculation (V04)	21,661	15,985	17,583	5,080

Notes: No policy average profit per large area farm = $54,161;
WP Scenario 3 only considered;
RFO Scenario 3 had only moderate impacts.

In the long run LWMP options would result in option specific benefits, water saving and other environmental benefits. It is mentioned above that the environmental benefits were not taken into account into this study. Thus in order to estimate long term financial impacts on LAF option specific and water saving benefits were considered. On the other hand, for the options to run, most of them would require recurrent costs to bear. So where applicable option recurrent costs were taken into consideration for analysis. Once implemented, it was assumed that the option project costs would not have any effect on farm profitability. However, this is an over simplification. If a landholder needs to borrow in order to implement an option, he will have to repay his debt during medium to long term.

The results presented in Table 4 indicate that Option V04 would result in a substantial increase in farm profits under changed water pricing and RFO policies in the long run. At the same time implementation of Option M07 would incur losses. This situation is due to the fact that Option V04 would produce substantial option specific benefits, moderate water saving benefits, though would incur higher recurrent costs. On the other hand, Option M07 would not produce any option specific benefit and only marginal water saving benefits. Thus the long term farm financial situation would depend on the nature of option the farm would implement. Moreover, a farm would probably implement a number of options depending on the size, geographical situation, crop-mix and on a host of other factors. It is also worth noting here that some of the options would bring substantial environmental benefits rather than financial benefits.

TABLE 4 LONG RUN PROFITS UNDER DIFFERENT POLICIES ($/LAF)

LWMP Options	LWMPs, Current WP & Base Case RFO	LWMPs, Changed WP and RFO Scenarios		
		Scenario 2	Scenario 4	Scenario 5
Reducing Accessions on Mixed Farms (M07)	53,747	48,071	49,670	37,166
Drainage Recycling with 12 mm Runoff Storage (M20)	60,029	54,352	55,951	43,448
Mole Drainage & On-Farm Recirculation (V04)	104,684	99,008	100,606	88,103

Notes: No policy average profit per large area farm = $54,161;
WP Scenario 3 only considered;
RFO Scenario 3 had only moderate impacts.

The number of farms eligible to implement different LWMP options under alternative policy scenarios are presented in Table 5. The number of farms eligible to implement an option declines under new policies. The RFO Scenario 5 would result in the most limited farms having the eligibility. Thus fewer farms would be able to implement LWMP options if the policies on higher water charge and river flow objectives were being implemented.

Comparison of the results of Table 4 and Table 5 reveals that the option that would produce the highest long term profit that option could not necessarily be implemented by the largest number of farms. This is because, while farm profitability largely depends on option specific and water saving benefits, eligibility largely depends on the project cost of the option in question.

TABLE 5 NUMBER OF ELIGIBLE FARMS UNDER DIFFERENT POLICIES

LWMP Options	LWMPs, Current WP & Base Case RFO	LWMPs, Changed WP and RFO Scenarios		
		Scenario 2	Scenario 4	Scenario 5
Reducing Accessions on Mixed Farms (M07)	510	483	491	431
Drainage Recycling with 12 mm Runoff Storage (M20)	652	626	633	575
Mole Drainage & On-Farm Recirculation (V04)	603	576	584	524

Notes: Number of LAF in the MIA 1000;
WP Scenario 3 only considered;
RFO Scenario 3 had only moderate impacts.

7 CONCLUSION

The modelling framework used in this study is a preliminary attempt to model the joint impacts of a number of policy options on farm financial condition. Further development of the model would be needed to provide a generic modelling framework that could incorporate all the interacting variables, in particular, the environmental variables.

The MIA case study reveals that the joint impacts on LAF profits of all three policies under consideration would be negative in the short run. In the long run, however, despite negative effects of water pricing and RFO policies, overall impact on farm profits could be positive depending on the option specific and water saving benefits. It is also found that, under a changed policy situation, eligibility of a farm to implement a LWMP option would decline.

The results of this analysis indicate that the changes in policies under consideration would affect the farm financial conditions adversely, particularly in the short run. However, the environmental benefits that might be accrued to the individual landholders could have some positive effects. Quantification of such benefits in future attempts would provide clearer picture. The benefits of these policy changes to the environment and as such to the regional economy would, however, be the main argument for such changes. For the sake of such benefits, the individual landholders might incur some losses in the short run; but in the long run, they would probably be able to make some structural adjustments to cover such short term losses.

8 FURTHER RESEARCH

It is planned that the model would be further developed to provide a generic modelling framework that would incorporate all the interacting variables, in particular, the environmental benefits. The other areas that would be considered are:

- Incorporating LWMP option project costs in the estimation of long run profits;
- Incorporating other type of farms into the model, eg., horticultural farms;
- Taking a whole farm approach in terms of LWMP option implementation;
- Estimation of regional economic benefits/losses of a set of policy changes.

Development of such a generic model would make it possible to study the impacts of policy changes in other regions of NSW as well of other states/territories of Australia.

9 REFERENCES

Assim F; (Aug 1996): ***The Impact of Interim River Flow Objectives on the Regional Economy in the Murrumbidgee Valley***; An Unpublished Report; Economic Services Unit, Department of Land & Water Conservation, NSW.

DLWC; (Jul 1996): ***Murrumbidgee Irrigation Area & Districts Land & Water Management Plan: Economic Assessment of the Proposed Upstream Plan Strategy***; A Draft Report submitted to the Working Group for Discussion Purposes only; Economic Services Unit, Department of Land & Water Conservation, NSW.

IPART; (Oct 1996): ***Bulk Water Prices: An Interim Report***; Independent Pricing and Regulatory Tribunal of NSW.

Naunton; (Dec 1995): ***MIA Farm Business Survey***; Final Report prepared for the MIA&D Land and Water Management Plan; Naunton & Co. Pty. Ltd.

Pagan P, Curthoys C, Marshall G, Jones R; (Apr 1996): ***Economics of On-Farm Proposals - MIA&D Land and Water Management Plan***; Economics Services Unit, NSW Agriculture.