University of Alberta

Investigation of Reverse Auctions for Wetland Restoration in Manitoba

by

Katherine A. Packman

A thesis submitted to the Faculty of Graduate Studies and Research
in partial fulfillment of the requirements for the degree of

Master of Science

in

Agricultural and Resource Economics

Rural Economy

Fall 2010
Edmonton, Alberta

Your file Votre référence
ISBN: 978-0-494-68026-1
Our file Notre référence
ISBN: 978-0-494-68026-1

Examining Committee

Peter Boxall, Rural Economy

Chokri Dridi, Rural Economy

Marian Weber, Alberta Research Council

Edward Bork, Agriculture Food & Nutritional Science

Dedication

I would like to dedicate this thesis to my family and friends, and to everyone who made this document possible. Thank you for your continued love and support, and for making this ride so memorable.

Abstract

Reverse auctions for ecological goods and services are an alternative to current agri-environmental government programs to provide incentives for farmers. This thesis reports on a testbed of laboratory auction experiments to assess efficiency and cost effectiveness of different design treatments. These were developed using estimated costs of wetland restoration in southern Manitoba. The testbed included a comparison of payment type (discriminatory versus uniform payments), and ranking rule for both budget based and target based auctions over repeated auction rounds and reserve prices for the target based auctions. It was found that 1) uniform payments outperformed discriminatory payments under a budget constraint, 2) discriminatory payments were superior to uniform payments under a target constraint, 3) where there is no budget constraint a reserve price can greatly increase efficiency and cost effectiveness. These findings highlight the complexity of auction design and may be used as an aid to guide policy decisions and agri-environmental program design.

Acknowledgements

Research funding for this project was provided by Agriculture and Agri-Food Canada (AAFC), Manitoba Agriculture, Food and Rural Initiatives (MAFRI), Ducks Unlimited Canada (DUC), and the Linking Environmental and Agricultural Research Network (LEARN). I would like to recognize my supervisor, Peter Boxall for his guidance and advice through this research project, and Marian Weber for her direction. I would also like to thank Wanhong Yang and Yongbo Lui from the University of Guelph, as well as other members of my steering committee in Manitoba. Special thanks to Orsolya Perger, Dana Harper, and Alicia Entam for help with the experiments, as well as Antony Samarawickrema and Rick Andrews for their contribution to the cost estimations.

I'd also like to thank all the characters in Rural Economy and GSB555 for the good times. Finally special thanks to my family and Lukas for all of the love and support.

Table of Contents

List of Figures

List of Tables

Chapter 1 Introduction

1.1 Background

Human impact on the ecosystem is increasing around the globe resulting in the degradation of the local and global environment. This is very apparent when considering Lake Winnipeg in Manitoba, Canada. Human activities have compromised the health and quality of the lake to the point that it has become hazardous to ecological and human health.

According to the Lake Winnipeg Stewardship Board (LWSB), there has been an increase in the level of nutrients and contaminants entering the lake; since the 1970's LWSB (2006) have documented a 10% increase in phosphorus loading and 13% increase in nitrogen loading. Excessive nutrient loading has led to an extreme state of eutrophication[1] in the lake, and massive algal blooms comprised primarily of blue-green algae. Since blue-green algae can fix nitrogen from the atmosphere, phosphorus loading in particular has been the most damaging component because it is the limiting nutrient for blue-green algae. The presence of blue green algae harms the surrounding ecosystem and has a negative impact on the local economy, from releasing toxins to limiting the penetration of sunlight into the water column. Massive algal blooms have also led to the depletion of dissolved oxygen sources; when the algae die, it sinks to the bottom of the lake where is it decomposed by bacteria which use oxygen as a source of fuel.

LWSB (2006) notes that there are a variety of sources contributing to nutrient loads including human sources such as municipal sewage, septic fields, crop fertilizers,

[1] Eutrophication is an increase in the concentration of nutrients in a body of water which results in an increase in primary productivity (i.e. an increase in the productivity of plant matter).

industrial discharges, livestock manure, and urban runoff (lawn fertilizers, pet waste), as well as natural sources such as soil, the atmosphere, and decaying plant matter. With agriculture comprising 50% of land-use in the watershed, it is a significant source which should be dealt with (LWSB 2006). The LWSB makes several recommendations for handling nutrient loads in Lake Winnipeg from public education, international cooperation initiatives, to specific actions to be taken to tackle nutrient loading and contamination of the lake. One of these actions is to re-introduce or restore wetlands into the landscape by way of engineering and construction.

