

# Willingness to Pay for Wood-based Cellulosic Biofuels Among Washington and Oregon Communities

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# Introduction

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- ▶ NIFA \$40 million grant to establish a wood-based cellulosic biofuels industry in the Pacific North West (PNW)
- ▶ To address dual challenges of energy security and climate change
- ▶ Hybrid poplars provide 70% of the feedstock
- ▶ A cellulosic biorefinery is established in Boardman, Oregon



# Industry's Sustainability

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- ▶ Social acceptance is crucial for the sustainability of the new industry
- ▶ Particularly, market acceptance of cellulosic biofuels



# Research Question

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- ▶ How much people are willing to pay for wood-based cellulosic biofuels and what influences their willingness to pay?



# Sampling and Data Collection

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- ▶ Mailed surveys in WA and OR
  - ▶ Address Based Samples that cover 95% of households
  - ▶ Systematic stratified sampling of residential addresses
  - ▶ Of 2,828 valid addresses, 757 completed surveys received
  - ▶ Response rate: **26.8%**
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- ▶ ***Heckman two stage procedure – no selection bias***



# Contingent Valuation Scenario

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Advanced biofuels made from woody material (like hybrid poplar) may help reduce America's dependence on foreign oil, protect the environment and prevent the conversion of food into fuels. But the problem is that they cannot compete with corn ethanol or gasoline in the market due to their high cost of production at this time. The future of advanced biofuels may depend on the willingness of thousands of consumers like you to pay somewhat more for it compared to corn ethanol or regular gasoline. Please note that spending more on advanced biofuels could mean less money for you to spend on other things.

- ▶ Given your current income and expenses, would you be willing to pay \$X per gallon more for gasoline mixed with advanced biofuels?



# Logistic Regression

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- ▶  $P(\text{WTP}) = \alpha + \beta_1 \text{ bid price offered} + \beta_2 \text{ price of gasoline at the pump} + \beta_3 \text{ biofuels knowledge} + \beta_4 \text{ age} + \beta_5 \text{ age}^2 + \beta_6 \text{ gender} + \beta_7 \text{ education} + \beta_8 \text{ active in labor force} + \beta_9 \text{ religious affiliation} + \beta_{10} \text{ state of residency} + \text{error}$



# Turnbull Estimator

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- ▶
- ▶ Mean WTP =  $\sum_{j=0}^M b_j \times f_{j+1}$
- ▶ Variance =  $\sum_{j=1}^M \frac{F_{j-1}^*(1-F_{j-1}^*)}{T_j} (b_j - b_{j-1})^2$  (lower bound estimate)

Where,

$f_j$  = probability mass point estimate

M = number of bids

$b_j$  = bid price offered

$F_j$  = unrestricted likelihood estimate of the cumulative distribution function

