POTENTIAL IMPROVEMENTS IN THE PROVISION OF LONG RANGE WEATHER FORECASTS: ARE THERE BENEFITS FOR THE RURAL SECTOR?

Contributed Paper presented at 32nd Conference
Australian Agricultural Economics Society
La Trobe University, 8-11 February 1988

IR CRELLIN
POLICY DEVELOPMENT DIVISION
DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY, CANBERRA ACT 2600

Subject to the usual carveat, the author wishes to thank colleagues for useful discussions and criticisms of a variety of drought related matters. Particular acknowledgements are due to Kevin Parton, Bill Watson and Henry Nix.

The author has been Secretary of the National Drought Consultative Committee, 1985-87.

SUMMARY

Climatic variability is an integral feature of Australian rural production systems. Recent developments in the meteorological sciences hold the promise of increased accuracy and extended time horizons for climatic forecasting. In the years ahead it may be possible to issue accurate seasonal forecasts on which farmers and graziers can base management decisions. While increasing an individual's information clearly gives a benefit to that individual in isolation, it is less clear that increasing the level of information available to a whole sector will result in positive benefits. The additional information lowers the uncertainty of production which may elicit a supply response which in the existence of inelastic price responses for rural commodities would lead to a lowering of sector income. However, balanced against this reduction of income is the better protection of the production resource base of soil and rangeland and reduced losses of a capital nature.

INTRODUCTION

Drought is one of the most emotive issues in agricultural economics and the rural policy arena. The associated reduction of farm income, degradation of the resource base of soil and rangeland, plus losses of stock and improvements all contribute to this perception. Recent advances in the meteorological sciences give rise to hopes for accurate seasonal forecasts to aid the management decisions of farmers and graziers. Because of the general perception of the destruction and loss caused by drought, this potential development in drought prediction has been widely welcomed in rural, scientific and general community circles. The aim of this paper is to examine the economic implications for the rural economy in aggregate of an increase in the information available to decision makers as a result of better climate forecasting techniques, both for drought amelioration and general farm activity planning.

PREVIOUS STUDIES OF DROUGHT

Much of the literature on Australian drought relates to the meteorological, physical or biological sciences. No attempt is made to present a comprehensive review of this literature.

An understanding of the current situation in Australia may be obtained from the following articles. Coughlan (1985) reviews the meteorological aspects including developments in forecasting techniques. Freebairn (1983) reviews the economic aspects of drought assistance and policy. Hunt (1985) lists current drought research of a meteorological nature. The NDCC (1985) provides a government policy perspective on drought assistance.

For an overview of the current debate on drought issues, the Royal Meteorological Society, Australian Branch (1986) has published the Report and Recommendations arising from a drought workshop held in Melbourne in May 1986 which presents the views of a wide range of researchers, administrators and users of drought information and drought assistance.

DEVELOPMENTS IN CLIMATIC FORECASTING

In the last decade, developments in the understanding of atmospheric physics and the availability of computers capable of very large scale modelling, have led to advances in the forecasting of weather. Work is now being seriously directed towards the possibility of reliable forecasts which would assist farmers and graziers in decision making one season ahead.

A general overview of these developments may be obtained from Hunt (1985) and Royal Meteorological Society (1986). Specific information on the development of the El Nino Southern Oscillation phenomenon for forecasting may be found in Coughlan (1985), an example of the use of large scale atmospheric models may be found in Voice and Hunt (1984) and the use of sea surface temperature monitoring is discussed by Meyers (1985).

A detailed discussion of these techniques is beyond the scope of this paper. However, their potential use in long range forecasting is recognised.

VALUE OF CLIMATIC FORECASTS

I would appear the the provision of information on markets and production systems is considered by many economists, administrators and scientists to be ipso facto a desirable end in itself, eg the economic system works better when better information is available. This view is tempered by the declining marginal returns to additional information and the proposition that there is an optimal level of information seeking where the marginal cost of information seeking equals the marginal return from the information.

