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# **Field to flight: A techno-economic analysis of the corn stover to aviation biofuels supply chain**

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# Field to flight: A techno-economic analysis of the corn stover to aviation biofuels supply chain

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## Abstract

This analysis focuses on aviation biofuel production using fast pyrolysis from corn stover. Cellulosic biofuels carry a lot of risk, because conversion technology is expensive. As a result, incentives are needed to reduce the risk for private investors. The issue is choosing which policy will provide the most reduction in risk, while providing a lowest cost to the government. Uncertainty is added in benefit-cost analysis to fuel price and four technical variables: capital cost, final fuel yield, hydrogen cost, and feedstock cost. We look at the impact of two policies: reverse auction and capital subsidy. For the reverse auction and capital subsidy, we used contract lengths of 5, 10, and 15 years to see the impact a longer contract could have on probability of loss. A reverse auction reduced more risk of investment. As the contract length increased, the probability of loss and coefficient of variation in net present value were reduced substantially. When fuel price increased stochastically and a contract length of 15 years was used, probability of loss was reduced to 18.4 percent.

## Introduction

### Aviation Biofuels

Aviation biofuels can help to reduce GHG emissions, meet the Renewable Fuel Standard for cellulosic biofuels, and improve U.S. energy security.

### Corn Stover

- Corn stover is a relatively inexpensive cellulosic feedstock.
- There is an abundance of supply.
- Corn stover results in little to no induced land use change.

### Fast Pyrolysis

- It is a thermal process.
- Higher yields of liquids compared to other types of pyrolysis.
- Versatility, improved efficiency, and environmental acceptability.

### Policy options

- Reverse auction

In a reverse auction a prospective purchaser would request bids for a contract with government to supply aviation biofuels. Private investors would place bids on the price per gallon of fuel. The lowest unique bidder wins the bid.

- Capital subsidy

A capital subsidy involves government paying a portion of capital cost and can take many forms. Here we used a simple form in which the government just pays a fraction of total capital cost.

In order to compare the two policies, we modeled the level of the capital subsidy to have the same cost to government as the reverse auction cases.