$F_j^*$  = Turnbull distribution for meeting the monotonicity assumption

$T_j$  = total number of bid offered

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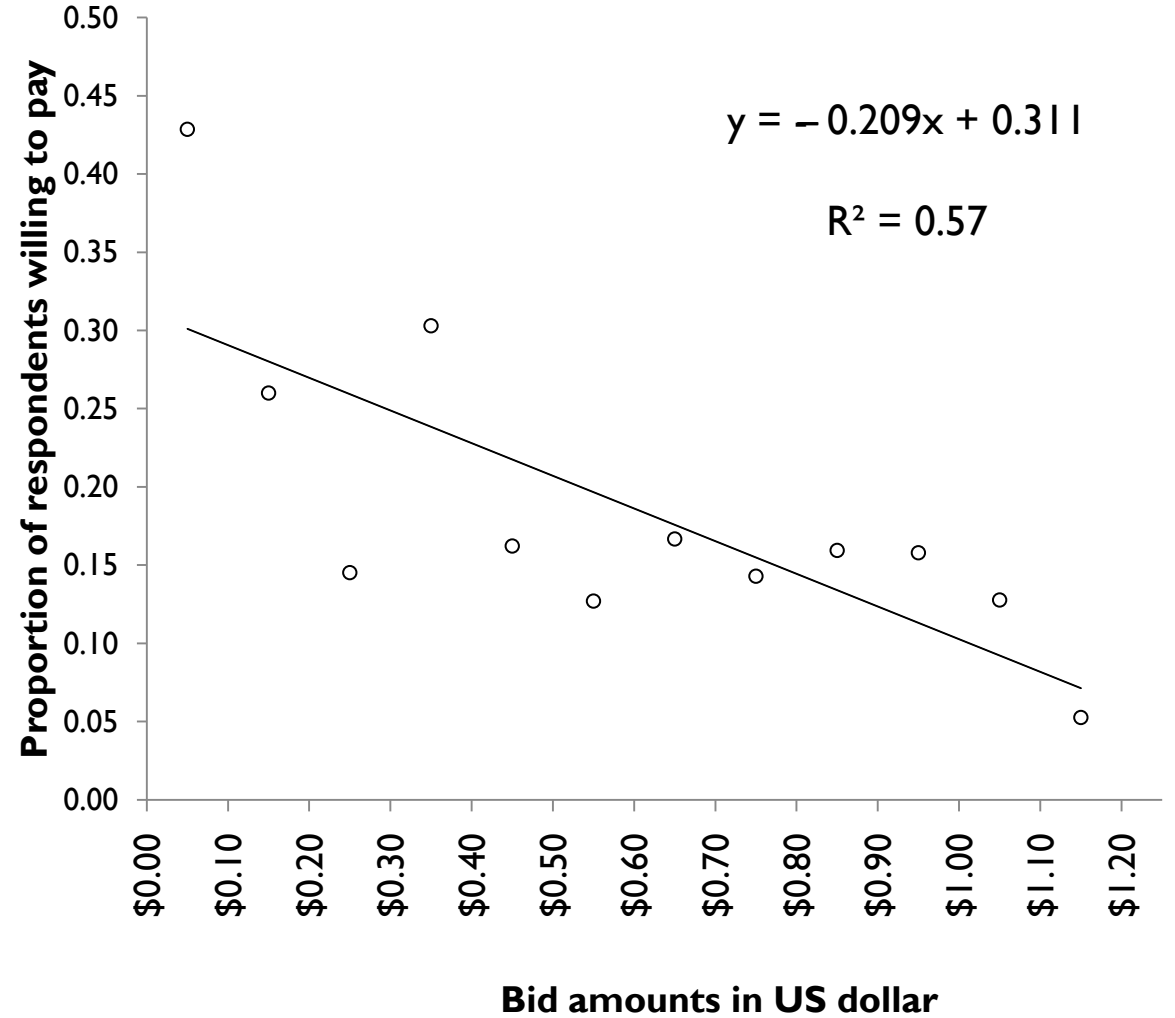
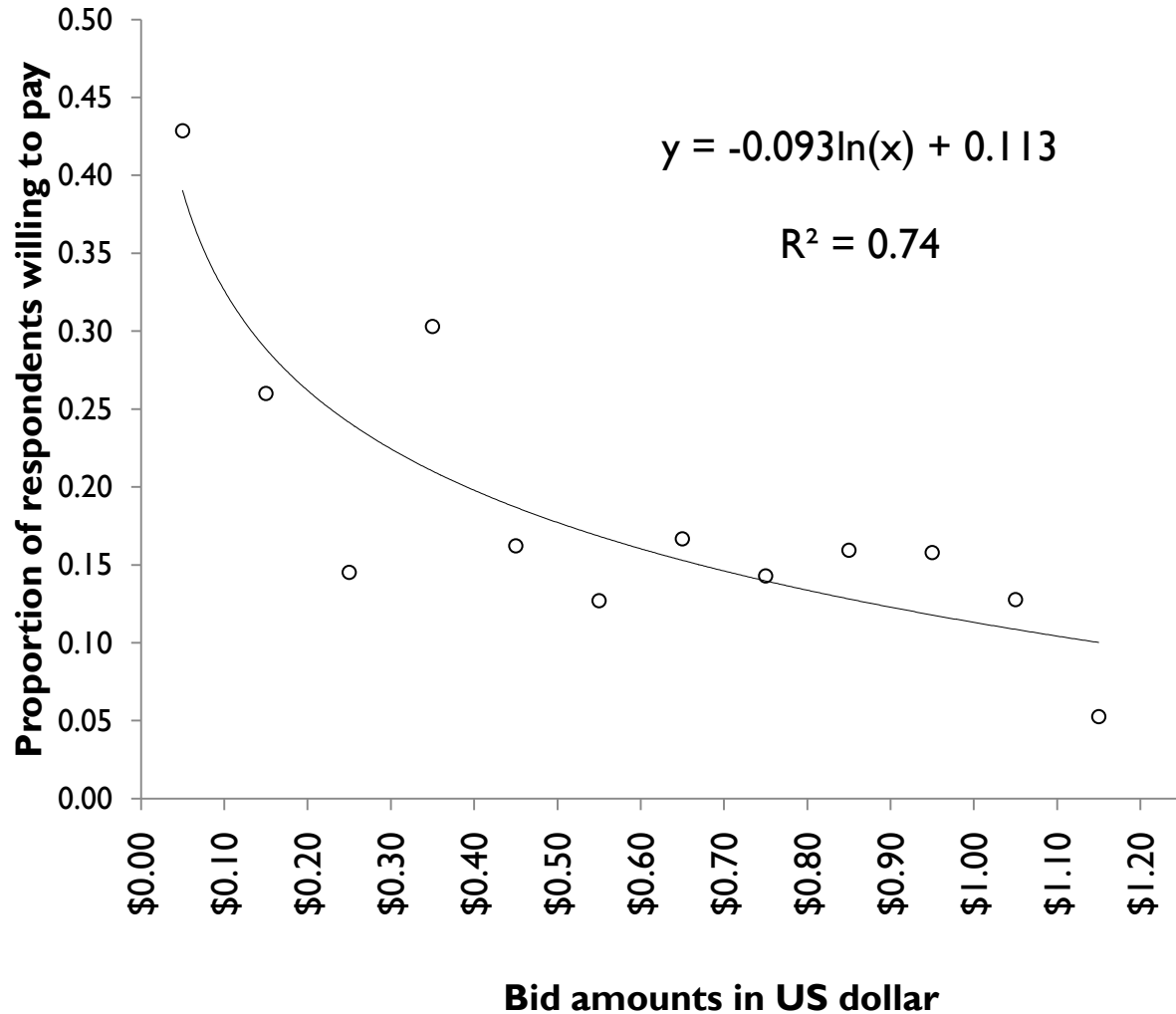




