ICO Price Optimization

Cox Automotive Case Study

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Problem Overview

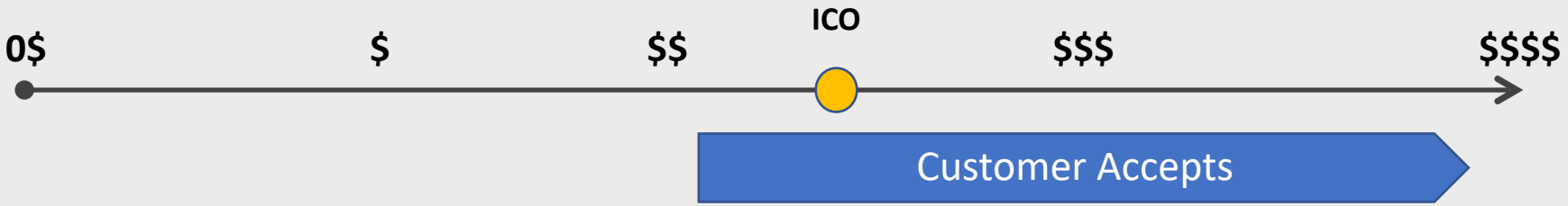
1. Instant Cash Offer (ICO) - **Prediction**

2. Instant Cash Offer (ICO) - **Optimization**

Customer Perspective

ICO = Instant Cash Offer

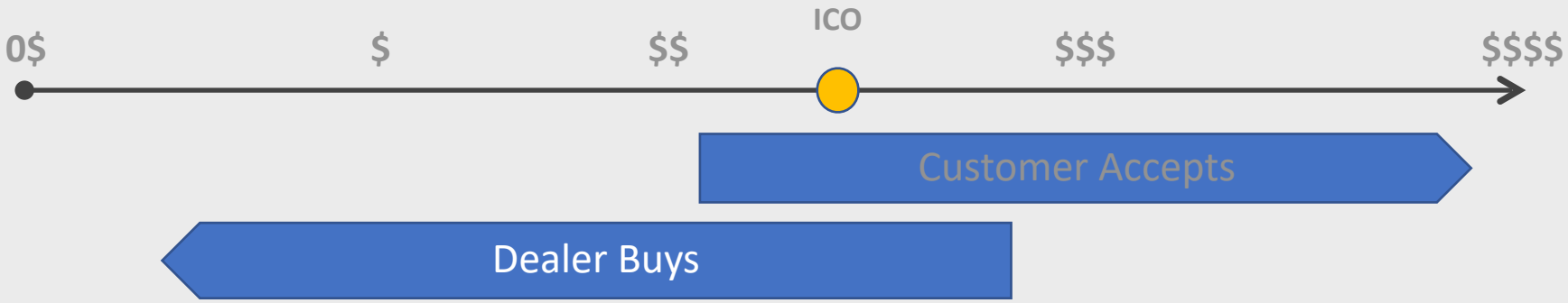
The price Cox predicts a customer's vehicle is worth.



Dealer Perspective

ICO = Instant Cash Offer

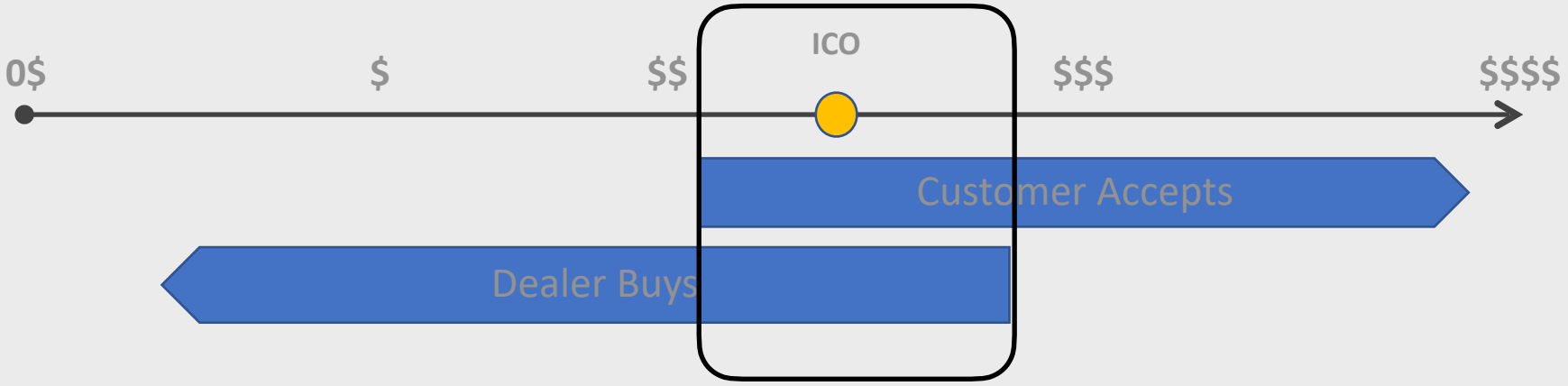
If a customer accepts the ICO, then Dealers have the chance to buy the vehicle at ICO.



Predicting Dealer Buys

ICO = Instant Cash Offer

Historical data has ICO values paid by the dealer to the consumer.



Goal: Build a model to predict ICO values based on historical dealer buys.

Historical data includes: Make, model, mileage, vehicle condition etc…..

ICO Prediction Steps

Dataset

	Varibles	.....	ICO Value
1			
2			
3			
.			
.			
.			
40491			

Training Data (80%)

Testing Data (20%)

1. Split dataset for model training and testing
2. Add & remove variables
3. Fit several models on training data
4. Report errors on testing data*

Mean Absolute Error = | Actual ICO - Predicted ICO |

Mean Square Error = (Actual ICO - Predicted ICO)^2

**Why? Report on test to simulate how our model will preform on unseen future data.*

ICO Prediction Steps

B. Key Variables

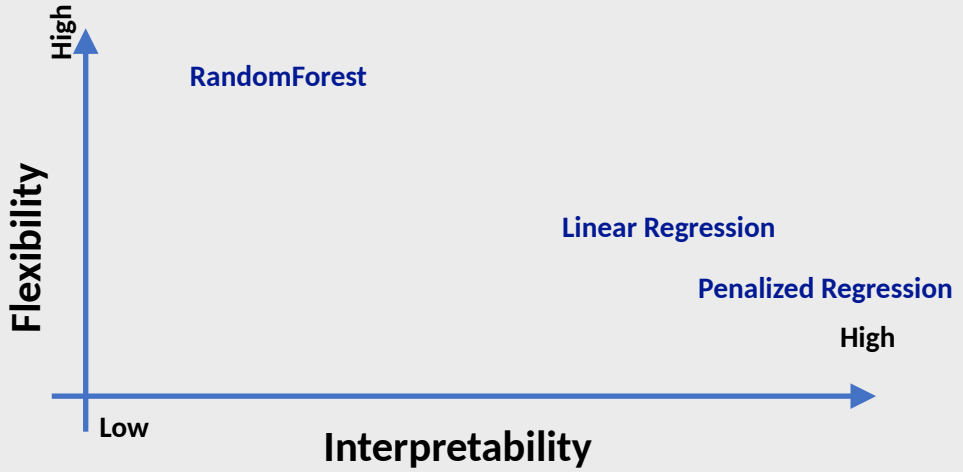
Age *= Offer Date - Model Year (created variable)*

