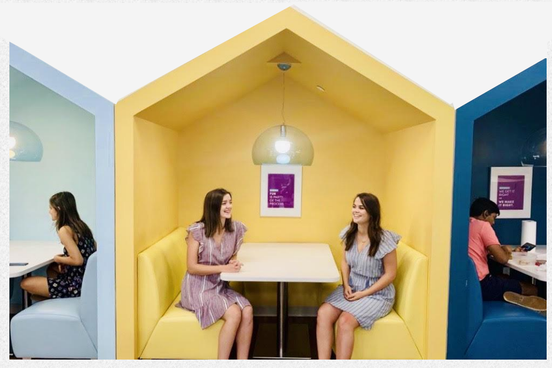
The Value of a Day:
Optimizing Delivery Time

by

Rachel Holmer
Lisa Walz



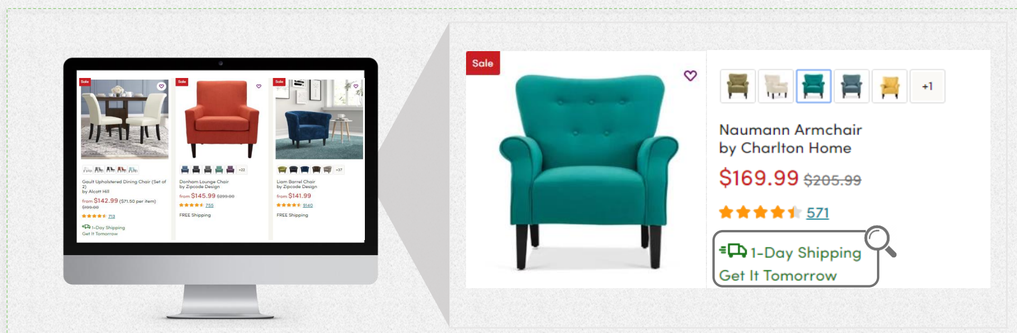
wayfair

Boston, MA, US

Ankit Mangal - Wayfair
Prof. Georgia Perakis - MIT
Divya Singhvi - MIT

PROBLEM STATEMENT

When should this chair arrive by?



Relevance: Shipping speed is a **crucial source of competitive advantage.**

Problem Definition
February – March

Data Acquisition & Feature Engineering
April - May

Instrumental Variable Regression
June - July

Optimization Framework
July – August

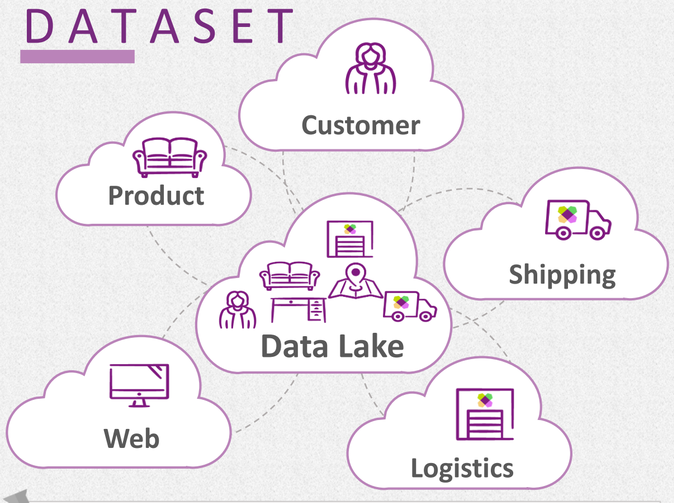
REVENUE VS. COST

1. **INCREASE IN IMMEDIATE SALES**
   *Measured by the **conversion rate.***
2. **INCREASE IN CUSTOMER LOYALTY**
   *Measured by the **Net Promoter Score.***
3. **EXPANDING CUSTOMER BASE**

1. **COSTS TO MEET FASTER SHIPPING PROMISE**
   *Measured by **truck utilization.***
2. **MISSED SHIPPING PROMISES**

We analytically **determine the optimal delivery speed** by **weighing the revenue and cost changes.** We **carve out the causal impact of deliver speed** and **optimize to make specific shipping recommendations** per customer group and product class.

DATASET



Data Scope
Limited data to large parcels in the US over 2018-2019
Conversion data captured at checkout page
Data from more than one million customers

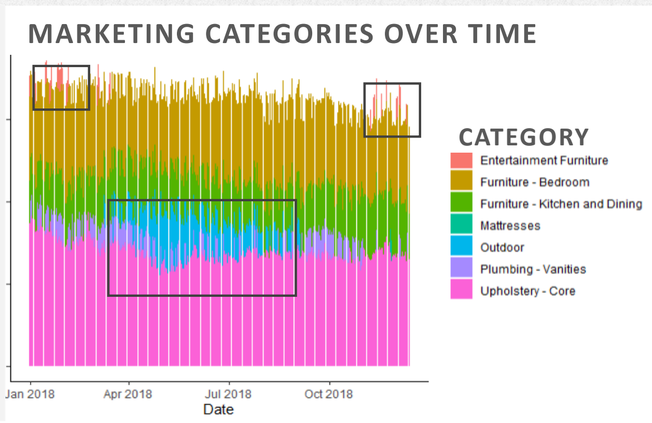
Dependent Variables
Conversion Rate, Net Promoter Score and Truck Utilization