# Predictors of WTP

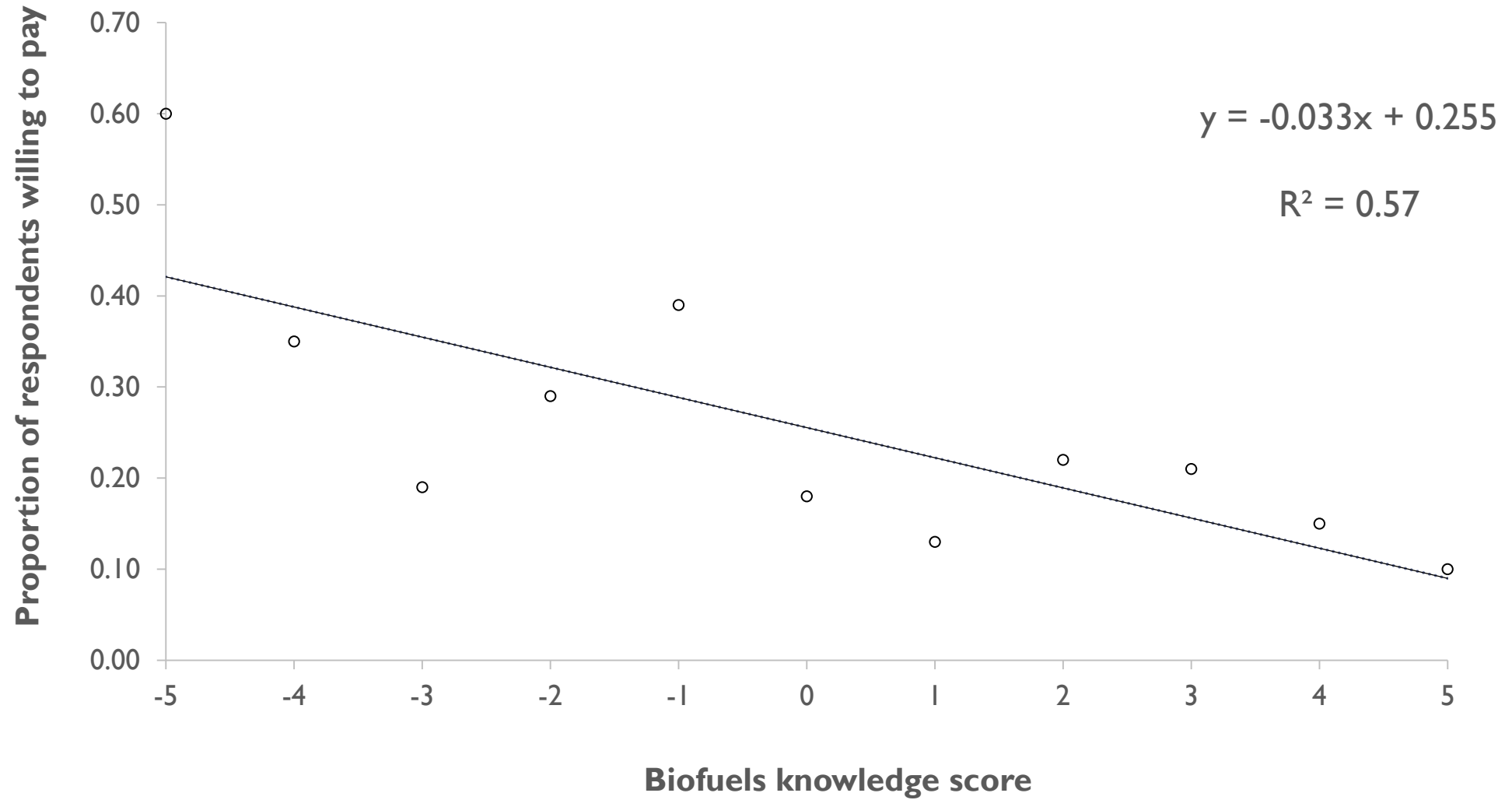
Explanatory variable	Coefficient	SE	z	p	Change in odds (%)
Bid price offered	<b>-1.8359</b>	<b>0.5332</b>	<b>-5.20</b>	<b>0.000</b>	<b>-84.1%</b>
Gasoline price at the pump	-0.3699	0.3456	-1.07	0.284	-30.9%
Biofuels knowledge	<b>-0.1692</b>	<b>0.0360</b>	<b>-4.70</b>	<b>0.000</b>	<b>15.6%</b>
Gender (men = 1)	-0.3323	0.2394	-1.39	0.165	28.3%
Age (centered)	0.0102	0.0114	0.90	0.370	1.0%
Age <sup>2</sup> (centered and squared)	<b>0.0012</b>	<b>0.0006</b>	<b>2.00</b>	<b>0.046</b>	<b>0.1%</b>
Education	0.0124	0.0793	0.16	0.875	1.3%
Active in labor force (yes = 1)	0.3072	0.2721	1.13	0.259	36.0%
Religious affiliation (Christian = 1)	<b>-0.9364</b>	<b>0.2288</b>	<b>-4.09</b>	<b>0.000</b>	<b>-60.8%</b>
State of residency (Washington = 1)	0.3087	0.2506	1.23	0.218	36.2%
Constant	1.1755	1.1519	1.02	0.307	
<b>Model fit statistics: Likelihood ratio <math>\chi^2_{10} = 77.17, p &lt; 0.01, -2 LL = 269.83, \text{pseudo } R^2 = 0.125</math></b>					