## Material and Methods

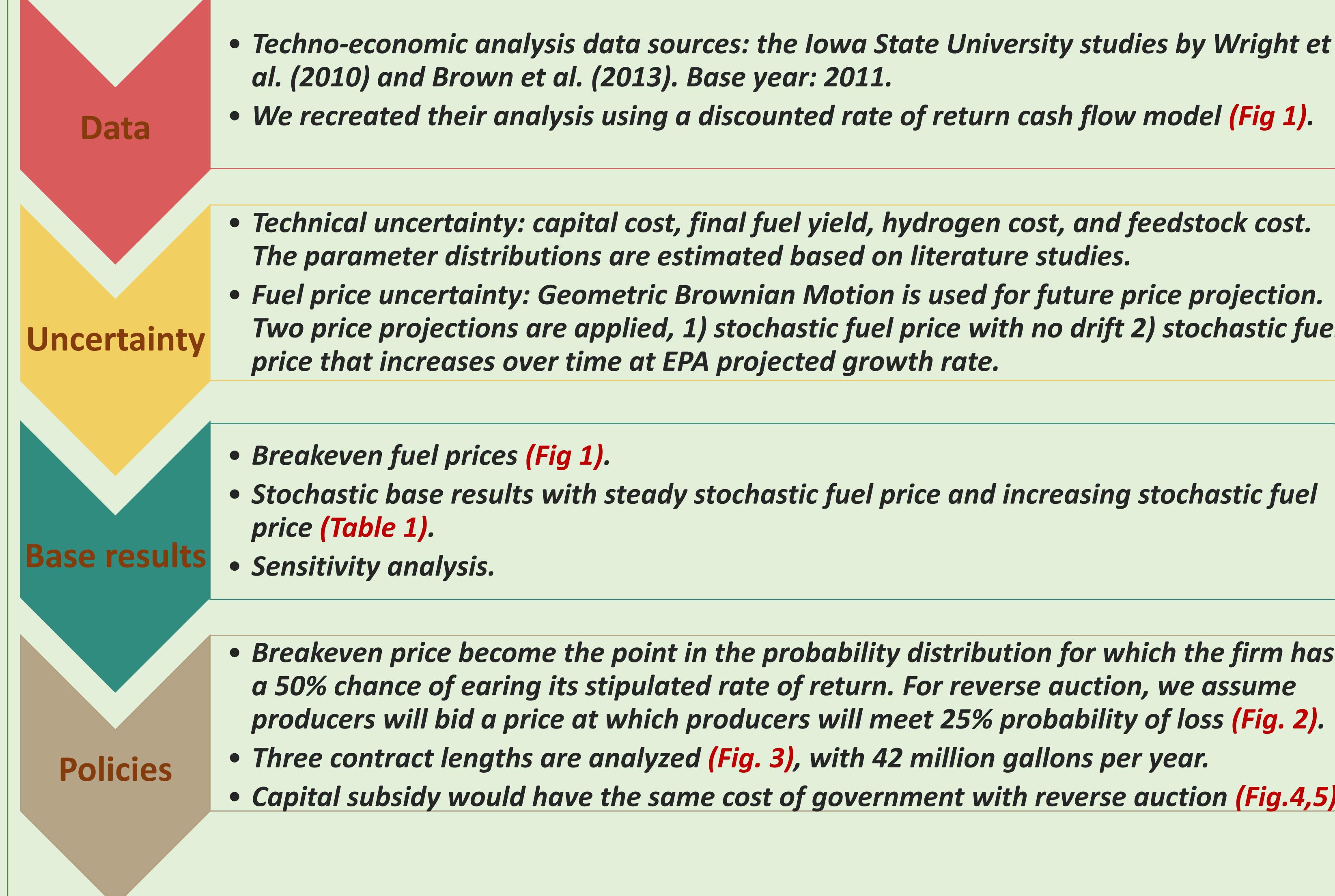


Fig. 1 Breakdown of Impact each Parameter has on Breakeven Fuel Prices (\$/GGE).