Environment Canada has defined a wetland as "land where the water table is at, near, or above the surface or which is saturated for a long enough period to promote such features as wet-altered soils and water tolerant vegetation. Wetlands include organic wetlands or "peatlands", and mineral wetlands or mineral soil areas that are influenced by excess water but produce little or no peat" (Environment Canada 1991). Wetlands are able to provide a multitude of Ecological Goods and Services (EG&S) including habitat for fish and wildlife, carbon sequestration, flood and sediment control, and water quality improvements. Wetlands act as an important nutrient sink. These benefits are well documented and supported by scientific evidence (Mitsch & Gosslink 2007).

Despite the ecological and social benefits derived from wetlands, they ultimately pose an economic problem to landowners or producers. Brown (1976) summarizes by saying that wetlands essentially "[create] a problem of optimal resource allocation" (pp 509) since the principle benefits are accrued by the public, while private landowners are left with the costs of maintaining them. This imbalance leads to market behavior, by farmers, which is not in favour of wetland conservation (Brown 1976). This has resulted

in an overall loss in wetland habitat. Since European settlement it is estimated that approximately 20 million hectares of wetland habitat have been drained in Canada primarily due to agricultural development, with about 70% of wetlands drained in Manitoba (LWSB 2006).

This loss of wetlands ultimately means that there is a loss of the EG&S provided by wetlands. Where there are no wetlands on the landscape, nutrients, as well as flood water containing other contaminants and suspended solids, enter aquatic bodies more quickly and in higher concentrations. This is especially true in the spring where drainage networks accelerate the movement of melt water off fields allowing for early seeding and reduction of crop damage (LWSB 2006). Putting wetlands back onto the landscape through restoration can make-up for the lost functions from previous drainage practices. Studies have shown that restored wetlands are still able to provide valuable EG&S comparable to natural wetlands, including nutrient abatement (Kadlec & Knight 1996; van der Valk & Jolly 1992).

The goal of conservation planning is focused on maximizing biological benefits and outcomes, while at the same time minimizing costs. While there may be sound science supporting biological needs, the economic considerations of conservation are usually not included, or if they are not in an appropriate manner (Naidoo et al. 2006). Naidoo et al. (2006) states that including the cost of conservation is important and having a better understanding of the related costs can provide opportunities to increase conservation. Naidoo et al. (2006) also assert that understanding the heterogeneity of costs in the landscape (e.g. differences in land quality, production type, etc) is just as important as understanding the spatial heterogeneity the supply of EG&S.

There have been some issues in the uptake of wetland restoration among landowners. For years wetland drainage has been encouraged by governments through perverse policies (e.g. the Wheat Board quota system, land and tax systems). Van Vuuren & Roy (1993) also state that through income protection for certain commodities, wetland drainage would be directly subsidized (pp 294). While there has been some policy reform there continues to be a benefit to drainage through perverse incentives from pre-existing programs. This sends a conflicting message from governments to producers. In addition, wetland restoration will require a change in practice by producers since wetlands alter the cultivated landscape and force farmers to amend their cropping routines and spend more time and money to maneuver machinery around wetlands. However, time and money is also required to accomplish wetland restoration itself.

An important factor to consider is the disparity between public benefits versus private cost to landowners. There is no incentive for the average landowner to voluntarily restore the desired level of wetlands because they would incur 100% of the cost of wetland restoration and would not receive the full public benefit. This leads to controversial questions of who should pay, and how much for wetland restoration.

1.2 Thesis Purpose and Objectives

The purpose of this thesis is to understand the challenges facing producers with respect to wetland restoration, and to test policy tools to encourage wetland restoration by producers. The specific objectives are to first estimate the cost of wetland restoration and

then to assess reverse auctions[2] as a potential policy tool to create incentives to encourage wetland restoration.

Currently, agri-environmental stewardship programs rely on either voluntary behaviour by producers and landowners or shared-cost payment programs. In order to implement effective policies and programs to encourage wetland restoration there needs to be an understanding of the costs producers face so that proper incentives can be granted. There have been some studies investigating the cost of wetlands in Canada (van Kooten 1993; DeLaporte et al. 2010), however their transferability to this region is questionable due to the complex heterogeneous nature of wetlands and producers. While there are some studies in the American context (Gelso et al. 2008; Heimlich 1994; Prato & Hey 2006; Schultz & Taff 2008) it is questionable whether these values could be transferred to the Manitoba context for the same reasons.. This thesis employs the use of multiple data sources in order to estimate the cost of wetland restoration for actual producers in the South Tobacco Creek (STC) watershed in southern Manitoban. A benefit of the data used in this present study is that it is rich enough to allow the investigation of both direct and indirect costs at the field level and gain a better understanding how the rotation and farm type may affect wetland retention and restoration costs. From this data, a actual cost curve was derived for the watershed.