Ammr *= Whole price estimate from Manheim Market Report*

Forecast_mmr *= Whole price forecast 5 weeks future*

Avgcond_mmr *= Average condition for vehicle type*

C. Models Considered



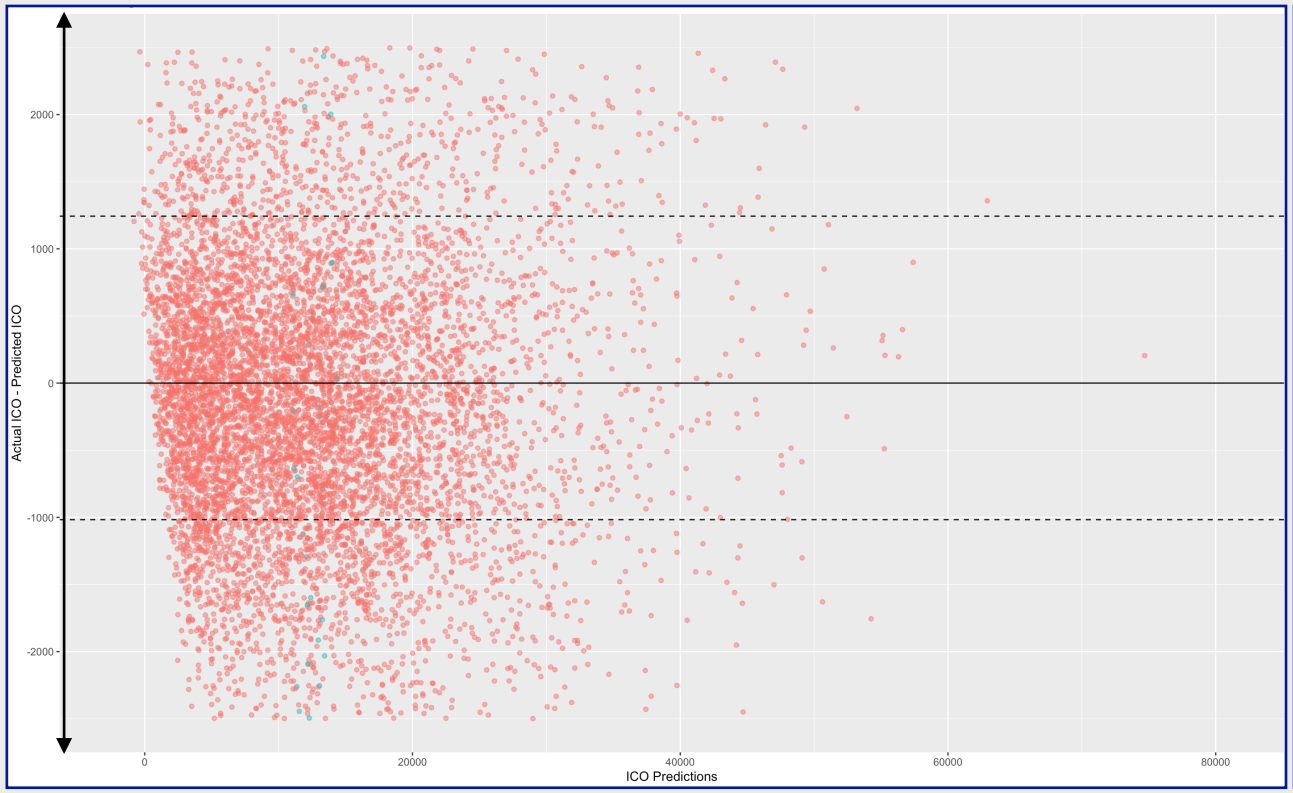
X-Axis = Predicted ICO
Y-Axis = Actual ICO - Predicted ICO