The following quote from notes prepared by K Parton (pers. comm.) after the Royal Meteorological Society, Australian Branch Conference, held at Melbourne, 20-23 February 1979 illustrate the conflict of view which can arise from the consideration of this matter:

> "An interesting point to me was the apparant conflict between Freebairn, who suggested that neoclassical economic theory indicates that a marginal improvement in forecast accuracy may lead to significant user benefits and Nicholls (Australian Numerical Meteorology Research Centre) who showed the opposite for the cost/loss situation."

A number of authors have addressed the general question of the benefits which arise from weather forecasting, including Berggren (1975) and Lave (1963). Baquet etal (1976) and Katz etal (1979) examine the benefits to the US orchard industry from frost forecasts.

In the Australian context, Parton etal (1981) concludes that the benefits of better weather forecast information was about 1% of the value of production for NSW extensive agriculture. He cautions however that the methodology may produce an underestimate of the size of the effect. The method was the APMAA model, an aggregative LP sector model, linked to a climatic simmulator. Further details of the model may be obtained from Wicks etal (1978) and details of the simulator from Francisco (1980). Byerlee and Anderson (1969) presented a method for valuing weather predictors in determining optimal fertilizer applications to wheat in a variable rainfall environment

The US frost forecast studies, Byerlee and Anderson's method and Parton's NSW study all assume that the actions taken by the individuals do not have any impact on the price levels of the products involved. While this may be reasonable in the case of a marginal producer, it may not hold if the change is sector wide and results in a substantial change to sector supply and demand relationships.

IMPACT OF BETTER FORECASTS ON THE INDIVIDUAL FARM

Better information on future climatic conditions reduces the risk facing individual farm decision makers. Technologies and activities can better be matched to production conditions. Above-average conditions can be taken advantage of and should drought conditions be accurately forecast, the expence of planting a crop which will fail can be avoided and stocking rates adjusted to suit the dry conditions, avoiding stock distress and deaths.

In addition to the short term effects on income and stock loss, longer term effects on the condition of the farm resource base could reasonably be expected by the minimisation of drought induced soil erosion and rangeland degradation.

Each farmer faces a range of production possibilities from which he selects the type and level of production activities and of inputs to his farm plan. For each combination of activities there is an expected production level, income level and risk level. In general within the range of normal production activity, as the level of production increases, so too do both income and risk. As it is generally considered that farmers are risk avoiders, there is a level of production beyond which the associated risk is unacceptable to the farmer. Thus if a reliable system of climatic forecasting were to reduce the risk levels for the farm activity options, the level of production could be increased to a higher level before the risk level becomes unacceptable to the decision maker. While other valid formulations of the farmer's reaction to risk are available, this one illustrates the general principles satisfactorily. Further discussions of alternative formulations can be found in Wicks (1979) and Anderson, Dillon and Hardaker(1977).

At the individual level, both the better matching of activities to seasonal conditions and the risk reduction effect, lead to increases in production attributable to the better climatic information available to the producer. In the absence of price effects relating to this increase in production, farm incomes would be expected to increase in line with production. As the information can be expected to be freely available to farmers from public forecasts, all of the increased income would accrue to the farmer.

THE IMPACT ON INTER-REGIONAL DROUGHT STOCK MOVEMENTS

In livestock industries, the major drought management tool available to managers is the adjustment of stocking pressure on the pastures or rangelands. This may be used in conjunction with the feeding of a retained nucleus of a flock or herd, where the manager so chooses. Regional destocking is a major feature of Australian droughts.

The availability of reliable longer term forecasts should increase the precision of destocking decisions. However, the market outcome for the sold stock will in some cases change favorably and in other cases infavorably because of the additional information.

If one considers a region which has experienced a period of dry conditions, there will be some graziers who are risk takers who will retain stock and others who are risk avoiders who will seek to sell stock. In the presence of a reliable forecast that dry conditions will persist, the volume of stock removed from the region would reasonably be expected to increase. Likewise if a recovery of conditions were forecast, fewer livestock would be moved. It would reasonably be expected that such information would decrease the stock losses and rangeland degradation in the region under consideration.