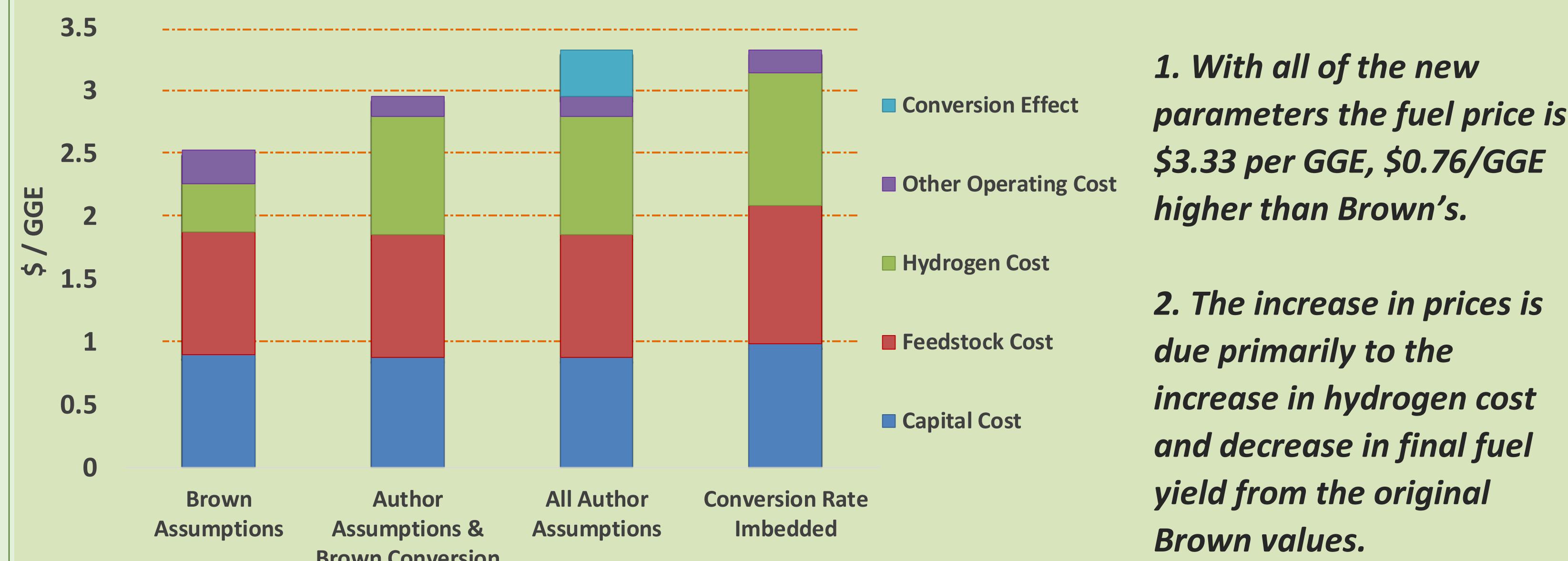


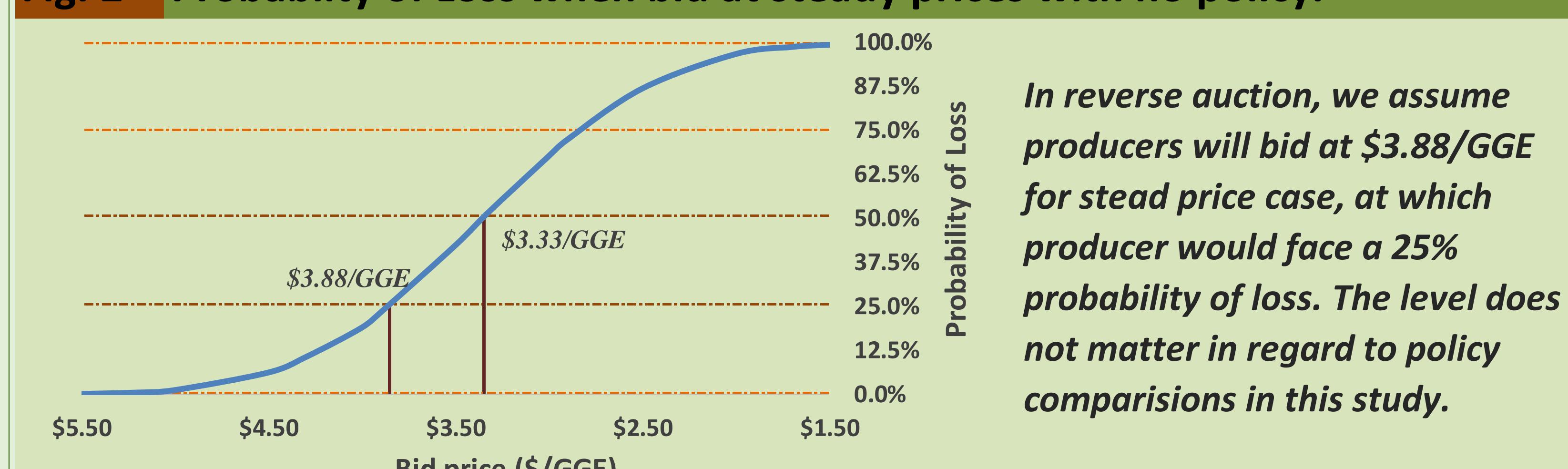
Table 1 Stochastic Base Results, distribution means for NPV, IRR, and B/C, for both steady and increasing fuel prices.

There are errors in IRR calculation in simulations. Negative prices are ruled out in simulations.

	Steady Stochastic Fuel Price			Increasing Stochastic Fuel Price		
	NPV	IRR	B/C	NPV	IRR	B/C
Mean (\$)	(\$84.94)	10.30%	0.92	\$5.13	13.30%	1
Std dev (\$)	\$215.10	10.20%	0.18	\$225.89	10.10%	0.19
Prob. Loss	66.80%			49.70%		

1. With steady prices, Prob. Loss is 66.8%; this Prob. Loss decreased to 49.7% with a increasing price scenario.
2. Overall, there is a lot of risk for an investment in this case. Private investors would be discouraged from making an investment.

