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Using experiments to improve understanding of limits to decision making in Grazing Land Management

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ABSTRACT

Modern farming is characterised by complexity, dynamics, and in many cases, heterogeneity in farming methods. Increasing use of dynamic investment theories, such as the Real Options Analysis method, allow integration of dynamic aspects but retain untenable assumptions in the face of widely acknowledged complexity and uncertainty in management of grazing systems. Relaxation of the requirement for rationality in decision making may provide economic models with a better 'fit' to observed behaviour of managers of rangelands grazing enterprises whilst allowing exploration of the reasons for and costs of particular patterns of decision making on farms. The economic analysis of decision making using explicitly dynamic choice functions and dynamic choice experiments framed in a grazing land management scenario is considered in this paper. Results indicate that models of bounded rationality, relaxing the assumptions of perfect knowledge and cognitive abilities, will have improved explanatory power for farm decision making whilst risk preferences appear to contribute little by way of variation in observed decision making. These insights suggest the need to broaden economic models of decision making to incorporate limits on rationality which will allow analyse of the costs of these limits and provide the framework to assist farm managers achieve higher enterprise and environmental efficiency.

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1. Introduction

Predicting and evaluating decisions is a cornerstone of economic analysis, yet understanding how decisions are made in complex and dynamic farming systems remains limited (Kingwell, 2011). The growth in the literature on decision making by managers of agricultural lands (Pannell et al., 2006) has occurred over a period in which the common approaches to economic decision analysis have been shown to be inadequate to characterise many empirical cases of decision making in farming industries (e.g. Ihli et al., 2013; Pannell et al., 2006). However, in the highly competitive industries of primary production wherein terms of trade for producers are constantly strained, economic efficiency is a key priority and economic factors must be viewed as the key constraints on management of farm enterprises (Malcolm, 2004). The poor predictive power sometimes found for economic theories applied to empirical phenomena in the management of agricultural enterprises does not mean that the theories are wrong: Economic analysis is largely a normative science. Rather the divergence between the predictions of economic models and empirical outcomes is a sign that there are some limiting factors facing decision makers or some additional preference information (i.e. in addition to profit) which is not included in the formal modelling approach. For example the study of Espinosa-Goded et al. (2013) indicates the existence of substantial transaction costs inhibit enrolment in Agri-Environmental Schemes (AES) which led to initial estimates of enrolment in AES to be too optimistic. Greiner and Gregg, (2011) and Bohnet et al. (2011) present outlines of how non-profit oriented preferences may influence decision making whilst Ihli et al. (2013) show that the value of waiting in investment activities is a key variable which often fails to manifest at the optimal level in decision problems which may be not well-known to farm managers. It is important to understand the sources of deviations from optimal economic decisions as these deviations are often costly and arise from predictable sources (Heiner, 1983) – i.e. they are potentially predictable and can be addressed using policy, research and education.

This paper presents a series of three incentivised framed field experiments undertaken with rangelands graziers in north eastern Australia designed to consider limits to rational decision making and thus to allow a description of how current economic models may not be capturing the decision processes of managers of these enterprises. In order to consider the limitations on rationality

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implied by complex decision processes in the management of agricultural enterprises we developed a sequence of three experiments set in a hypothetical Grazing Land Management (GLM) scenario. Participants in these experiments were the managers and owners of rangelands grazing properties located in north eastern Australia and were incentivised to ensure they were attempting to do the 'best' they could. Our aim was to consider the presence of limits to rationality in decision making for these managers, to show that these limits are measurable using well-designed field experiments, and to show that these limits are directly implicated in sub-optimal outcomes in common problems of decision making in farm management. Our finding of a systematic divergence from optimal decision making which appears to be consistent across the sample indicates the potential for research and extension programs to alleviate these limits in addition to how current models may be modified to characterise decision making on enterprises more exactly.

The structure of the paper is as follows. In the next section (Section 2) the origins and state of the art of economic analysis of farm management and investment decisions is reviewed with a focus on the limitations of current best practice approaches. In Section 3 the use of field experiments for decision analysis is reviewed with key learnings distilled into a small set of important criteria describing theoretical requirements and some practical considerations. In Section 4 the experimental approach to considering limitations on the rationality of grazing land managers is described in detail. Section 5 presents results along with discussion of response patters from the experiments considered in this research with particular focus on the presence of bounded rationality and sources of variation in decision making in agricultural resource management problems. In the final section we offer some insights for further analysis utilising structural models of choice in econometric models in the future.