Model Errors - Explainability vs. Accuracy

(-) when **predicted > actual**
(+) when **predicted < actual**

Linear Regression

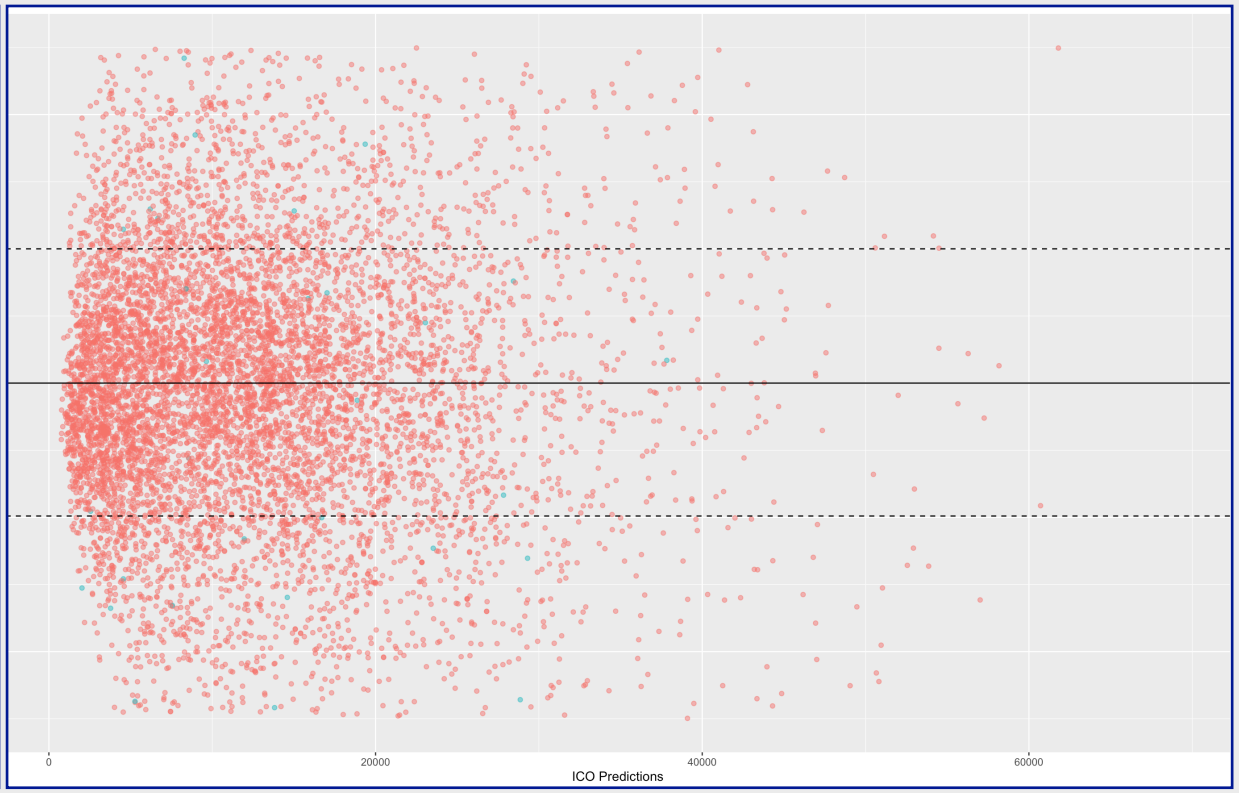
Average magnitude of errors is $1100



MAE = $1100
sqrt(MSE) = sqrt($4,807,894) = $2190

RandomForest

Average magnitude of errors is $990



MAE = $990
sqrt(MSE) = sqrt($2,821,194) = $1680

Model Errors - Explainability vs. Accuracy

X-Axis = Predicted ICO
Y-Axis = Actual ICO - Predicted ICO

(-) when **predicted > actual**
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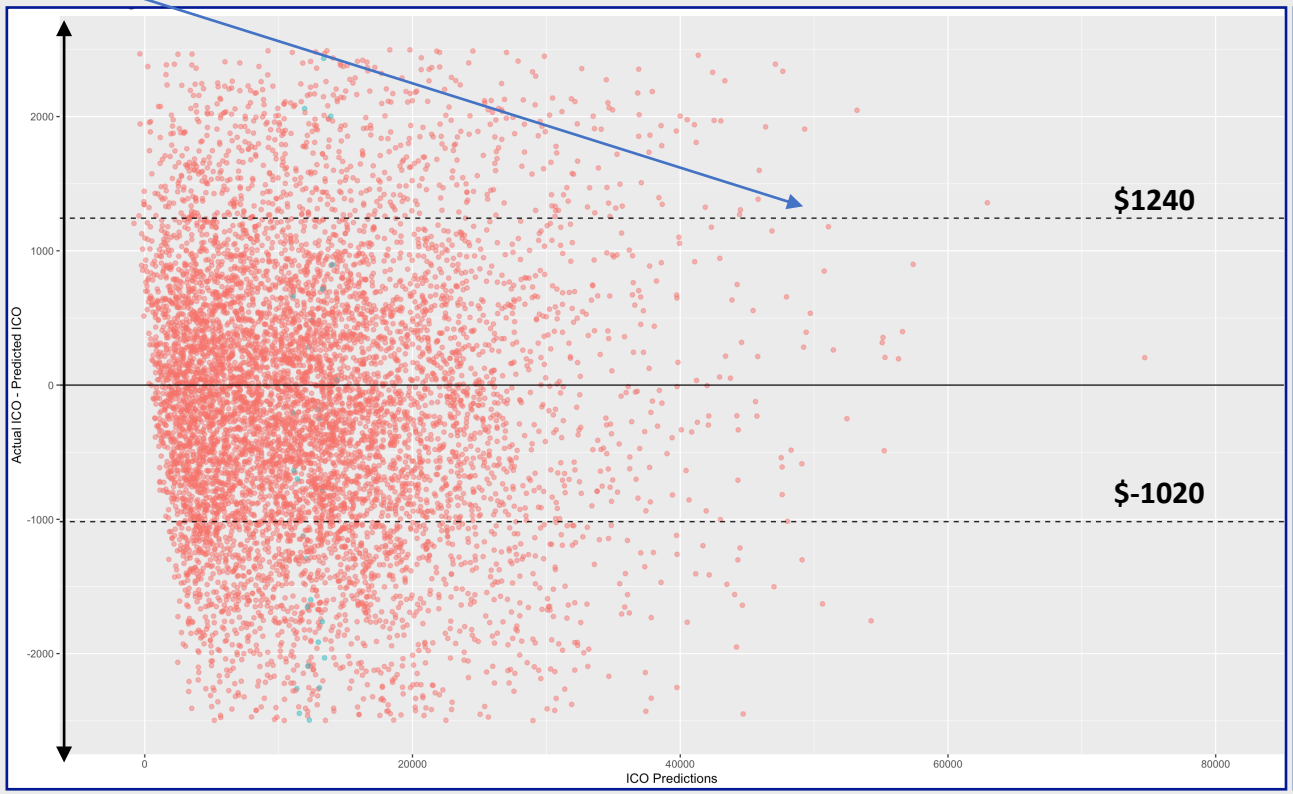
Linear Regression

