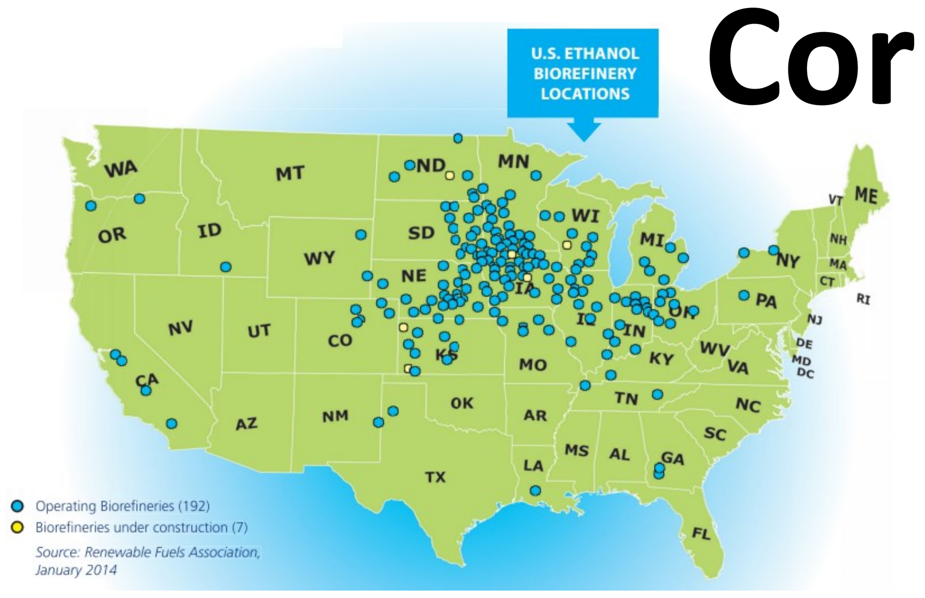
Corn Ethanol Plant Investment and Divestment Decisions
A Real Options Approach

William Secor* and Michael Boland
Department of Applied Economics, University of Minnesota
*** Email: secor027@umn.edu**

Selected Poster prepared for presentation at the Agricultural & Applied Economics Association's 2014 AAEA Annual Meeting, Minneapolis, MN, July 27-29, 2014.



Corn Ethanol Plant Investment and Divestment Decisions
A Real Options Approach

William G. Secor* and Michael A. Boland
Department of Applied Economics, University of Minnesota
*Email: secor027@umn.edu

Introduction & Background

- During the mid-2000s, the US corn ethanol-production industry increased capacity drastically with the prospects of high ethanol-corn margins.
- In reality, however, the margins for ethanol producers were squeezed due to corn price increases.
- As a result, many producers went out of business or changed ownership structure.
- Current and prospective ethanol investors want to learn from this past restructuring event.
- This paper attempts to explain the boom and bust of corn ethanol plants in the mid-2000s by analyzing the following question: Did investors use a simple investment approach that suggested it was wise to invest, while more complex techniques would have shown to wait?

Objectives

Could a real options framework have shown that expanding production capacity in the mid-2000s was a poor investment while a net present value framework could not?

The framework of this research is derived from Schmit et al. (2009). The current paper extends it by making an alternative assumption about the stochastic process gross margins follow.

The specific objectives of the paper are the following:

1. Construct trigger margins that tell investors when to invest in and plant owners when to mothball, reactivate, or sell an ethanol plant for three representative plant sizes (small, medium, large):
   A. Using the Net Present Value (NPV) evaluation framework.
   B. Using the real options evaluation framework:
      i. Under the assumption that gross margins follow Geometric Brownian motion.
      Ii. Under the assumption that gross margins follow a mean-reverting stochastic process.
2. Compare these constructed trigger margins to determine if the real options framework indicates to wait (not invest) while the NPV framework indicates to invest.
3. Determine which framework best explains the investment and divestment decisions that actually occurred.

Methods

- The key contribution of the real option framework is that it takes into account the "real option" of waiting when evaluating an investment opportunity. The NPV framework assumes this value is zero.
- The trigger margin switching from regime k_0 to regime k_1 under the real options framework must satisfy the two following conditions:

$$V_{k_0}(\theta_k) = V_{k_1}(\theta_k) - S$$
$$V'_{k_0}(\theta_k) = V'_{k_1}(\theta_k),$$

where V_{k_0} is the value of being in regime k_0, V_{k_1} is the value of being in regime k_1, θ_k is the gross margin, and S is the switching cost, and the prime symbols indicate first derivatives.

- This first condition has an intuitive meaning that the value of switching to regime k_1 must be equal to value of being in regime k_0 less any switching costs.
- Suppose k_0 is entry and k_1 is wait. Then, the real options framework allows for the value of waiting to be positive, while the NPV framework assumes it is zero.
- The Geometric Brownian motion process (GBM) is specified as:

$$d\theta = \alpha\theta\, dt + \sigma\theta\, dz,$$

where α is the drift parameter and σ is the volatility parameter.

