Incentivizing No-Rush Delivery in Omnichannel Retail

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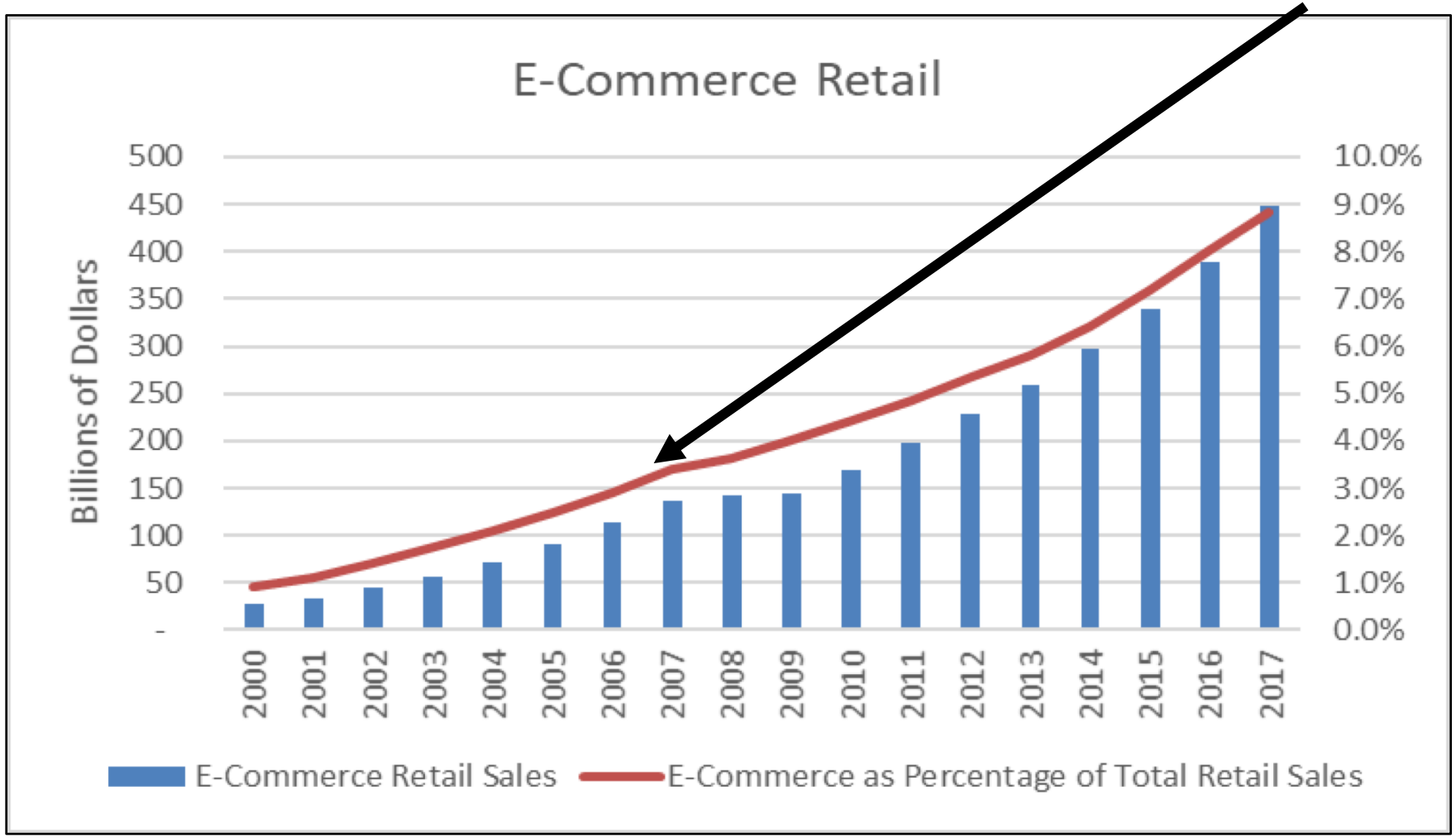
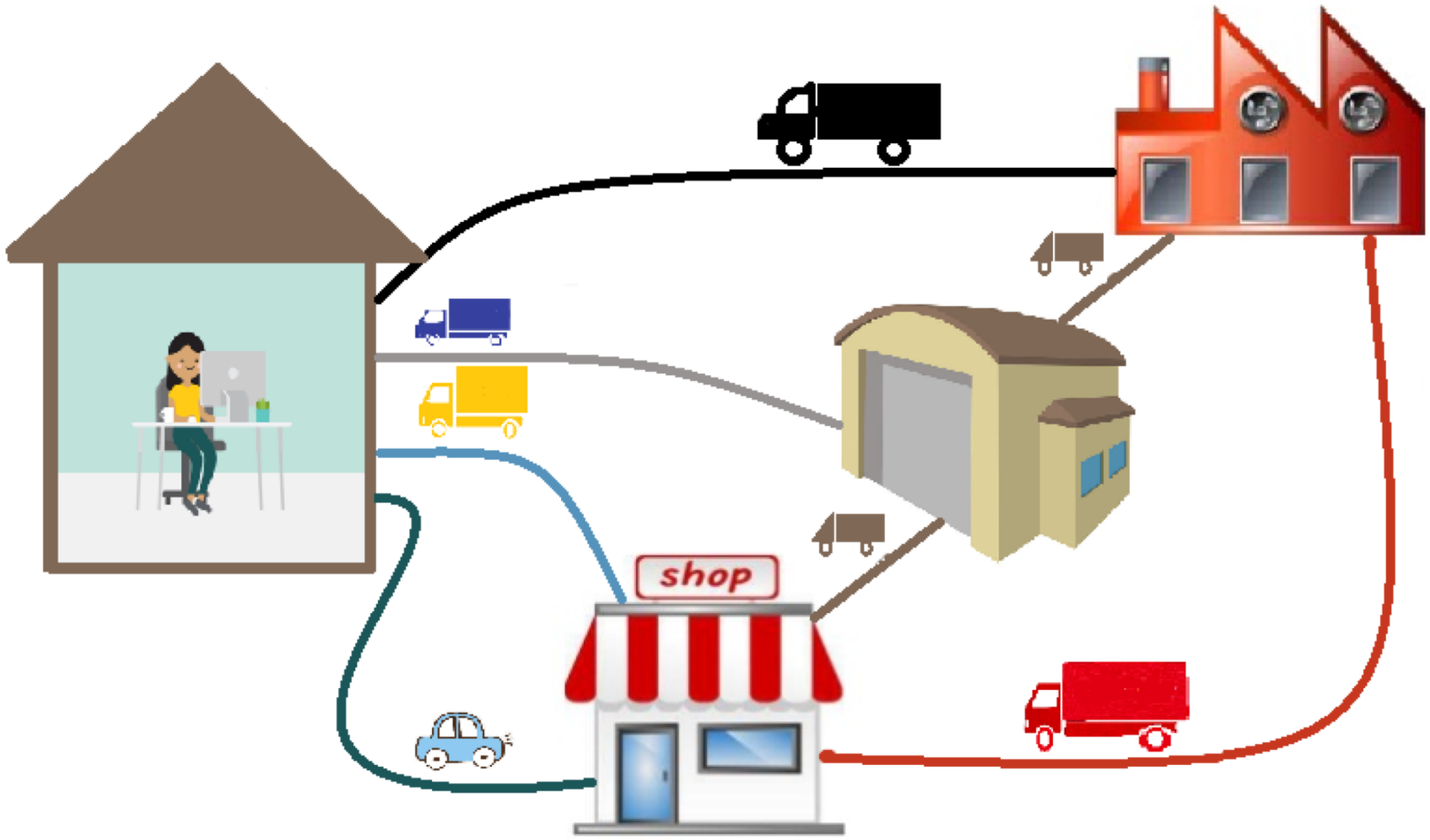
E-commerce Sales in the United States