Reverse or conservation auctions are becoming more popular as a method to procure EG&S in many parts of the world. Procurement auctions are a Market Based Instrument (MBI) used to establish prices where there may not be a direct market for the goods in question. The United States Department of Agriculture (USDA) has used

[2] Auctions for EG&S are also known as, or may be referred to as procurement auctions, conservation auctions, or eco-tenders.

conservation auctions since 1993 in their Conservation Reserve Program (CRP), and they have also been utilized in Australia (e.g. eco-tender). In this study we will investigate the design of reverse auctions in the context of wetland restoration. The objective of these auctions is to select producers and distribute compensation for restoring wetlands in a cost effective manner to yield high environmental benefits. Given that we have access to an estimated cost function, we are able to use experiments in order to test the auctions' ability to act as a cost discovery mechanism and what design features contribute – or counteract – efficiency/cost effectiveness, in the auction.

1.3 Study Area

The study area in question for this thesis was the STC Watershed, located in southern Manitoba, Canada. The total size of the STC watershed is 7638 ha (AAFC 2006) and is close to the town of Miami MB, and is south west of Winnipeg (49°9′28″N, 98°21′50″W) (Figure 1). It is located in the Manitoba Escarpment where the drainage area originates in the Pembina Hills and drains into Tobacco Creek, the Morris River, and exits into the Red River and Lake Winnipeg. The overall drop in the watershed is approximately 130 meters over 8 kilometers. The soil type in the area is predominantly clay-loam, overlaying shale bedrock (AAFC undated).

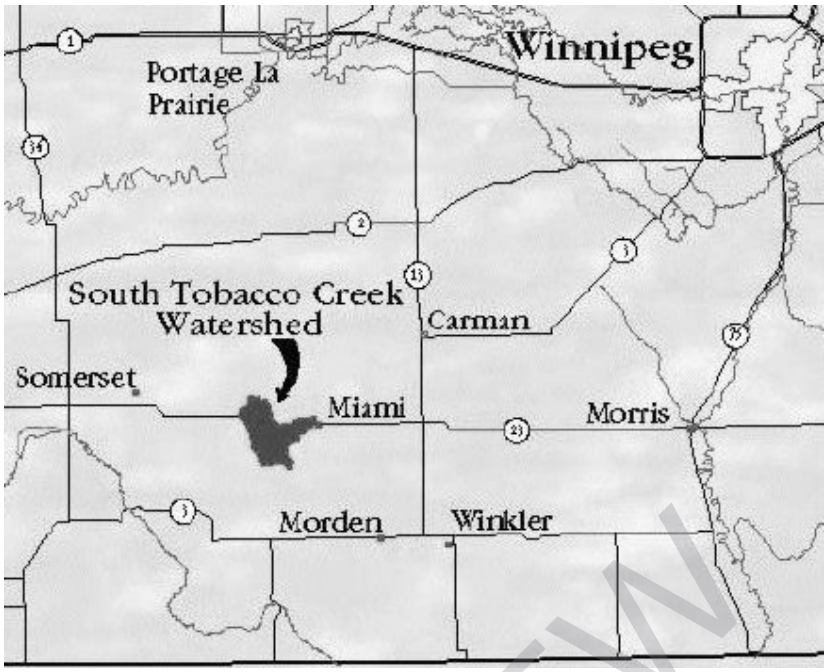

Figure 1 Location of South Tobacco Creek watershed (http://www.cici.mb.ca/deerwood/stc01.html) Deerwood Soil and Water Management Association

The primary land use in the area is agricultural activity (e.g. cropping, forages, and livestock) which has replaced the natural vegetation. As of 2000, 71% of the watershed was cultivated, with the remaining 29% being non-cultivated grasslands, trees, water bodies, road allowances, and yard sites (Yang et al. 2008). The four main crops are wheat, canola, flax, and barley, with other crops including oats, fall rye, triticale, peas, sunflowers, corn, and soybeans in small proportions.