Fig. 2 Probability of Loss when bid at steady prices with no policy.



## Results and Discussion

Fig. 3 NPV, Standard Deviation and Probability of loss result from reverse auction (Steady fuel market fuel price).

The line levels indicate NPV means. The vertical error bars indicate standard deviations. The horizontal error bars indicate probability of loss.

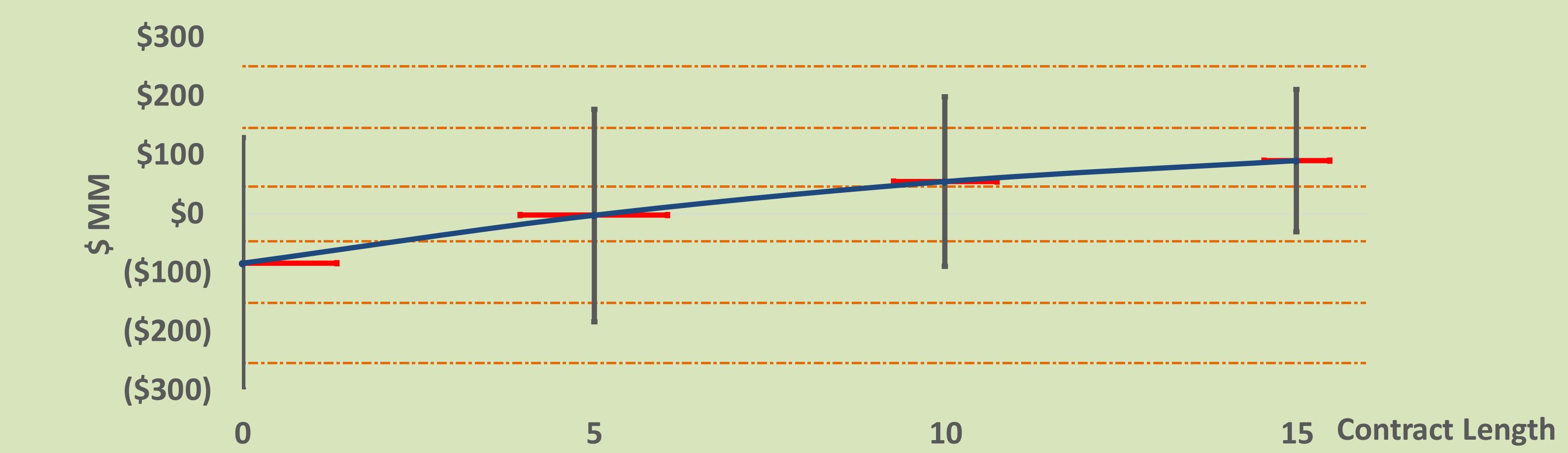


Fig. 4 Comparison of reverse auction and capital subsidy, NPV and Standard Deviation results with steady prices.

The level of bars indicate NPV means. The vertical error bars indicate standard deviations.