2. Origins: the economic analysis of farm management and investment decisions

Historically, the main form of investment analysis in many investment or management decisions has been based on Net Present Value (NPV) analysis (Khanna et al., 2000; Frey et al., 2013) which treats decision points as fixed and annual outcomes as independent or linearly dependent realisations generated from some chosen probability distributions. The core component of NPV analysis is a time series of net benefits comprised of annual costs and benefits. In the context of agriculture, the net benefits series are based on the gross margins of the investment activity constituting common costs of all possible activities plus the benefits from the project activity and minus additional costs associated directly with the project (investment of interest). The net benefit series are discounted and summed to obtain the NPV of the potential project. Net benefits are usually negative at early stages of the time series and become positive over time reflecting the initial investment costs and maturation of profit streams from the project.

The NPV method, whilst simple and seemingly logical, has been shown to poorly reflect actual decision making problems in real life due to limitations of the NPV approach associated with its failure to incorporate dynamics in decision making and the importance of the evolution of uncertainty in project returns (Ihli et al., 2013). As Malcolm (2004) describes, dynamics in agricultural production and management are pervasive meaning that the assumption of independence between time periods, embodied in NPV analysis, in production is untenable. Another aspect of dynamism in investment analysis is that decisions are typically not 'take it or leave it' in nature – managers of farm enterprises can hold off on making a decision until they know more about the decision problem. Managers usually prefer to wait until they are more certain of the implications of their decisions before taking an investment action. Furthermore, producers often face staged investment decisions wherein the investment can be taken in stages with future investments contingent on how the current stage is proceeding – for example a cattle finishing enterprise may decide to invest in a small feedlot as a tentative extension to their business. If the additional enterprise proves profitable and/or grain-finished cattle prices prove resilient or increase then the producer may choose to increase the scale of the feedlot.

Going some way to addressing these issues, and representing current best practice in economic analysis of decision making is the method of Real Options Analysis (ROA) which allows for shifts in the form or distribution of uncertainty over time, delays in decision making ('value of waiting') and dependence of outcomes on the history of realisation of the production function allowing incorporation of, for example, climate uncertainty which manifests as alternative resource states driving alternative profit flows. The more recent ROA approach, despite being more realistic in allowing for adaptive management, is nevertheless based on strict assumptions relating to the decision function and knowledge of the producer. Two main considerations present as obvious issues in the ROA approach. Firstly, ROA is usually assessed using a profit maximising objective function for producers allowing for risk aversion over realised profits. The presence of technical inefficiency in rangelands grazing in Australia (e.g. Gregg and Rolfe 2011; Islam et al., 2014) suggests the possibility that managers may not be profit maximising if they have full information due to the presence of inefficiency indicating that inefficient producers may be choosing the 'easy life' (Leibenstein, 1966; Perelman, 2011) The results of Greiner and Gregg (2011). Bohnet et al. (2011) and Greiner (2014) also show more directly that producers may have multi-faceted value functions which are not sufficiently described by the profit-maximising criterion. These are not issues with the ROA method itself however, merely with the choice of value function usually employed with ROA. Of more relevance to this article, the ROA approach assumes that decision makers have perfect cognition and full knowledge of the distributions of stochastic events (e.g. perfect information on rainfall probabilities) and know the dynamics of the profit function perfectly. These assumptions are clearly untenable in an environment of high climatic uncertainty (Kingwell, 2011) and in which the dynamics of resource management involve complex interacting functions of two or more biological and abiotic resources (e.g. livestock biomass, pasture biomass, soil quality, herbage quality).

In order to make the ROA approach more in-line with actual farm-level decision making the limits to decision making by farm managers must first be understood. That complexity is a key limiting factor in decision making is well known (Kingwell, 2011; Moffat, 2005; Heiner, 1983). Yet it is not well understood how this complexity impacts on rationality in decision making amongst farm managers. Herbert Simon developed the concept of bounded rationality in 1972 (Newell and Simon, 1972) in an effort to acknowledge the ubiquitous limits on rational decision making in real life (Bendor, 2002). In order however to operationalise Simon's models of bounded rationality, information on how limits to competency in decision making (Heiner, 1983) and perspectives on the costs of effort (Salant, 2011) must be taken into account. It was the aim of the experiments presented here to consider the possible existence of these factors.

3. Review of the theory and analysis of dynamic decision problems

An economic consideration of choice, in both static and dynamic problems, rests on a framework for the representation of relative

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