STC has been used by Agriculture and Agri-Food Canada (AAFC) as the source of several scientific research studies for over 20 years pertaining to water sampling (AAFC undated). As a result, there is very rich hydrological data for the STC. It is also part of the AAFC Watershed Evaluation of Beneficial management practices (WEBs) program, which is collecting data on the environmental and economic effects of BMPs in agriculture. In addition to the detailed hydrologic and water quality records, the Deerwood Soil and Water Management Association (DSWMA) have also maintained more than 10 years of economic information on farm production in the area.

1.4 Organization of Study

The following section, Chapter 2, will provide a review of auction theory and conservation auction design. It will begin with information motivating the use of auctions for EG&S in general and also in a Canadian context. This is followed by an overview of auction theory and how conservation auctions are different from conventional auctions. Design issues in conservation auctions are then summarized and explained. The information provided in this chapter is used to motivate the experiments used to test different auction design features in the Manitoba context that would maximize cost efficiency.

Chapter 3 examines the cost of wetland restoration to producers. The methodology and data used to estimate costs are explained in detail. A summary of the costs of wetland restoration in the study area is then provided. The information in this chapter is subsequently used in the auction experiments.

Chapter 4 summarizes the experimental design and results of a testbed of budget constrained auctions. This chapter explains the motivation for different design treatments. An explanation of the experimental auction procedure during the experimental session is also provided. This is followed by an explanation of the regression analysis used to determine the impacts of different design features and auction outcomes. Descriptive results of the auction outcomes and cost effectiveness variables are provided and explained in detail. This is followed by an empirical analysis investigating the effect of auction design on cost effectiveness, and results are compared with the work of Cason & Gangadharan (2004, 2005).

In Chapter 5, the experimental design and methodology as well as results of the testbed of target constrained auctions is provided. Like Chapter 4, this chapter will explain the motivation for design as well as procedures and regression analysis. The descriptive results of auction outcomes and cost effectiveness are provided. Again, regression analysis was used to investigate the effect of auction design treatments on auction efficiency. Results presented in this chapter are compared to those of Schilizzi & Latacz-Lohmann (2007) who also examined target constrained auctions. Comparisons between target and budget based auctions are then drawn.

Chapter 6 provides conclusions and summarizes the contribution of this work to the literature on conservation auctions. Limitations to the study are discussed along with potential areas of research.

Chapter 2 Review of Conservation Auctions

2.1 Introduction

This chapter provides the context and theoretical background for the use of reverse auctions in an environmental context. Section 2.2 provides background information on why auctions should be used along with evidence of their success in other jurisdictions, such as Australia and the United States. Section 2.3 summarizes auction theory and provides a theoretical framework for understanding conservation auctions. This is followed by Section 2.4 which addresses specific auction design factors that contribute to the success of conservation auctions. Since there are few analytical results from auctions to guide conservation auction design this section is primarily based on experimental auctions from the laboratory as well as in the field. The research objectives are summarized in Section 2.5. This chapter concludes with an overall summary.

2.2 Motivation for Procurement Auctions

A challenge in the provision of EG&S is that they are public goods. Landowners provide EG&S through the adoption of Beneficial Management Practices (BMPs), such as wetland restoration, or changing farm practices to improve water quality and the environment (e.g. zero tillage or forage conversion). However, there is little motivation for the private landowner to voluntarily provide EG&S because they would bear the costs through changing their practices or buying new equipment, while the public enjoys the benefits. In response, cost-sharing programs have been developed to offer incentives for landowners to provide EG&S. A national survey of farmers in Canada finds that financial concerns are one of the most important barriers to participation in environmental

programming (Environomics 2006). This is coupled with the sentiment that the benefits are reaped by the public (Environomics 2006).

In Canada, EG&S incentive programs have historically been based on fixed payment/cost sharing agreements. In a fixed payment program, all landowners who choose to enter the program are paid the same fixed price for providing EG&S (e.g. $200/acre for affected land). Payments are intended to act as a price signal for landowners to incent a change in behaviour (Windle & Rolfe 2008). Cost sharing agreements imply that a given proportion of costs borne by a producer for providing EG&S will be reimbursed. An example from Canada was the National Farm Stewardship Program (NFSP)[3] available to producers with an Environmental Farm Plan (EFP). These proportional reimbursements of costs were dependent on the type of project allowing for certain projects to receive a larger proportion of compensation. Wetland restoration projects were accepted under the NFSP where producers could apply to receive a reimbursement of 50% of their administrative and construction costs to a maximum of $20,000.