Introduction of the Smart Phone.
iPhone released in 2007



(SSSD, 2019)

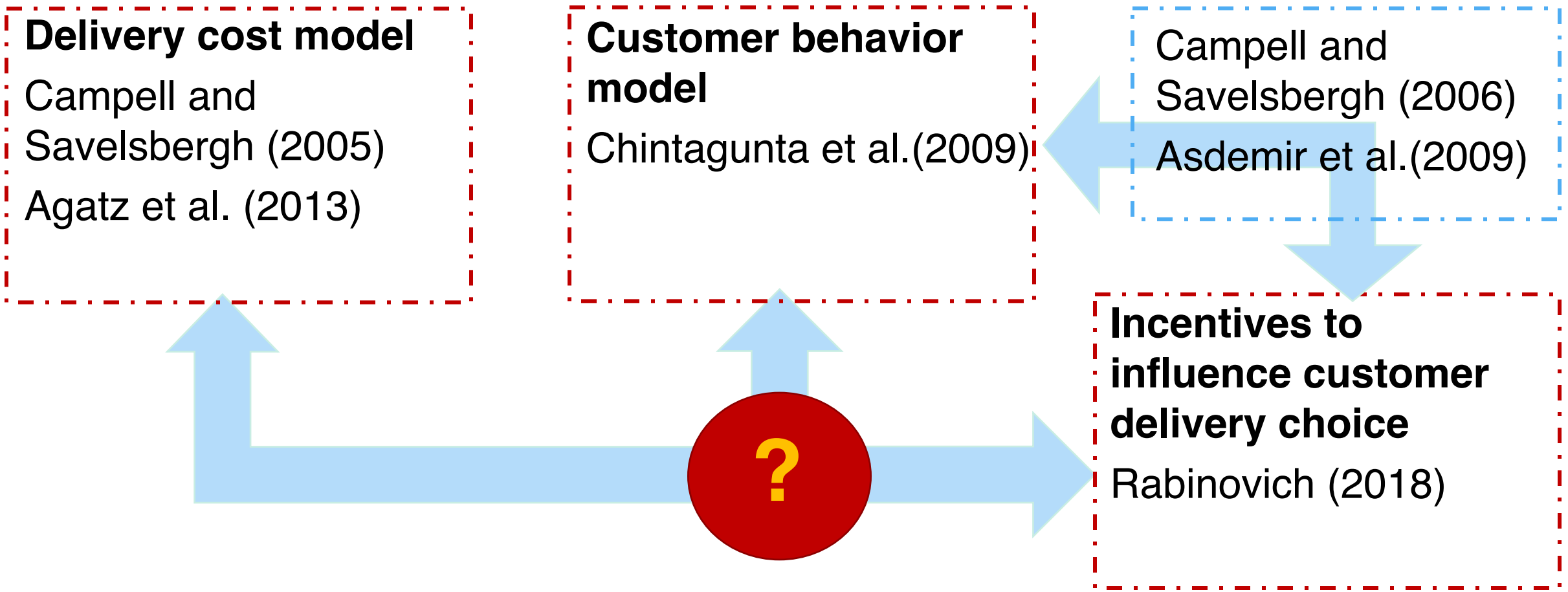
The Face of the Retail Industry Is Changing



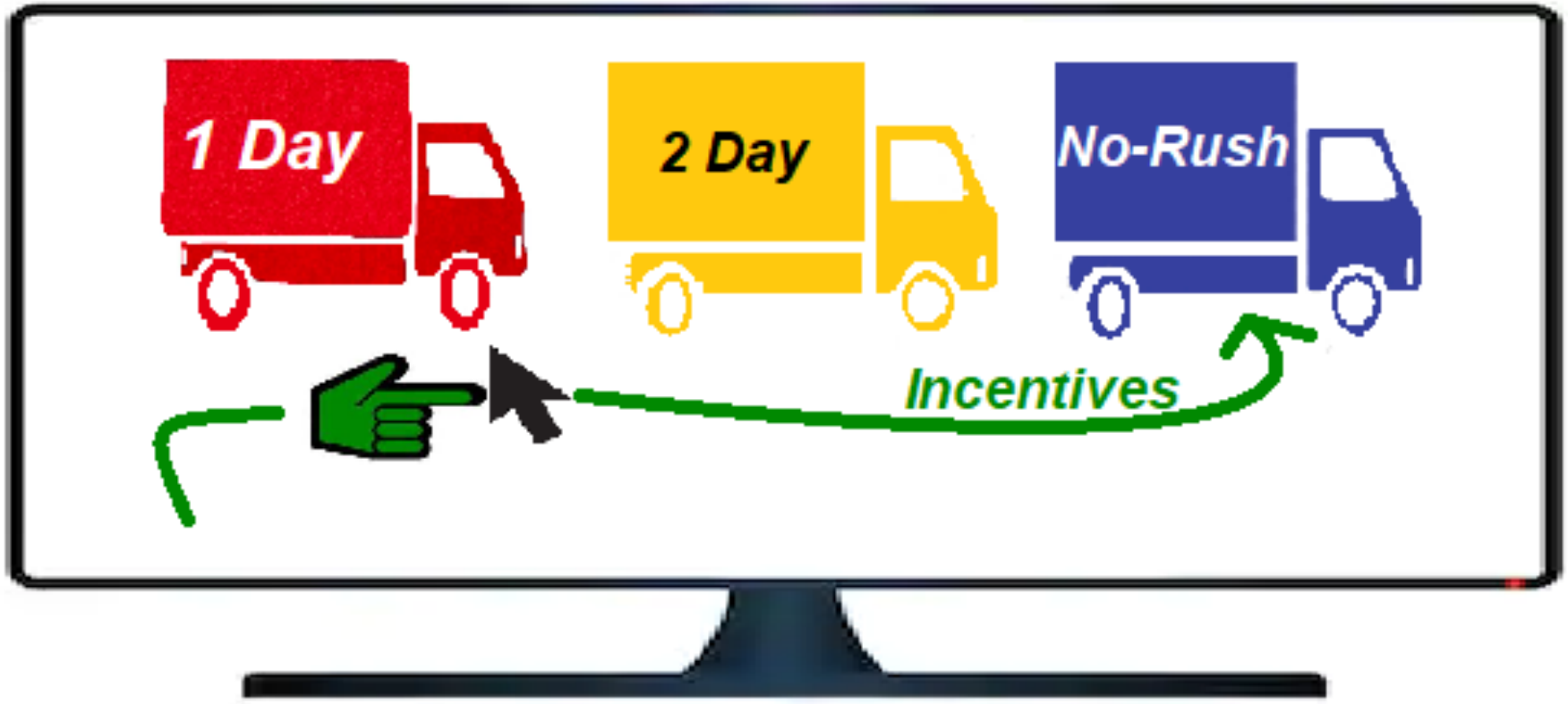
Logistics costs in 2017 represented 7.7% of the US GDP with transportation costs adding up to 64.6% of total logistics costs