If one considers the situation in a two region case where one region is experiencing dry conditions, the joint outcome may be favorably or unfavorably influenced by the additional information. In the absence of a reliable forecast of the seasonal conditions in the second region, there will be a certain demand for stock from the dry region. Should a reliable forecast indicate that the recipient region will experience a favorable season, the demand for livestock from the drought area would increase. Should however the forecast indicate below average conditions for the recipient region, the demand for such livestock would fall as the graziers in the region would know with a high degree of certainity the they would not be able to carry any additional stock in that season.

Thus, while the additional information permits a greater precision in stock and land management, it is likely to increase the variability of stock prices and stock movements, with sharper peaks in the demand for transport and sale facilities, because of a reduction in the variability of expectations within the market.

AGGREGATE EFFECTS ON RURAL INCOME

In the earlier discussion on the effects of additional information on individual farm managers, it was assumed that the changes at farm level have no impact on the market prices for the additional production which arises from the provision of better climatic information. If this assumption is now relaxed, the impact of the increased production is allowed to flow on to the prices of agricultural products.

Typically, the price relationships of agricultural products are inelastic. Aggregate demand for agricultural products is considered to be inelastic.

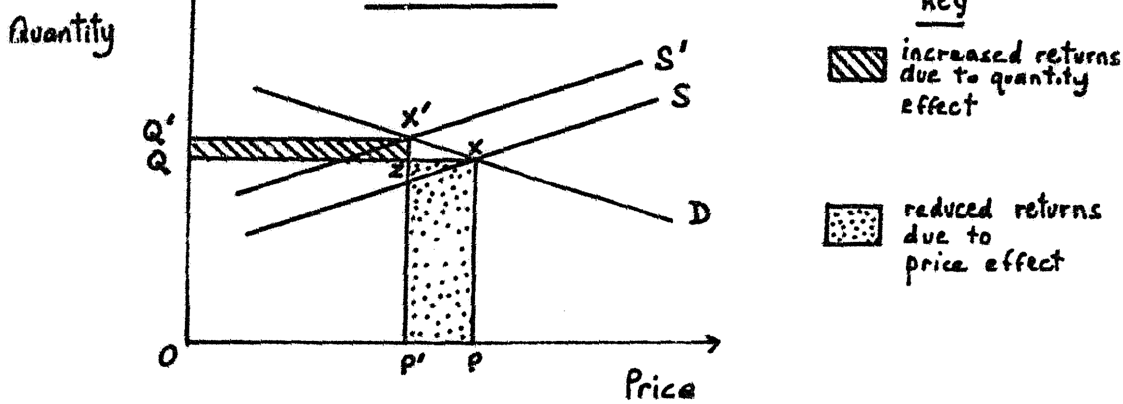
Pandey, Piggott and MacAulay (1982) report aggregate Australian agricultural supply price elasticities to be highly inelastic in the short run and relatively inelastic in the long run. Thus an increase in the quantity of product supplied to a market can be expected to produce a price effect which is proportionately greater than the quantity effect. This leads to a reduction in returns (eg price X quantity) for the sector. Thus the risk-related effects of the increase in reliable information on weather to the rural sector may produce a downward influence on the income of the sector through its impact on supply and thus on prices.

This discussion concentrates on the supply effects. While there may be demand effects, these are considered to be of a smaller magnitude than the supply effects and are not considered in the analysis.

The effects of these changes are shown on Figure 1 which illustrates a pair of generalised aggregate supply and demand curves for the rural sector. The curves, S and D respectively, represent the situation before improved forecasts become available. The curves intersect at X, resulting in production level Q, at price P. Returns to the sector are represented by the rectangle OPXQ.

After the provision of improved information on weather conditions, the supply shifts to S' which intersects D at X'. Returns to the sector are now represented by the rectangle OP'X'Q'. Production is now Q' which is greater than Q, while price is P' which is less than P. Returns will increase if the benefit of additional quantity (eg rectangle QQ'ZX') excees the losses from reduced price (eg rectangle PP'ZX). Information presented earlier concerning the inelastic nature of supply responses suggest that the losses may exceed the gains. However, the calculation of the magnitude of these effects is beyond the scope of this paper.