The ultimate intent of these programs is to provide payments to act as incentives to encourage voluntary participation in environmental programs. However, one must ask the question whether sufficient or excessive incentives were being provided? Arguably, appropriate incentives are not being provided for the average producer accounting for the low observed participation rates. As of 2009, only 36% of Manitoban farmers supported the EFP and only 30% were eligible for funding under the cost sharing agreement (data source: MAFRI undated, StatCan 2009).

[3] This program has recently been discontinued; however it was in existence during the course of this study.

The lack of appropriate incentives and low participation rates is ultimately attributed to information asymmetry between the public and producer. This is a significant issue explaining why the existing incentive payments from government programs may not effectively procure E&GS from producers. Information asymmetry exists when multiple parties in a transaction each hold private information that the other party (or parties) is (are) not privy to. Private landowners hold private information related to the costs they would bear if they were to adopt an environmentally friendly practice such as wetland restoration. This is because costs are made up of observable (e.g. cost of capital or consultations) and unobservable components (e.g. opportunity costs, nuisance costs, or environmental preferences) [4]. If governments have access to any cost information, it is most likely the observable cost which is only one component used in the private decision making process.

Information asymmetry contributes to the ineffectiveness of environmental programs. In fixed price schemes information asymmetry creates challenges in the determination of the appropriate level of payment to provide (Groth 2005). Payments set greater than actual costs will not lead to cost minimization and waste money; conversely low payment levels will yield a low rate of participation and high administrative costs per unit of EG&S gained (Groth 2005). Windle & Rolfe (2008) note that where there are heterogeneous costs among farmers a government determined fixed rate cannot provide an appropriate price signal for all farmers to participate. In a cost sharing agreement, the proportion of costs being shared by the government matters as well as what costs are to be shared. Under information asymmetry the inappropriate costs may be shared (e.g. NFSP did not cover opportunity costs which could be a significant component of total

[4] The private costs facing producers will be discussed in further detail in Chapter 3.

costs) and an inappropriate share may be covered by the government for providing benefits to society because of a lack of information.

The government, or public, also holds private information related to their preferences for EG&S and furthermore their value. Landowners are typically unaware or lack understanding of the environmental goals established by the government or have little information about potential EG&S provision on their land. Latacz-Lohmann & Schilizzi (2005) identify that there may also be problems with adverse selection of producers in a fixed price program in the presence of information asymmetry since farmers with a lower EG&S potential would have higher incentives to apply for a fixed price program than producers with higher EG&S potential. For example, a farmer who restores wetlands on low quality land, with low EG&S potential will more likely enter into a contract than a farmer who has good quality land and high EG&S potential. A farmer with low quality land will benefit more because the opportunity cost of wetland restoration is relatively low resulting from land with low productivity. Any payment this farmer would get would directly contribute to income. In contrast, a farmer who has good quality land may have very high opportunity costs related to highly productive land. For this farmer, there are fewer benefits for receiving a payment for restoring wetlands. Relating to the aforementioned comment by Groth (2005: 12) about fixed payments, the level of payment chosen will influence the effect of adverse selection. A low price may be sufficient to induce low potential producers to participate, although excluding those producers who have the capacity to contribute more EG&S. It is very likely that adverse selection would also be a challenge in a cost sharing scheme as well. Similarly, those with low potential for providing EG&S would have higher incentives to participate in the

program knowing that some of the costs could be covered for a given activity, and those with high potential may not participate because the payments issued do not cover a sufficient level of their costs out of pocket.

2.2.1 Conservation Auctions

Conservation auctions are an alternative to fixed price or cost sharing programs supported by many governments to buy and encourage the provision of EG&S by landowners. Auctions are a type of Market Based Instrument (MBI) in that they use market forces, prices, or other economic variables to change behavour. MBIs may create a market where no market is currently operating, or improve a market if there is market failure. Given that there is no current market for EG&S from wetland restoration, and there is information asymmetry, conservation auctions may be a useful instrument for the provision of EG&S from wetland restoration.

Auction mechanisms use competitive bidding to reduce information asymmetry and act as a price discovery system for EG&S. In a conservation auction, participants submit bids to the responsible authority representing the amount they would like to be compensated for their actions (e.g. adopting BMPs), and the most cost effective projects are selected until a budget is exhausted or a target is reached. With competition as the driving force, participants are induced to reveal their true compliance costs through the bidding process (Latacz-Lohmann & Schilizzi 2005). This is because participants must face tradeoffs related to the probability of their bid being accepted and their resulting payoff. Thus participants are revealing some of their own cost information to the auctioneer while receiving a payment adequate to cover their costs of a conservation action.