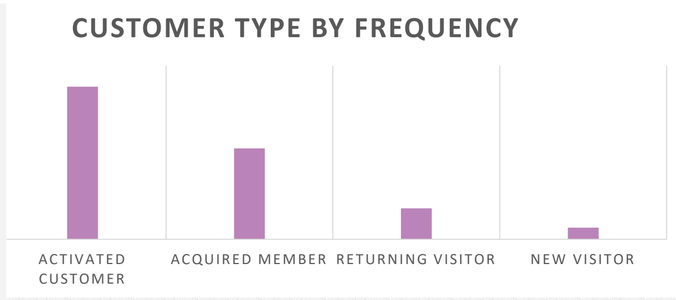
Independent Variables
Delivery promise*, Price, Quantity, Seconds on Site, SKUs viewed, Volume, Historical Visits* & Purchases*, Product Category, On-time*

Instrumental Variables
Distance to the warehouse * and whether supplier is part of Castle Gate network

Identification Variables
Session Date, Order ID, Product ID, SKU, Color ID, Event Session Key

*** Indicates feature engineered variables**





Outdoor furniture spikes in the summer months

Entertainment furniture spikes after Black Friday and Christmas

The most popular category is **upholstery**

Activated customers are the biggest group in our data

instrumental variable regression

PROBLEM

Conversion Rate ← Delivery Speed ← Controls

Unobservable

SOLUTION

Conversion Rate ← Delivery Speed ← Controls

Instrument

- **Causation ≠ Correlation**
- Instrumenting the delivery promise with a variable that is **exogenous** and **correlated with delivery speed**
- We used the **distance to warehouse and CastleGate supplier** as an instrument

RESULTS

Product type / customer segments see **significantly different effects** of delivery promise on conversion rate (see right)

Faster delivery speed significantly **increases conversion by 0.1% baseline** per day

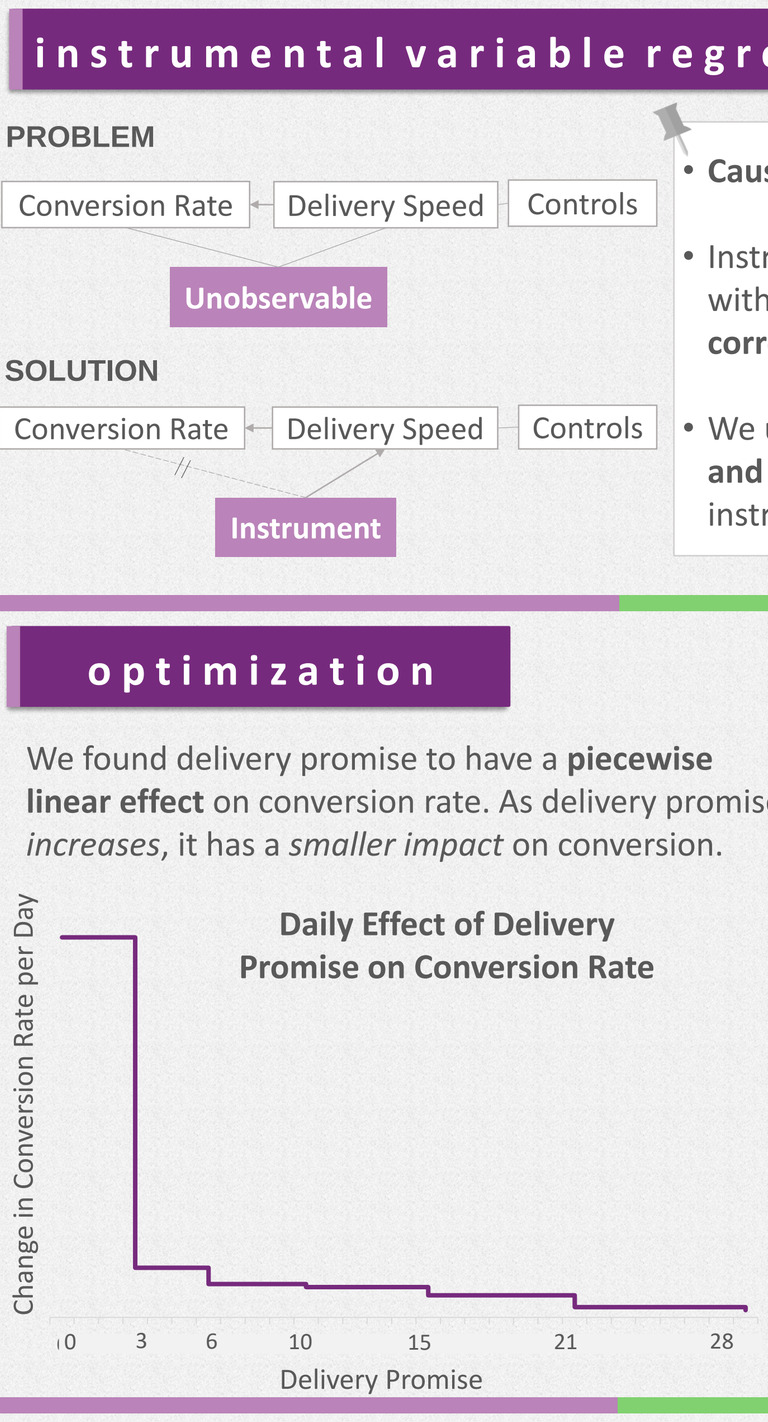
Lengthening delivery promise by one day **increases truck utilization by 0.23%**