FIGURE 1



AGGREGATE SUPPLY AND DEMAND BEFORE AND AFTER AVAILABILITY OF IMPROVED WEATHER FORECASTING INFORMATION

CONCLUSION

The provision of reliable forecasts to the rural sector enabling better allocation of resources and selection of production technologies one year ahead, would undoubtedly lead to more precision in the management of farm soil and rangeland resources. It could also reasonably be expected to reduce the losses of stock associated with drought and the expences associated with preparing and planting crops which receive insufficient moisture.

However, the main effect at farm level is the reduction of risk facing the decision maker through the provision of better information on production conditions. In the first instance this would lead to increased income and production at the margin. However, taken across the whole rural sector, the impact of the general reduction of risk and increase in production could arguably lead to a reduction in rural incomes when the subsequent effects on prices are considered.

On the balance, the benefits from the development of better seasonal forecasts for farm decision makers are likely to be less than might intuitively expected, and in certain cases might indeed be negative. While the development of better weather forecasting techniques will be welcomed in many parts of the community, there may be unexpected effects on other parts where the weather uncertainty supports the prices and incomes at higher levels than otherwise might be the case in the presence of better information on future conditions.

REFERENCES

Anderson, J.R., Dillon, J.L. and Hardaker, B. (1977), Agricultural Decision Analysis, Iowa State Uni. Press, Ames, Iowa.

Baquet, A.E., Walter A.N. and Conklin, F.S. (1976), 'The value of frost forecasting: A Bayesian appraisal', American Journal of Agricultural Economics, 58, 155-20.

Berggren, T. (1975), The Economic Benefits of Climatological Services, Technical Note 145, W.M.O., Geneva.

Byerlee, DR and Anderson, JR (1969), 'Value of predictors of uncontrolled factors in response functions', Australian Journal of Agricultural Economics, 13(2), 118-27.

Coughlan, M.J. (1985), Drought in Australia, Paper presented at 'Natural Disasters in Australia', 9th Invitation Symposioum, Australian Academy of Technological Sciences, Sydney, October 1985.

Francisco, E.M.(1980), Regional Rainfall, Crop Yields and Farm Incomes in New South Wales - A Simulation Approach, APMAA Report No 9, UNE, Armidale.

Freebairn, J.W. (1983), 'Drought assistance policy', Australian Journal of Agricultural Economics, 27(3), 158-99.

Hunt, B.G. (ed)(1985), Report on Drought Research in Australia-Meeting held in Melbourne 1985, CSIRO Division of Atmospheric Research, Aspendale Victoria.

Katz, R.W. and Murphy, A.H. (1979), Assessing the Value of Frost Forecast to Orchardists: A Decision-Analytic Approach, Paper presented at American Meteorological Society's 14th Conference on Agriculture and Forest Meteorology, Minneapolis, 1979.

Lave, L.B. (1963), 'The value of better weather information to the raisin industry', Econometrica, 31 (1-2), 151-64.

Meyers, G. (1985), Sea Surface Temperature and Australian Drought, Paper presented at Meeting on Drought Research 21-22 October 1985, Melbourne.

NDCC (1985), Report by the National Drought Consultative Committee on Drought Policy, Dept of Primary Industry Canberra.

Pandy, S, Piggott RR and MacAulay, TG (1982) 'The elasticity of aggregate Australian agricultural supply: Estimates and policy implications', Australian Journal of Agricultural Economics, 26(3), 202-19.

Parton, K.A., Wicks, J.A. and Dillon, J.L. (1981), Drought Workshop Report and Recommendations, Melbourne.

Voice, M.E. and Hunt, B.G. (1984), 'A study of the dynamics of drought initiation using a global general circulation model', Journal of Geophysical Research, 89(D6), 9504-20.

Wicks, J.A. (1979), 'Introducing risk into an aggregative programming model', in Walker, N. and Parton, K.A. (eds), An Aggregative Programming Approach to Agricultural Sector Analysis, UNE, Armidale.

Wicks, J.A., Mueller, R.A.E. and Crellin, I.R. (1978), APMAA7-Project Development, Model Structure and Applications of the Aggregative Programming Model of Australian Agriculture, APMAA Report No.11, UNE, Armidale.

1636p