- The mean-reverting process (OUP) used is specified as:

$$d\theta = \eta\left(\bar{\theta} - \theta\right) dt + \sigma\, dz,$$

where η is the mean-reversion parameter and $\bar{\theta}$ is the normal value to which the gross margins revert.

- These stochastic process parameters are estimated using publicly available ethanol and corn price data.

Results

Table 1. Trigger margins by plant size (¢/liter)

Plant Size	Trigger Margin	GBM (SLT)	Ito Process GBM (Current)	OUP	NPV
Small	Entry	48.4	33.5	15.2	15.2
	Reactivate	21.7	18.7	10.1	-
	Mothball	5.1	3.6	5.9	-
	Exit	4.7	0.7	3.8	12.0
Medium	Entry	36.7	25.9	12.0	12.0
	Reactivate	17.3	15.2	8.4	-
	Mothball	4.4	3.2	4.6	-
	Exit	3.6	0.5	-1.6	9.7
Large	Entry	34.1	24.5	11.6	11.6
	Reactivate	16.9	15.0	8.5	-
	Mothball	4.6	3.5	5.0	-
	Exit	3.4	0.5	-1.9	9.6

GBM (SLT) uses the parameters from Schmit et al. (2009) in the GBM Ito process.
GBM (Current) uses parameters found by the current author in the GBM Ito process.
OUP refers to the OUP Ito process.

Results (cont.)

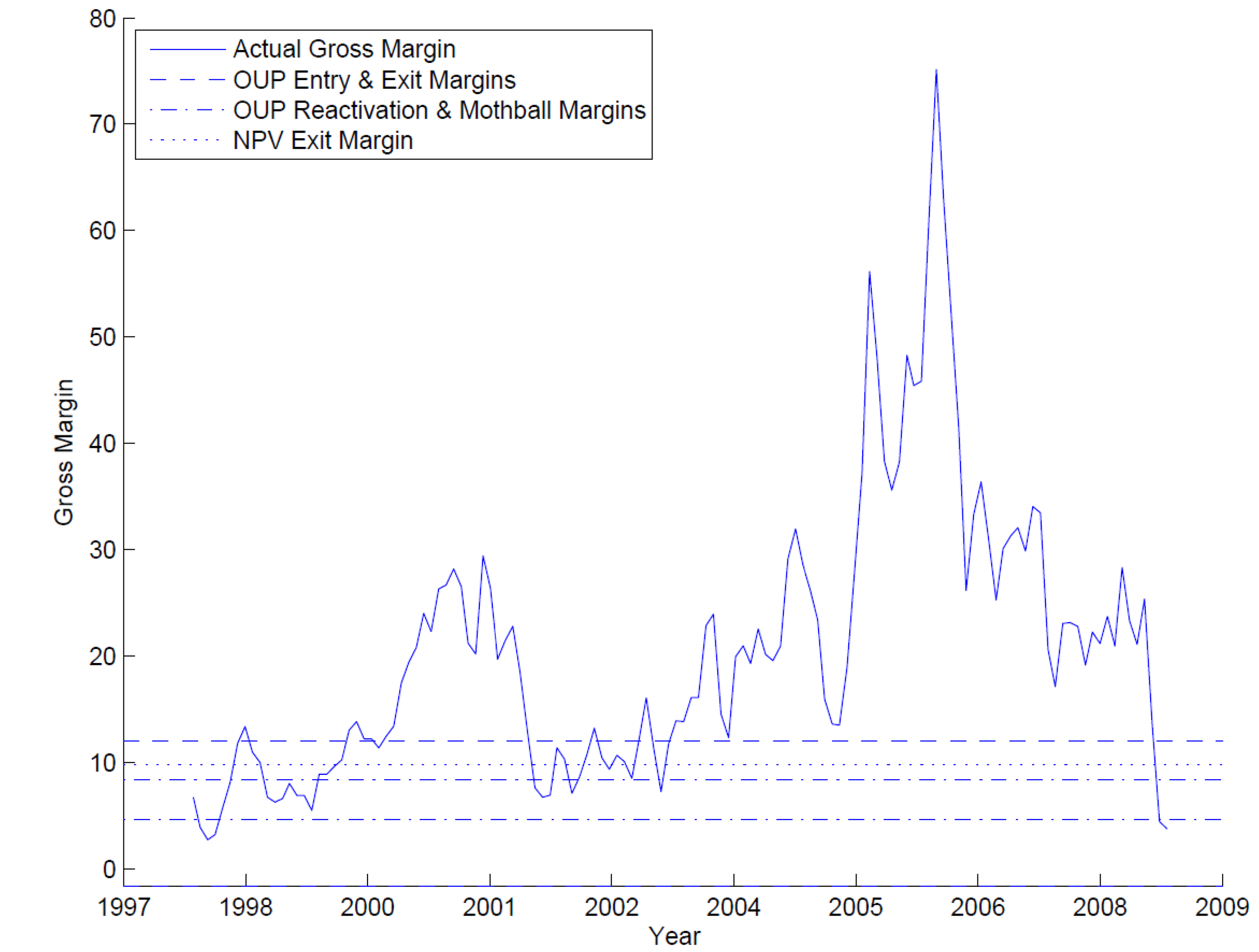


Figure 1. OUP trigger and actual gross margins for medium plant (¢/liter)