# Empirical WTP Demand Curve



# Biofuels Knowledge and WTP

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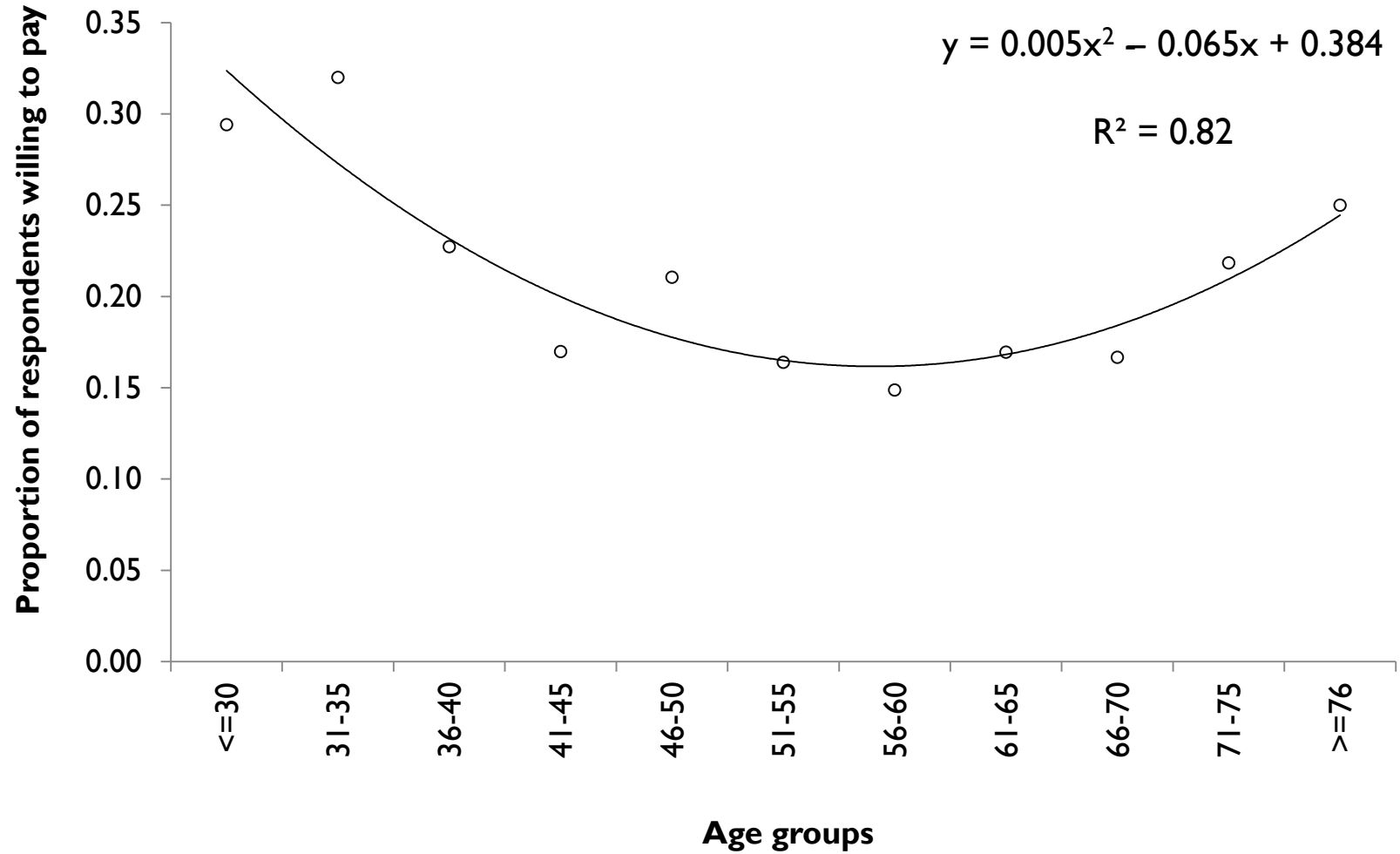
# Biofuels Knowledge and WTP

Biofuels knowledge items	Coefficient	SE	z	p	Change in odds (%)
A gallon of ethanol has less energy content than a gallon of gasoline	0.0341	0.0937	0.36	0.716	3.5%
More than 10% of ethanol in gasoline degrades the engine of automobiles	<b>-0.3418</b>	<b>0.0878</b>	<b>-3.89</b>	<b>0.000</b>	<b>-29.0%</b>
United States can produce 100 billion gallons of ethanol per year from wood-based materials	0.1979	0.1246	1.59	0.112	21.9%
Biofuels, if properly done, do not produce any pollution	-0.0401	0.1011	-0.40	0.692	-3.9%
Biofuels are an ultimate solution to climate change	<b>-0.3044</b>	<b>0.0905</b>	<b>-3.36</b>	<b>0.001</b>	<b>-26.2%</b>
Constant	-1.1738	0.1239	-9.48	0.000	
<b>Model fit statistics: Likelihood ratio <math>\chi^2_5 = 45.87</math>, <math>p &lt; 0.01</math>, -2 LL = 314.28, pseudo <math>R^2 = 0.068</math></b>					



# Age and WTP's Curvilinear Relationship

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## WTP Amount

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- ▶ Mean WTP amount: **\$0.19 ± \$0.03** per gallon  
**\$0.05** per liter
- ▶ The 95% confidence intervals: **\$0.17 to \$0.21** per gallon  
**\$0.04 to \$0.06** per liter
- ▶ Equivalent to **6.4%** on top of the market price for gasoline



# Reasons for WTP

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## Willing to pay

- ▶ biofuels are *locally produced*
- ▶ biofuels help to *reduce the dependence* on foreign oil

## Not willing to pay

- ▶ biofuels are *expensive* so there is no point in paying more for them
- ▶ biofuels *destroy the engine*
- ▶ biofuels *increase costs* to consumers due to high maintenance and low mileage
- ▶ biofuels are not a good solution because they *use more energy* to produce and release emissions
- ▶ biofuels' production *leads to the destruction of natural forests*
- ▶ biofuels are just *waste of tax payer money* because other better alternatives already exist



