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The spillover effects of biofuel policy on participation in the conservation reserve program

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ABSTRACT

This paper studies the spillover effects of rising biofuel production on participation in the Conservation Reserve Program. Landowner participation decisions are modeled using a real options framework. We develop a land use decision model that captures biofuel-driven structural changes in market demand and derive threshold conditions that trigger participation in the program. We then quantify the impacts of biofuel production on participation at both the national and state levels using Monte Carlo simulations. The model is also used to analyze how changes in the persistence of the biofuel production boom and in the volatility of farming returns affect conservation participation decisions. Policy implications of the results are discussed.

1. Introduction

Over the past few decades, increased public awareness of environmental issues has prompted the U.S. government to make environmental protection a priority policy area. The Conservation Reserve Program (CRP), enacted in 1985, is a major environmental protection initiative in the U.S. The program aimed to retire 10% of the U.S. cropland from production and it is by far the most important U.S. land conservation program in terms of scale and budget. The CRP was created to provide environmental benefits (e.g., reduce erosion and sequester carbon) through retiring environmentally sensitive cropland. In exchange, participants are given a dependable source of income in the form of CRP land rental payments. The program's economic and environmental benefits have been well documented (see, e.g., Young and Osborn, 1990; Wu, 2000; Wu et al., 2001; Wu and Lin, 2010). In its first 20 years of implementation, the program has prevented an estimated 450 million tons of soil from erosion and sequestered 50 million tons of carbon dioxide per year (USDA-FSA, 2007).

Another policy initiative that has had profound environmental and economic impacts is the 2005 and 2007 Energy Acts (2005 Energy Policy Act and 2007 Energy Independence and Security Act (EISA)), which set a roadmap for bioenergy production and mandates in the U.S. This policy was designed to mitigate greenhouse gas emissions and reduce U.S. dependency on energy

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imports. It has caused significant increases in domestic biofuel production, and possible structural changes in agricultural commodity markets and farming returns (USDA-ERS, 2007; Collins, 2008; Lipsky, 2008; Frank and Garcia, 2010). Supported by ethanol tax credits and mandates on biofuel consumption, annual ethanol production has increased dramatically along with acreage and production of corn, a major feedstock for ethanol production in the U.S. While the desire to reduce greenhouse gas emissions was an important driver of the increased biofuel production, the ethanol-driven structural changes in U.S. agriculture have been pressuring lands out of conservation into crop production. As of 2009, CRP enrollment stood at 31.2 million acres, approximately 5 million acres lower than in 2007 (USDA-FSA, 2010). Land use changes due to exits from CRP result in increased greenhouse gas emissions and have compromised the very goal of emission reduction associated with biofuel policy.

This research studies the spillover effects of biofuel policy on CRP participation and analyzes the implications of potential policy options. We illustrate the nature of competition and extent of spillover between these two major government policies. The analysis requires understanding landowners' conservation participation decision process. When making participation decisions, landowners trade off the costs and benefits of participation. Factors such as annual CRP land rental payments and farming returns are likely to be key determinants (e.g., Parks and Kramer, 1995; Lubowski et al., 2008; Suter et al., 2008; Change and Boisvert, 2009). Since the Energy Policy Act was passed in 2005, farming returns have experienced a sharp increase, suggesting returns to agricultural production have entered a high growth state, departing from the former low growth state. The prospect and persistence of the biofuel driven agricultural boom will have direct impacts on landowners' conservation participation decisions. Another important factor that impacts participation is risk and uncertainty (Capozza and Li, 1994; Dixit and Pindyck, 1994; Schatzki, 2003; Isik and Yang, 2004). This is particularly relevant in the current context because of the biofuel-driven structural changes and uncertainties surrounding the magnitude and persistence of the changes. Faced with these uncertainties, landowners may choose to wait for more information about future returns and thus delay participation. Though participation in the CRP offers landowners a stable stream of cash flow from government payments over the contract period, once enrolled, the land will be locked up for 10 or 15 years, so the participation decision is essentially irreversible during the fixed contract period. In particular, landowners who participate in the CRP may be losing out economically due to higher, forgone farming returns in the future in the context of increasing biofuel production.

In this study we propose a two-state continuous time Markov chain process to model structural change in farming returns and investigate the impacts of biofuel production on conservation participation using a real options framework. Traditionally, real options models assume uncertain returns follow a geometric Brownian motion (GBM), in which the location (mean) of the distribution is assumed to be fixed (see, e.g., Dixit and Pindyck, 1994). Under biofuel-driven structural changes, however, the assumption of a *constant* growth rate for farming returns would be inappropriate. In this study we allow the growth rate of farming returns to follow a two-state process, in which the current high growth state may revert to a low growth state as the ethanol industry matures, or as a result of policy changes (e.g., repealing the ethanol tax credit or removing the ethanol import tariff). The process is general enough to allow for multiple state shifts in the future as farming may move through booms (high return growth rate) and busts (low return growth rate) as the industry and biofuel policy evolve. We further assume that the durations of high and low growth states are random due to exogenous economic and policy uncertainties. The model we propose in this study assumes a geometric Brownian motion with a *stochastic* growth rate (Gennotte, 1986; Brennan, 1998; Xia, 2001; Abasov, 2005), in which landowners continuously update their expectations, conditional on new information arriving at the time of the decision. The expectation formation with information updating is consistent with the actual decision process facing landowners as they observe only historical information and make decisions based on their expectations of the future. This is particularly true at a time of structural change when past realizations only contain partial information about the future growth rate. The parameter uncertainty associated with the stochastic growth rate causes an extra layer of uncertainty compared to the traditional GBM assumption. This has not been previously addressed in the literature on modeling land use decisions.

Based on the proposed model, we derive thresholds of farming returns (profit per acre) that would make land conversion attractive, which is then used to investigate the impacts of biofuel production on program participation at both the national and state levels using Monte Carlo simulations. We further analyze the sensitivity of the land-use conversion thresholds to changes in market conditions, including the expected duration of the biofuel boom and the uncertainty surrounding future agricultural returns. The results provide a number of important insights with significant policy implications.

2. Landowner decision making under uncertainty

The CRP provides an annual per-acre rental payment to landowners to take highly erodible or environmentally sensitive cropland out of production. The payment is fixed over the contracted period once the land is enrolled. The program also provides cost-share assistance to participants who establish approved resource-conserving vegetative covers on eligible cropland. The cost-share assistance can be no more than 50% of the participants' costs in establishing covers. Landowners who decide to enroll in the program must enter into a $\overline{T}$ year contract (10 or 15 years).

Consider a landowner facing a decision to convert a unit of land from crop production to conservation.[1] We assume that the participation decision is made in a continuous-time framework. Defining the farming return as R_t, the expected

[1] We limit our discussion to a single switching decision from cropland to the CRP. After the contract expires, the landowner is faced with an opposite land conversion decision–stay in the CRP or convert back to production. Our model could also be extended to address this problem, but such an extension is outside the scope of the current study.