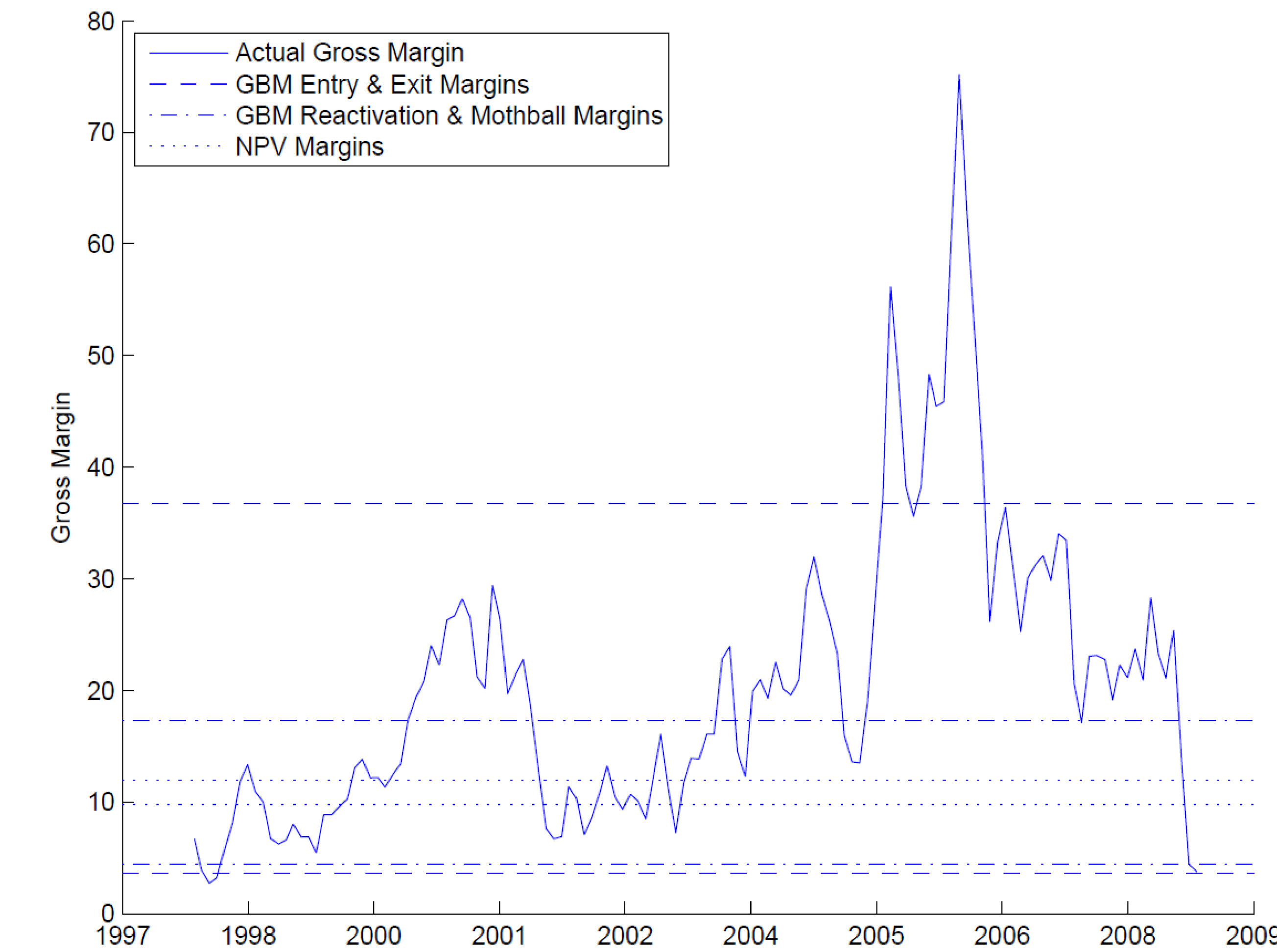


Figure 2. GBM (SLT) trigger and actual gross margins for medium plant (¢/liter)

Conclusions

- The value of waiting drastically changes the trigger margins.
- Making different assumptions about the future behavior of the gross margin drastically changes the results.
- It appears that the trigger margins using the real options framework best approximate the behavior of ethanol plant investors.
- The choice of evaluation framework may not have played an important role in the boom-and-bust period of the mid-2000s.

1. Schmit, T. M., Luo, J., & Tauer, L. W. (2009). Ethanol plant investment using net present value and real options analyses. *Biomass and Bioenergy*, *33*(10), 1442–1451.