# Total Economic Value

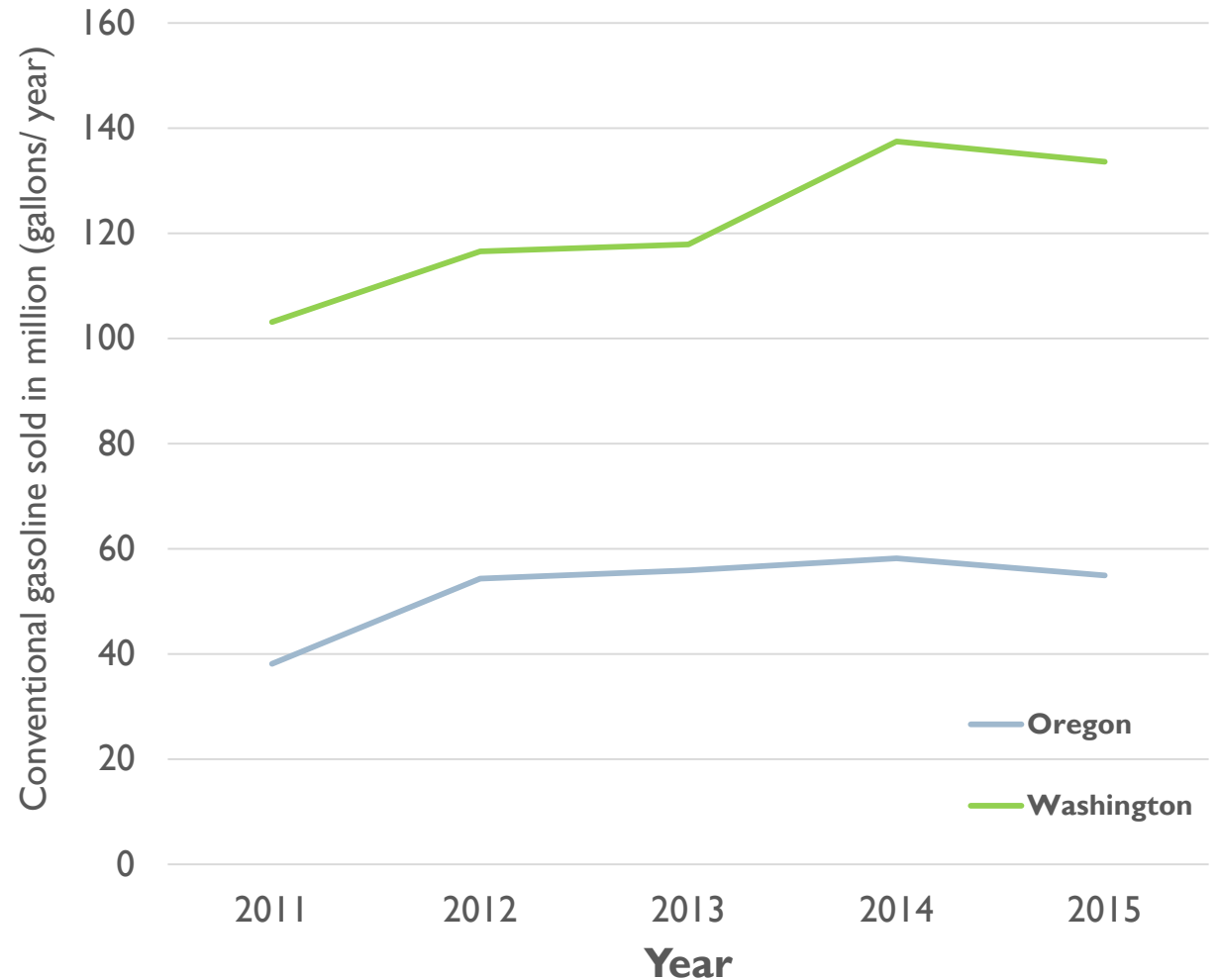
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## Conventional gasoline sold

- ▶ OR: 52.3 ± 8.0 million gallons
- ▶ WA: 121.7 ± 13.9 million gallons

## Economic value (in USD)

- ▶ OR: 9.9 ± 1.5 million per year
- ▶ WA: 23.1 ± 2.6 million per year





# Conclusions

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- ▶ People ascribe some value to wood-based cellulosic biofuels
- ▶ WTP amount could be used for local cost-benefit analysis
- ▶ Results will be helpful in consumer profiling and demand characterizations for cellulosic biofuels



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**Thank you!**

**Questions?**  
**Comments.**