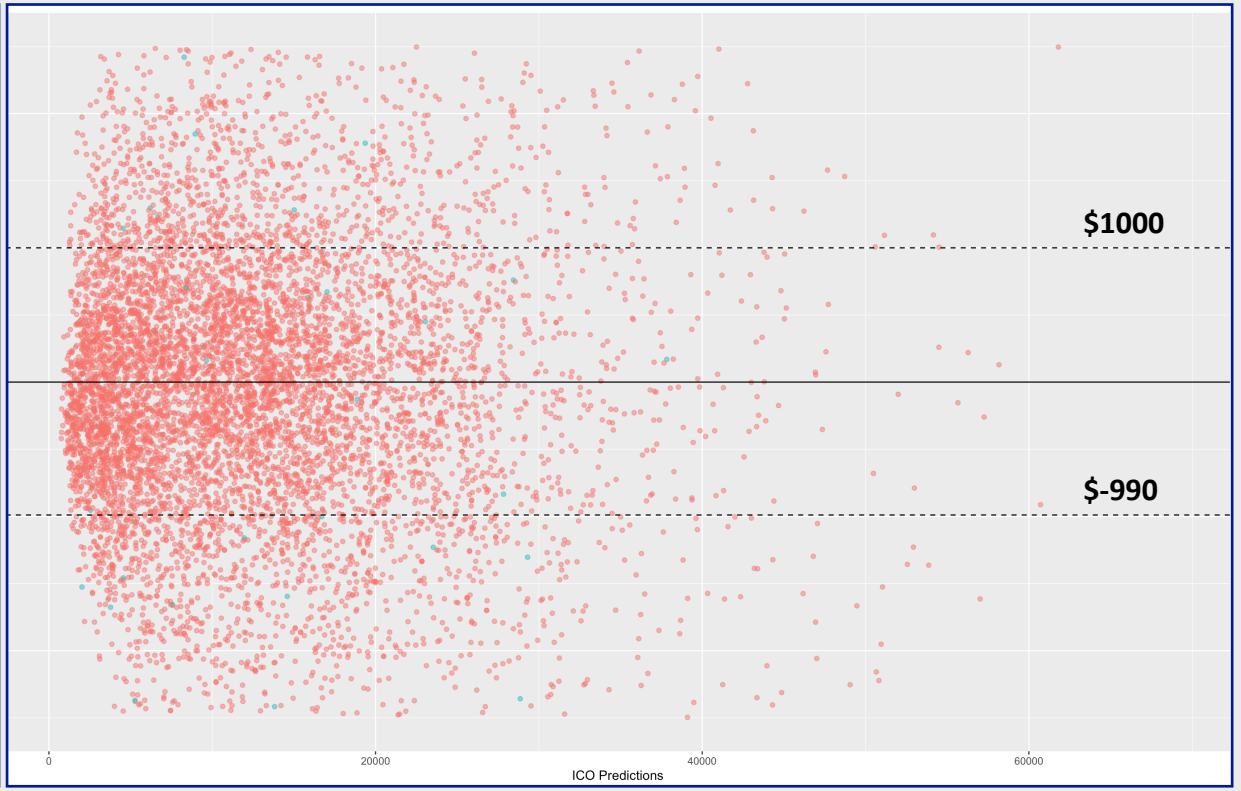
Average magnitude of errors is $1100

RandomForest

Average magnitude of errors is $990

Linear tends to make worse underestimate errors compared to the RandomForest





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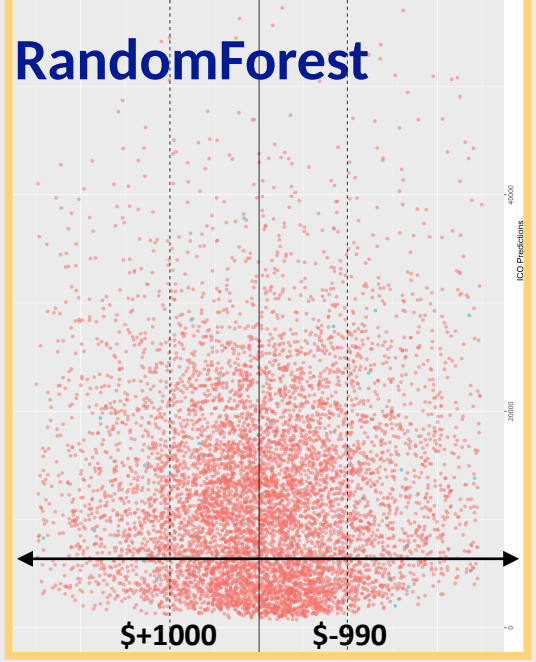
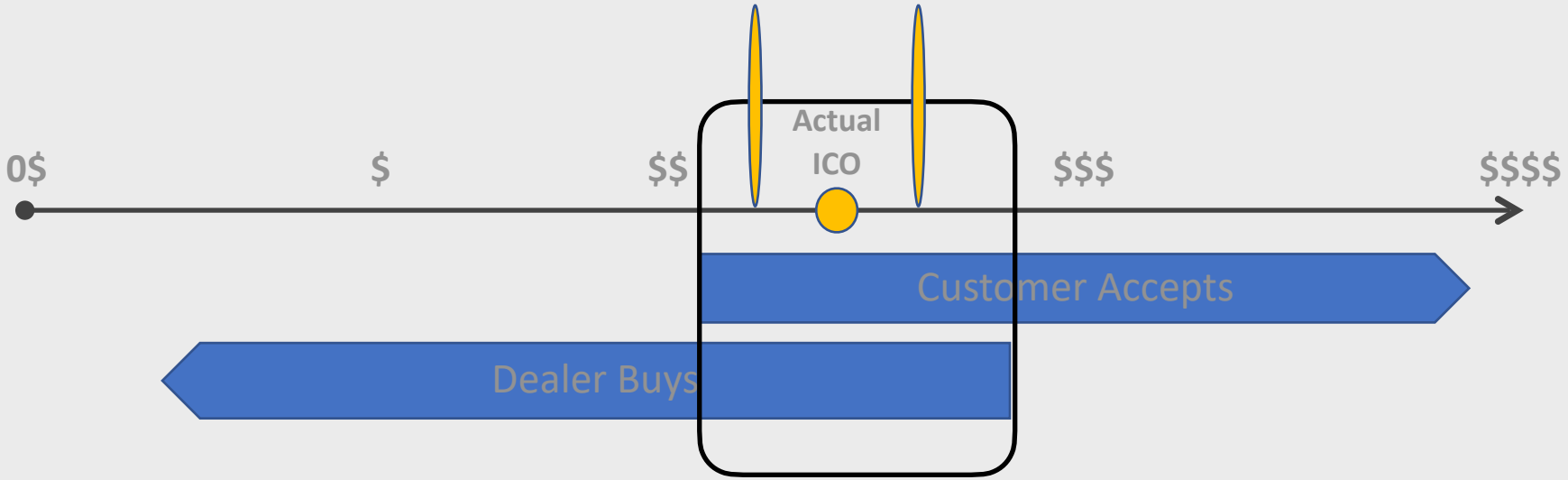
Predicting Dealer Buys



ICO = Instant Cash Offer

Actual ICO - Predicted ICO

(-) when **predicted > actual**
(+) when **predicted < actual**



Goal: Build a model to predict ICO values based on historical dealer buys.

Problem Overview

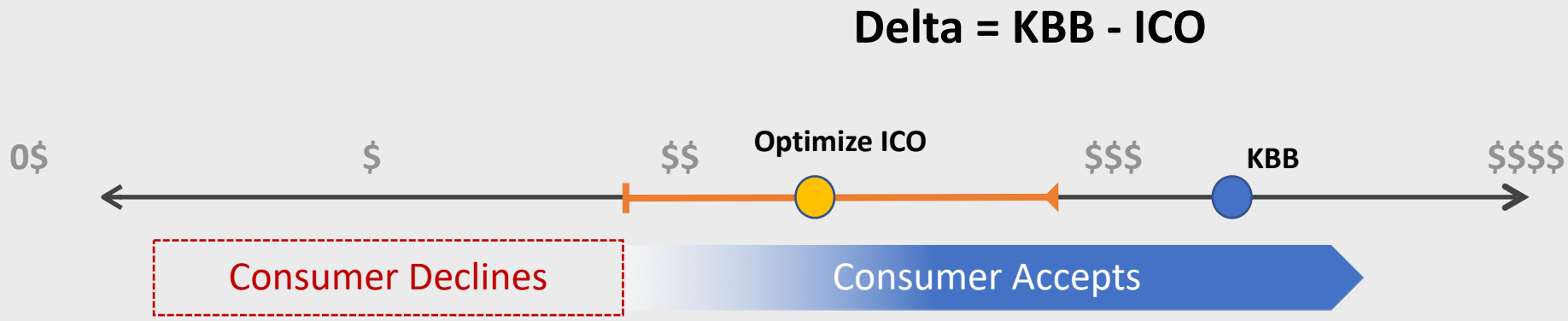
1. Instant Cash Offer (ICO) - **Prediction**

2. Instant Cash Offer (ICO) - **Optimization**

Part 2: Optimizing ICO

KBB = Kelly Blue Book

The market value of selling the car.