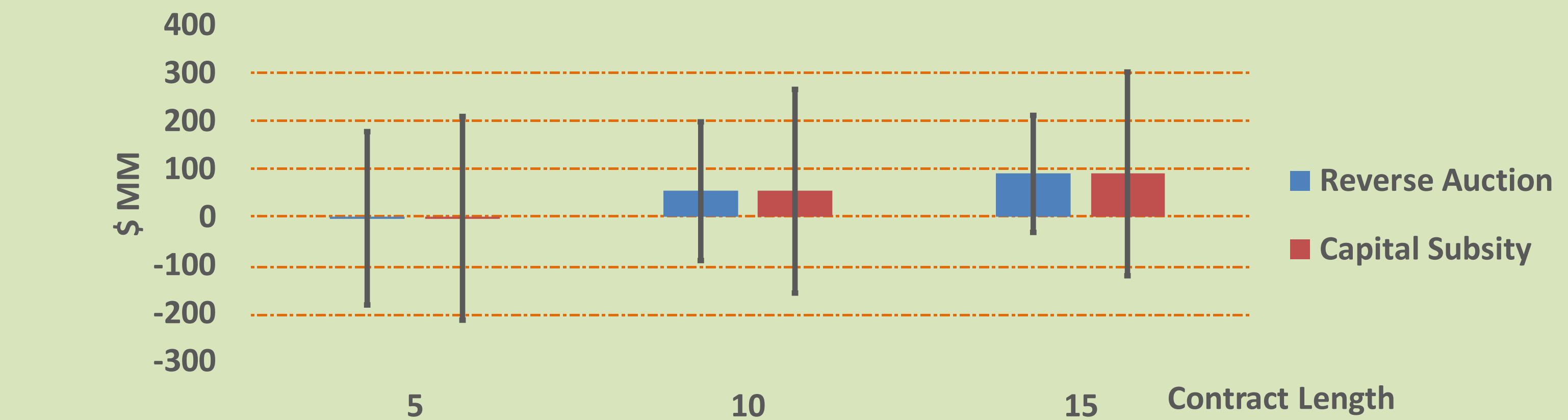
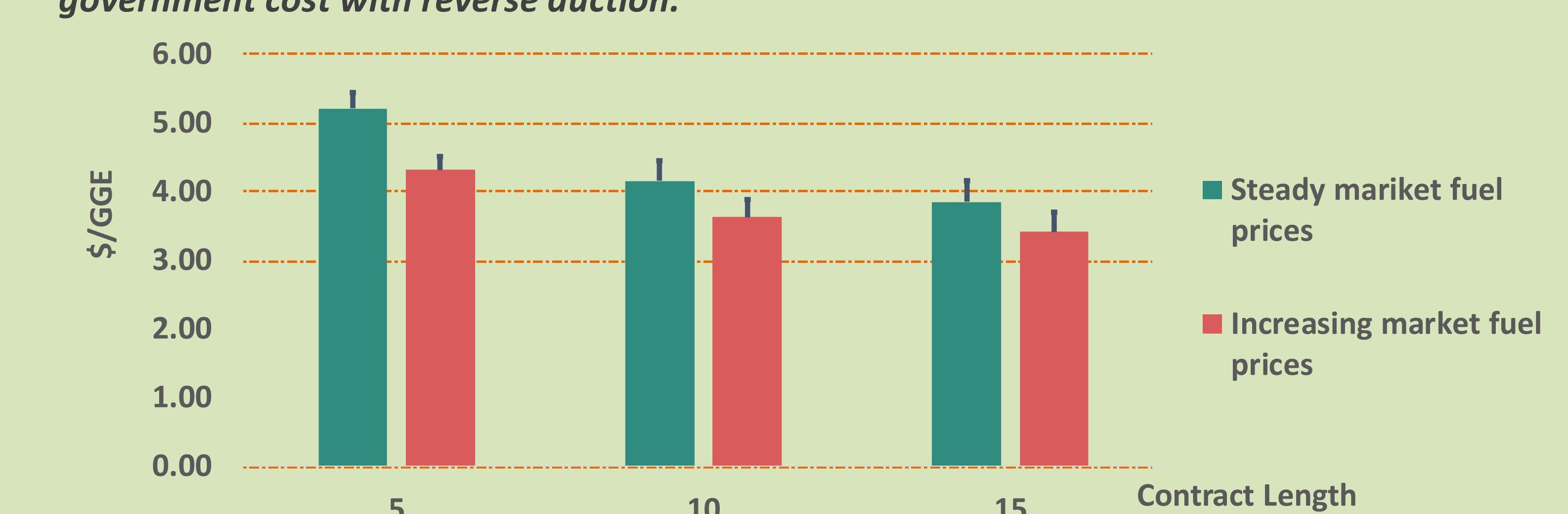


Fig. 5 Bid prices at 25% probability of loss (with policies) for reverse auction with steady and increasing market fuel prices.

The bar levels indicate bid prices. The vertical error bars indicate the equivalent bid prices for capital subsidy that has the same government cost with reverse auction.



## Conclusions

1. The reverse auction reduced risk more than capital subsidy when the costs to the government are the same.
2. More risk would be reduced as reverse auction contract length increases.
3. However, there may be difficulties in securing adequate competition for new processes such as pyrolysis based aviation biofuels.