	Activated Customer	Acquired Member	Returning Visitor	New Visitor
Upholstery	✓ 0.03%	✗	✓ 0.00%	✓ -0.04%
Bedroom	✓ 0.34%	✓ 0.21%	✓ 0.02%	✓ 0.06%
Kitchen	✓ 0.16%	✓ 0.29%	✓ 0.23%	✓ 0.42%

✓ *Significant Difference from baseline*
✗ *Insignificant Difference from baseline*

optimization

We found delivery promise to have a **piecewise linear effect** on conversion rate. As delivery promise *increases*, it has a *smaller impact* on conversion.



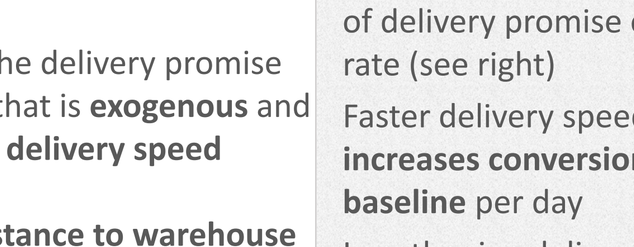
MODEL

We determine the optimal delivery promise for all customer segment / product pairs using **integer programming**

Maximize Profit

where profit = additional revenue due to conversion rate increase minus additional costs due to truck utilization decrease

By selecting first delivery promise bucket & then specific delivery promise



Example Decision: 4 day delivery promise

RESULTS

	Activated Customer	Acquired Member	Returning Visitor	New Visitor
Upholstery	6 Days	5 Days	6 Days	3 Days
Bedroom	4 Days	5 Days	4 Days	5 Days
Kitchen	5 Days	4 Days	5 Days	3 Days

Wayfair should **prioritize** decreasing delivery promise for **new visitors** because there are larger gains to be made

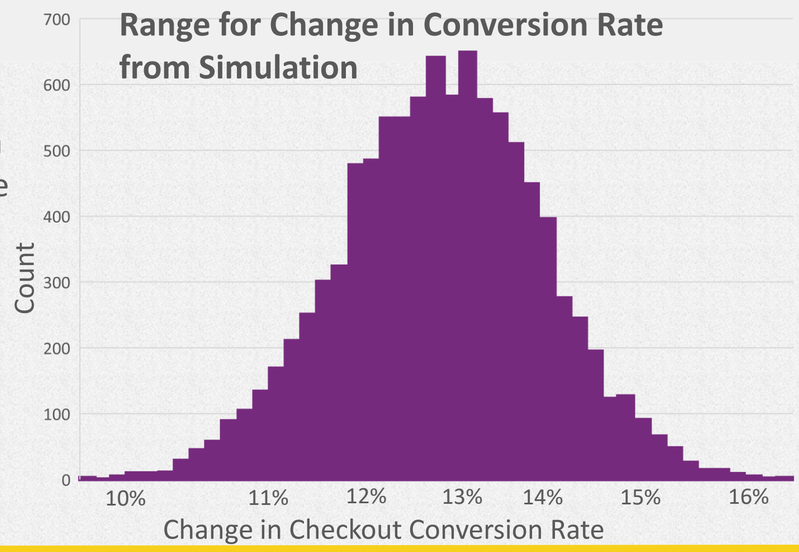
Among the different customer segment / product pairs, we see a maximum **10% increase in conversion rate** (for customers who reach the checkout page)

SIMULATION

We **simulated instances of online shopping** to **account for customer variability** and determine a range of expected increase in conversion rate (see right)

The **minimum lift** Wayfair can expect to see is **10%,** which aligns with the optimization output**,** and the **maximum lift** is **16%**

The distribution of checkout conversion rate increase is approximately normal, with the **expected lift in conversion rate being 13%**



CONCLUSIONS & NEXT STEPS

By using our framework, Wayfair will realize an increase in checkout conversion rate of **approximately 13%,** which translates to an **overall conversion rate lift of 0.5%**

Wayfair will be able to quickly **make data-driven decisions** about shipping speed using the methodologies we have developed this summer

The framework we have developed (IV regression & optimization) can be expanded upon in a few ways: more in-depth transportation costs incorporated, adding long-term loyalty benefits, etc.