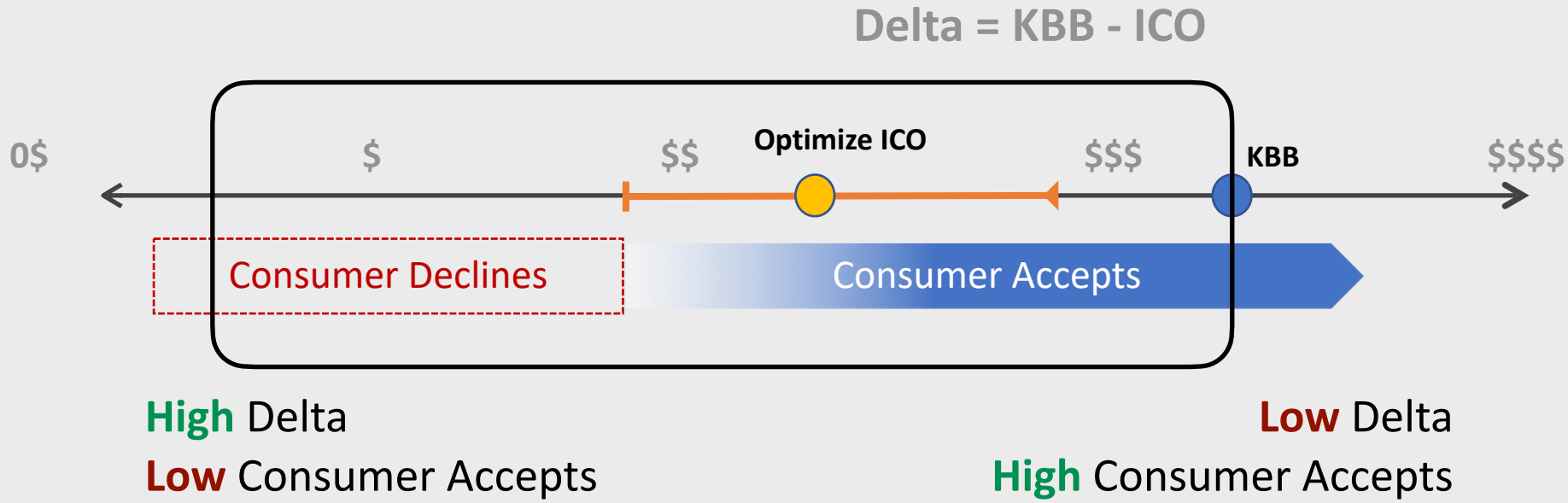


Part 2: Optimizing Dealer Profit

KBB = Kelly Blue Book

Formally:
Profit = Probability (accept | delta) * delta

Profit = *Probability Consumer Accepts * Delta*



Available Data

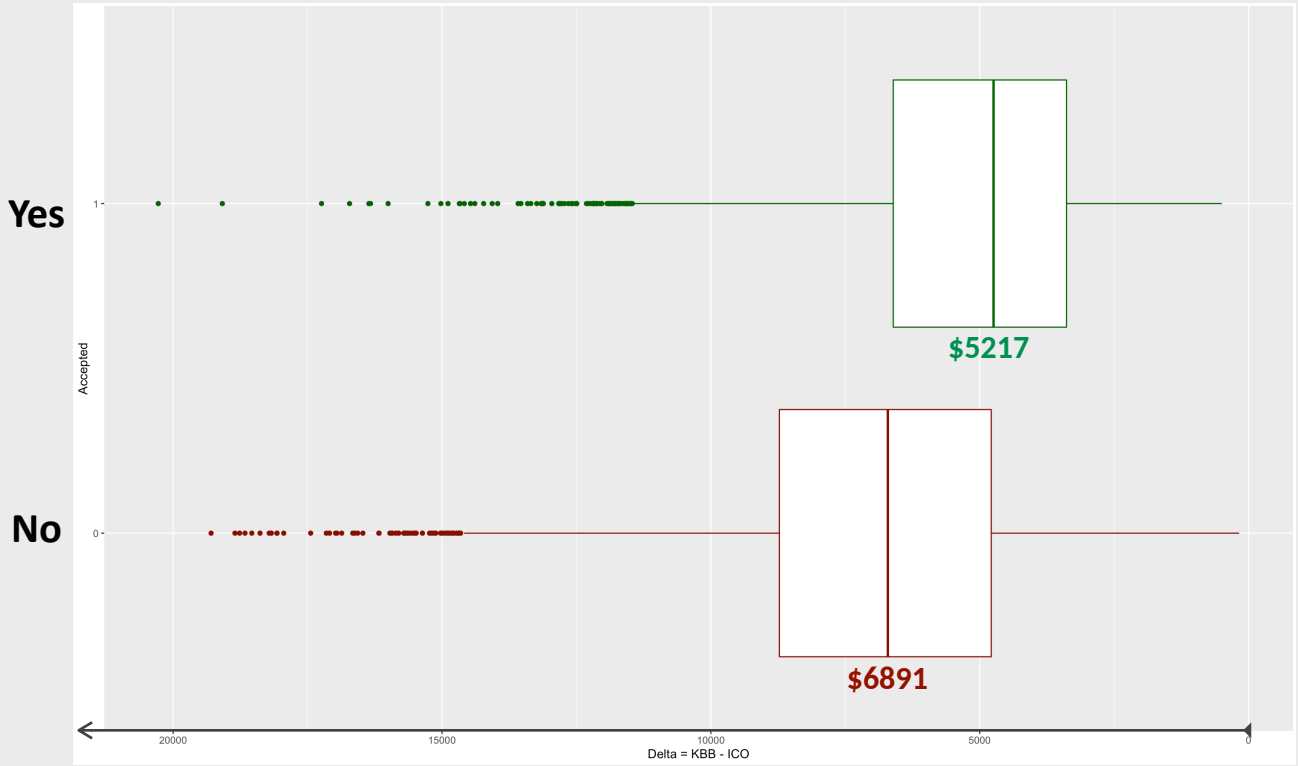
Dataset

	KBB	ICO	Accept
1	$	$	Yes
2	$	$	No
3	$	$	Yes
.	.	.	.
.	.	.	.
15243	$	$	Yes

> KBB - Market value of the car

> ICO - Offer made to Consumer

> Accept - Consumer accepted or not



Delta = KBB - ICO

> Consumers accepted ICO offers on avg* $5217 less than KBB

> Consumers did not accept ICO offers on avg* $6891 less than KBB

*avg is actually the median or 50% percentile of the data

Modeling Expected Profit

Expected Profit = Probability Consumer Accepts * Delta

Linear:

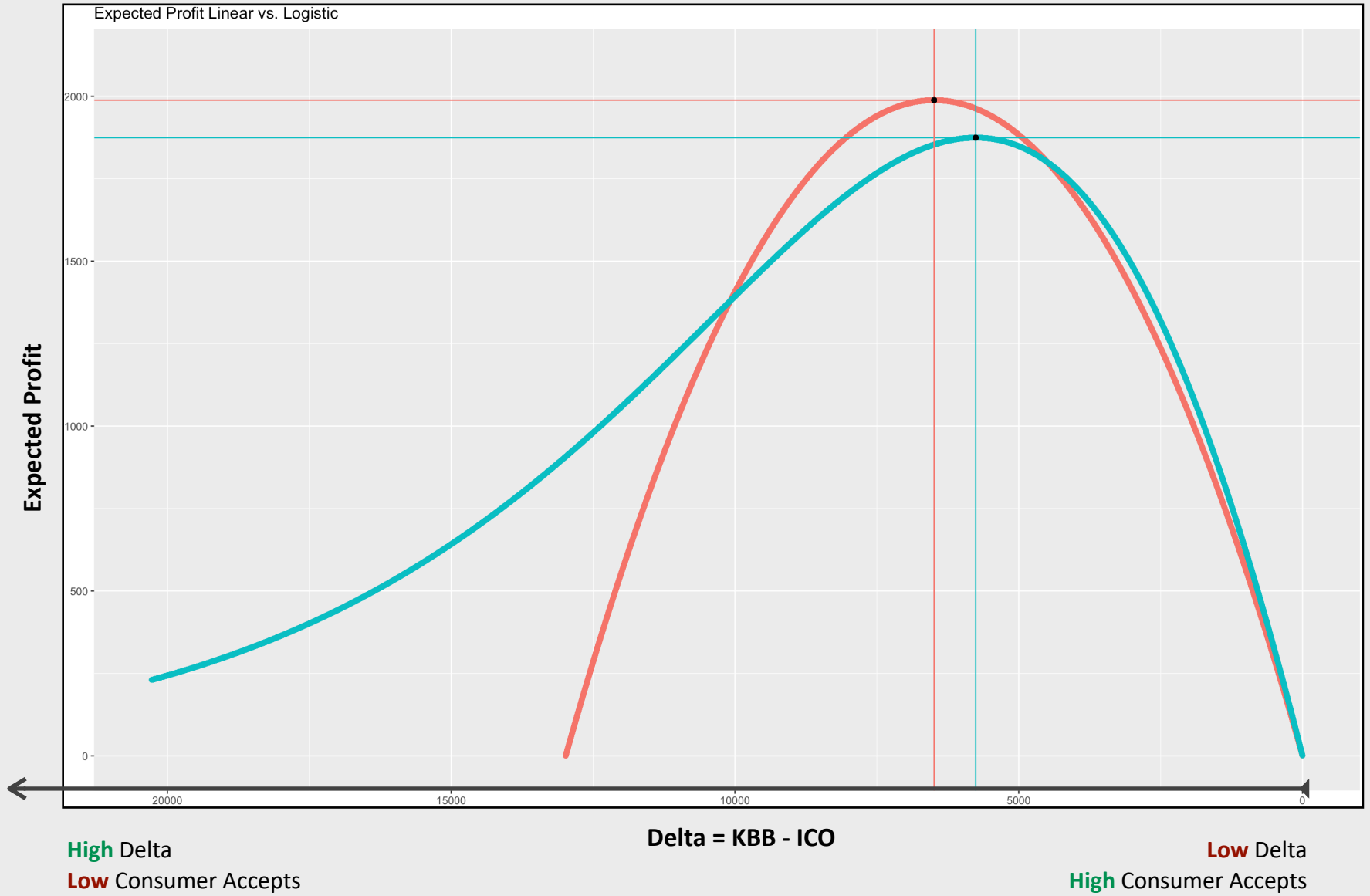
Delta = $6491
31% Chance of Accept

Expected Profit =
$1988.13

Logistic:

Delta = $5758
33% Chance of Accept

Expected Profit =
$1874.4



Part 2: Optimizing Dealer Profit & Minimizing Cox Risk

KBB = Kelly Blue Book

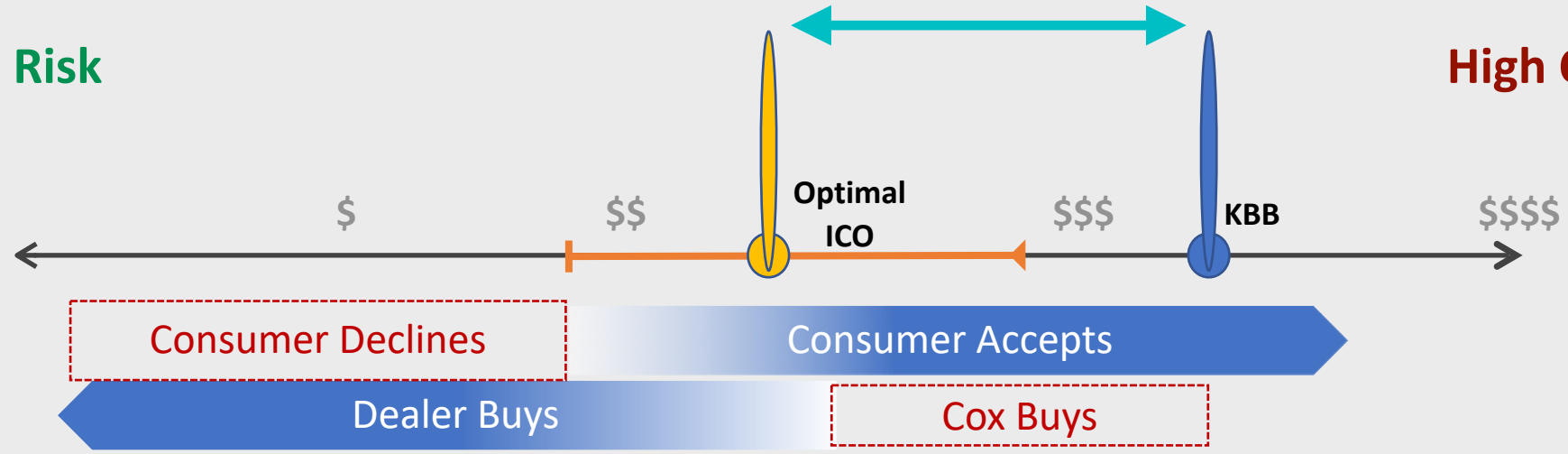
The market value of selling the car.

Delta = KBB - ICO

Dealer Profit & Low COX Risk

Logistic Model: Optimal Delta = $5758

Customer Cash & High COX Risk



Summary

1. Built **Prediction model** to predict ICO with error of **$1000 over/under.**

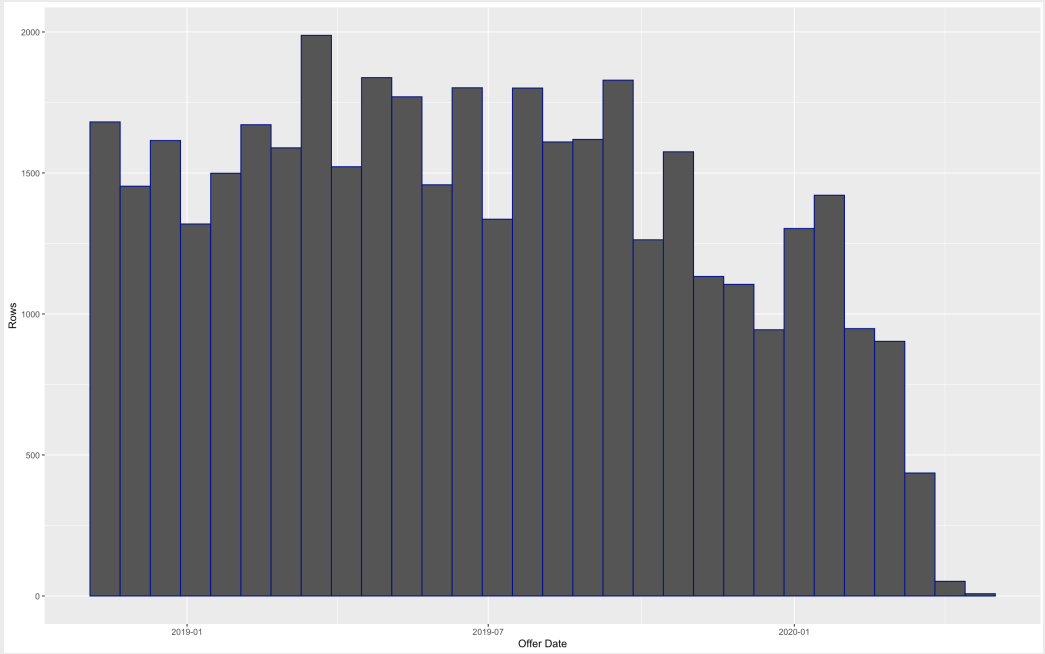
2. Fit **Optimization model** to show that predicted ICO should be moved so that it is **$5600 to $6000 less than KBB value**.

Questions

Back Up

Prediction Data

Number of rows over time



Nov 2018 April 2020

Trade in Value

quantile(df$trade_in_value)

0%	25%	50%	75%	100%
200	5900	11300	17700	97500

Why Logistic over Linear?

Linear:

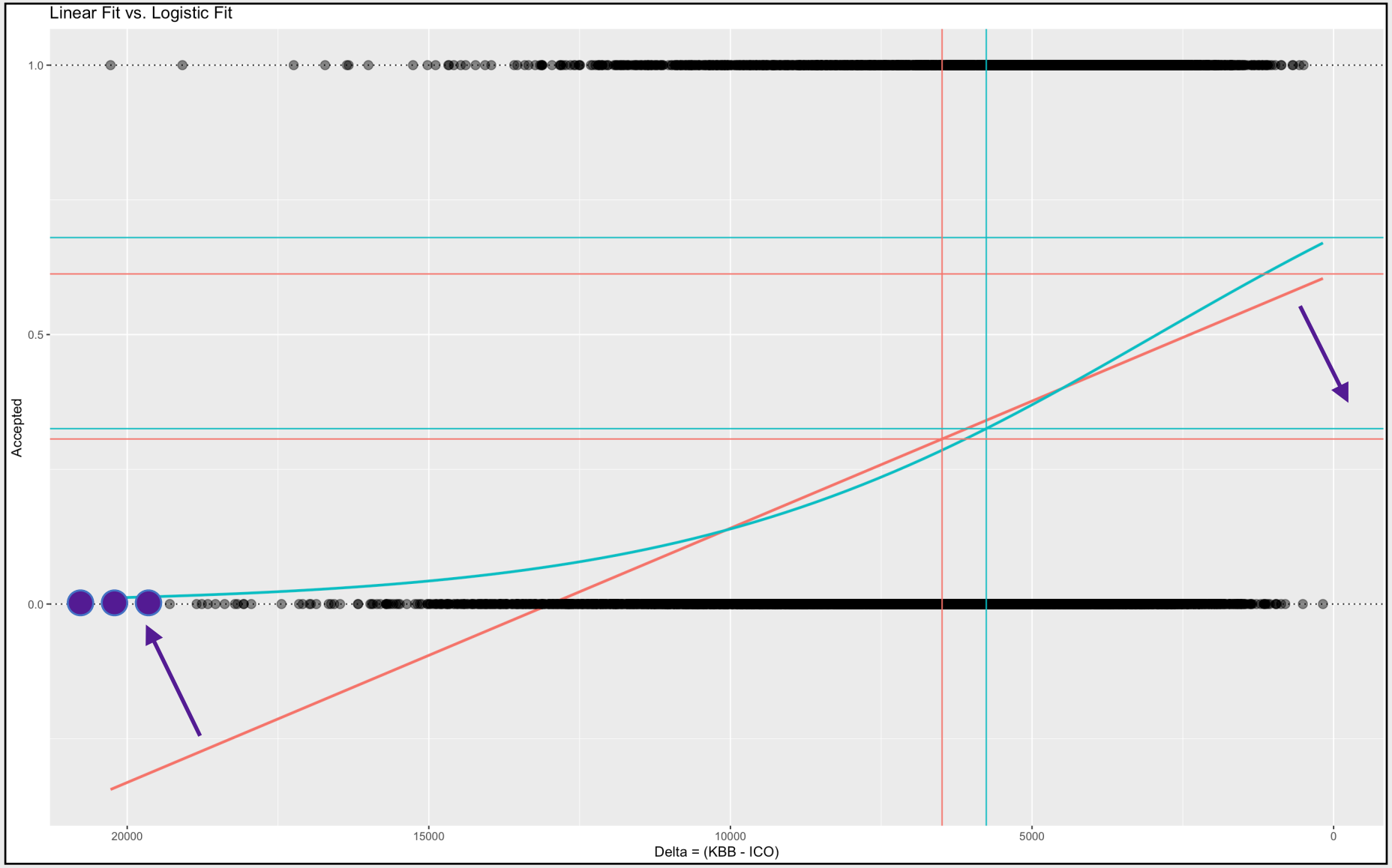
Delta = $6491

31% Chance of Accept

Logistic:

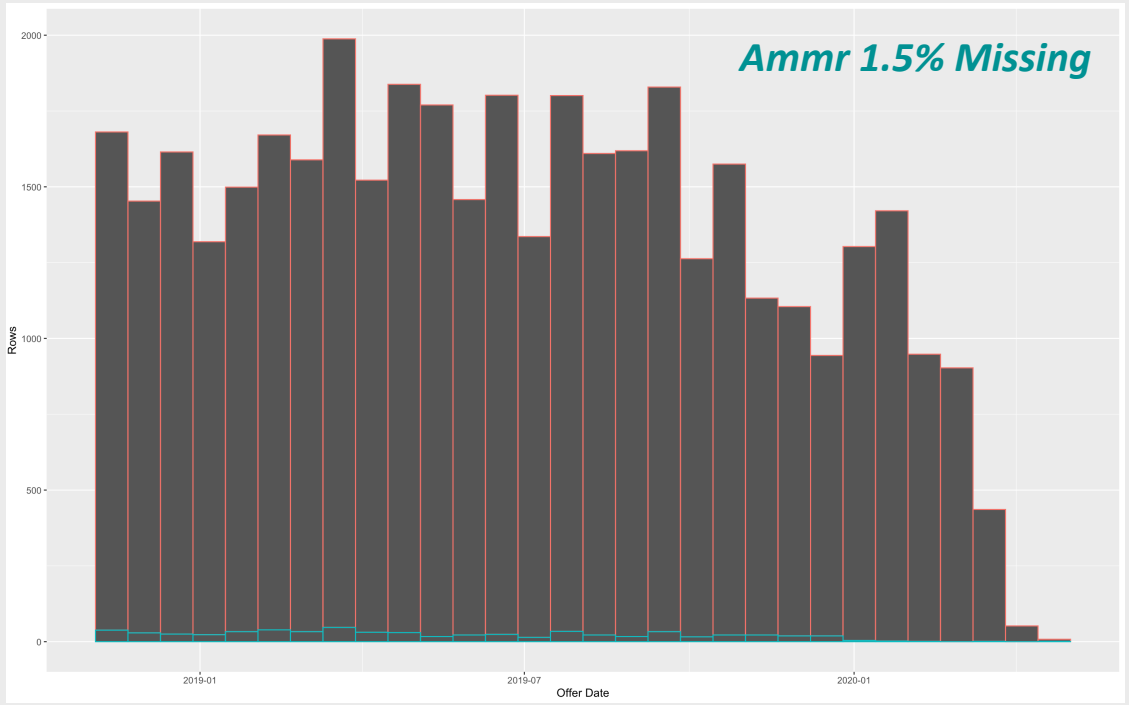
Delta = $5758

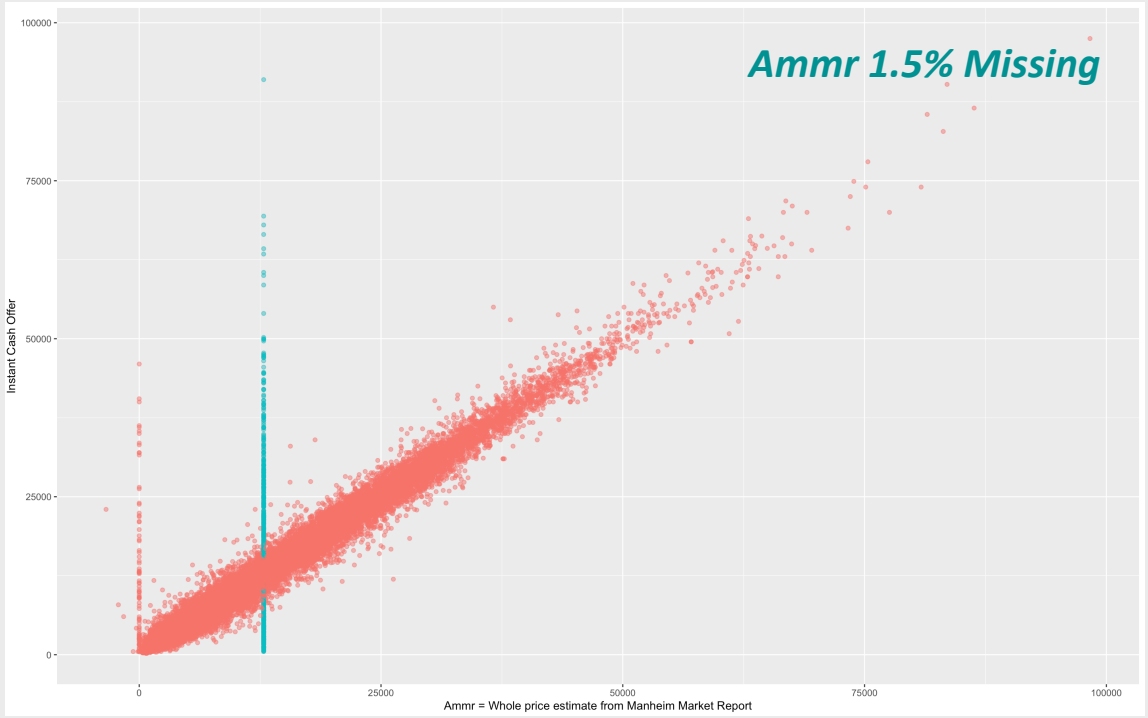
33% Chance of Accept



Prediction Data

Missing Values of strongest predictor Ammr





Part 2: Optimizing Dealer Profit & Minimizing Cox Risk

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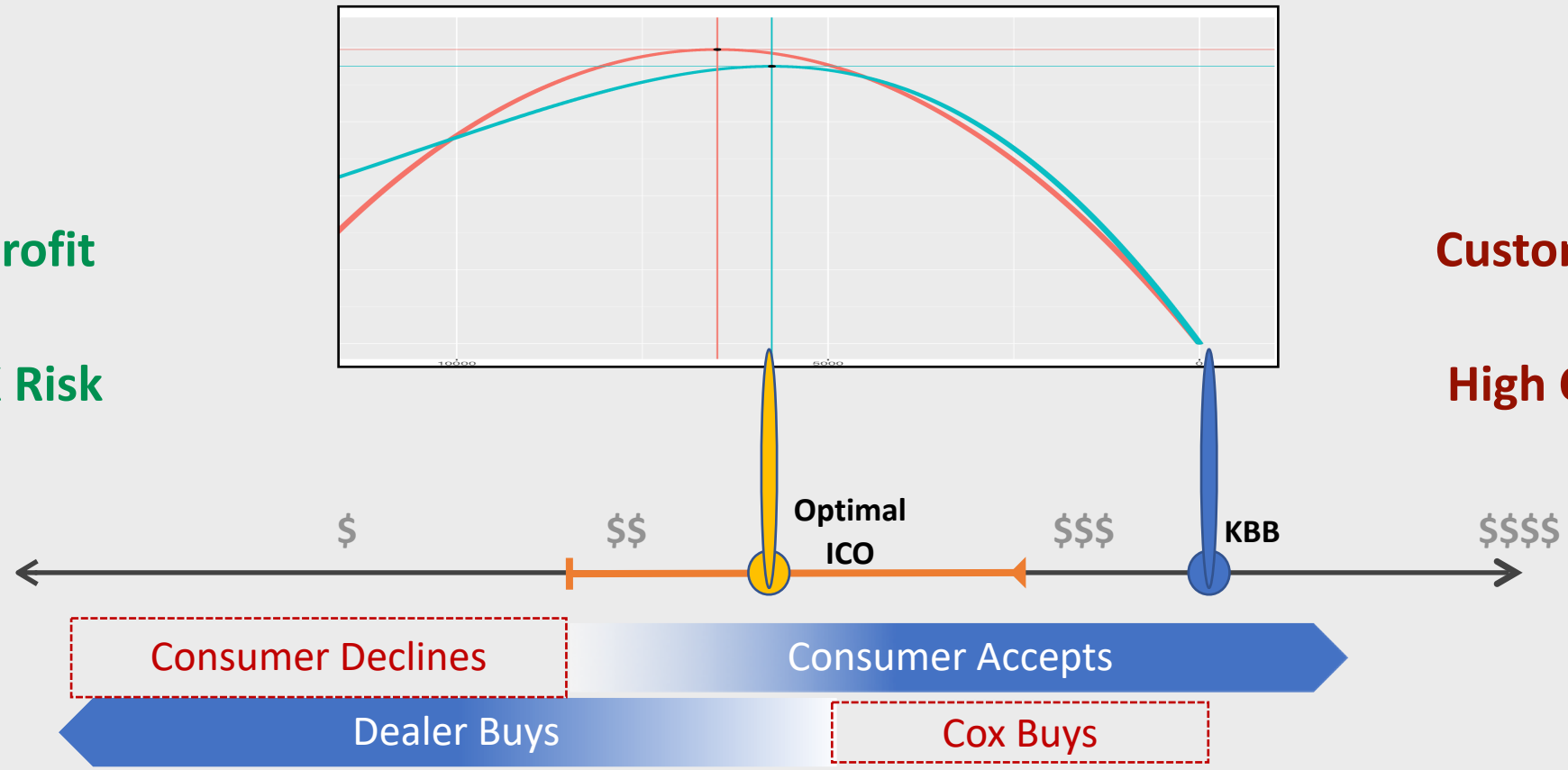
Dealer Profit & Low COX Risk



Customer Cash & High COX Risk

Confidence in Logistic

1. Sample data w/ replacement
2. Fit logistic model on sample
3. Extract coefficients
4. Plug into profit function derivative to get Delta value that maximizes profit.

P(accept|d) = 1 / e ^ -(a * d + B)

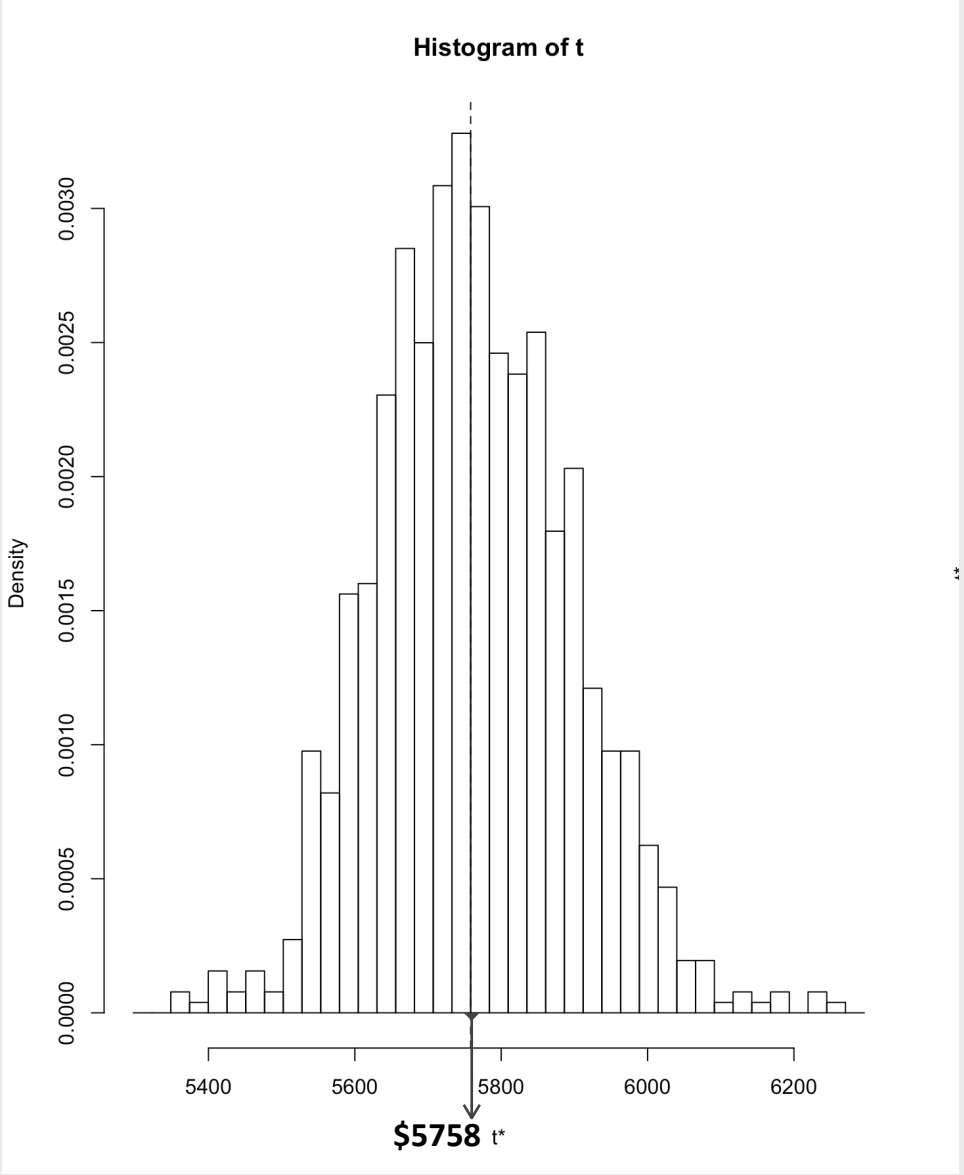
Profit = P(accept|d) * d

$$\frac{\partial}{\partial d}\left(\frac{d}{1+e^{-(a\,d+b)}}\right)=\frac{e^{a\,d+b}\left(e^{a\,d+b}+a\,d+1\right)}{\left(e^{a\,d+b}+1\right)^2}$$

= 0

https://www.wolframalpha.com/input/?i=derivative+of+d%2F%281+%2B+e%5E-%28ad%2Bb%29%29+wrt+d

Logistic:



Optimal Delta