(Gilmore, 2018)

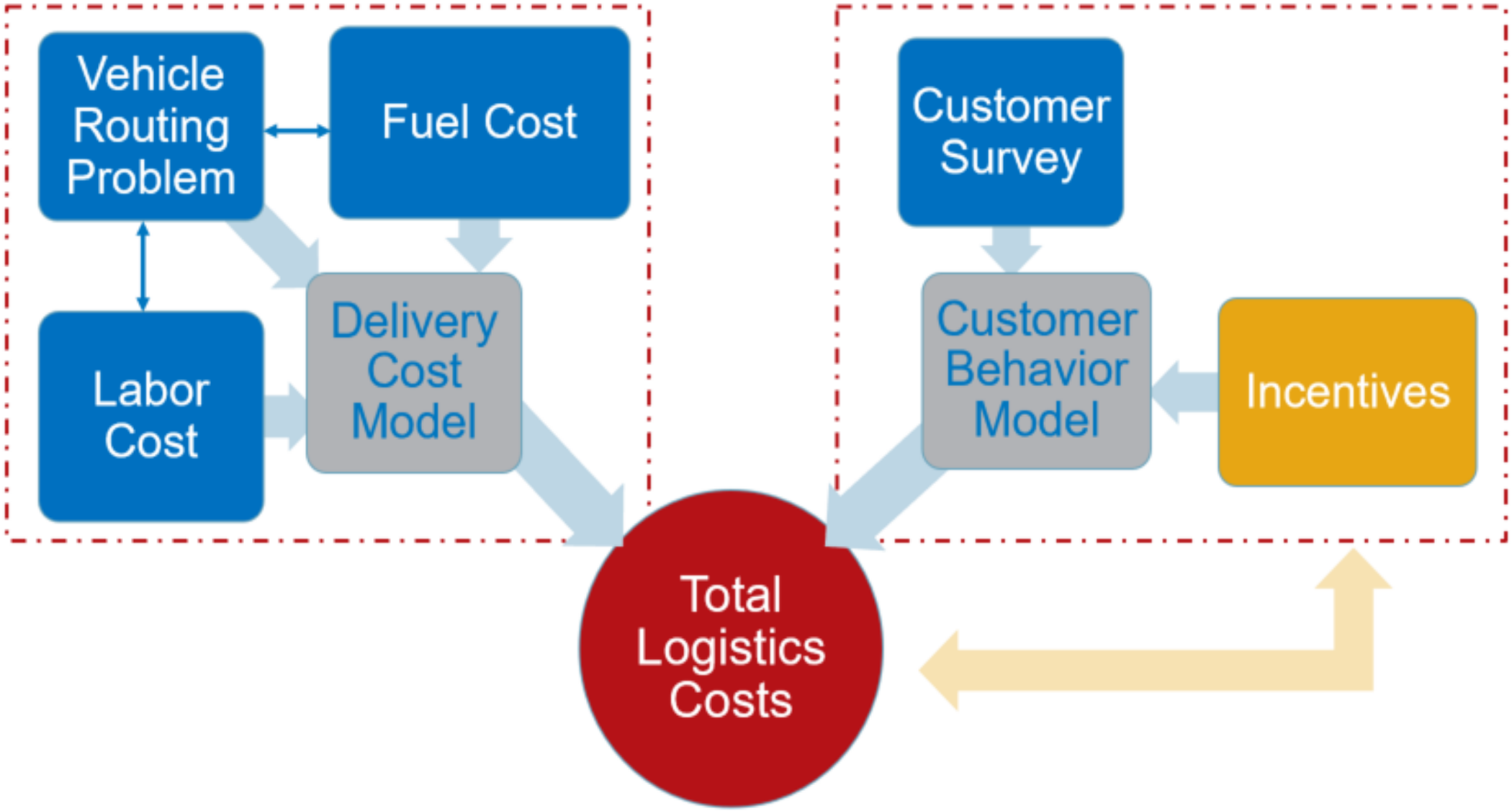
Previous work does not study the connection between a detailed delivery cost model and a customer behavior model



What are the right incentives to motivate customers to choose no-rush delivery and minimize total logistics cost?



Methodology



Consumer Survey

1. Pre-Questions

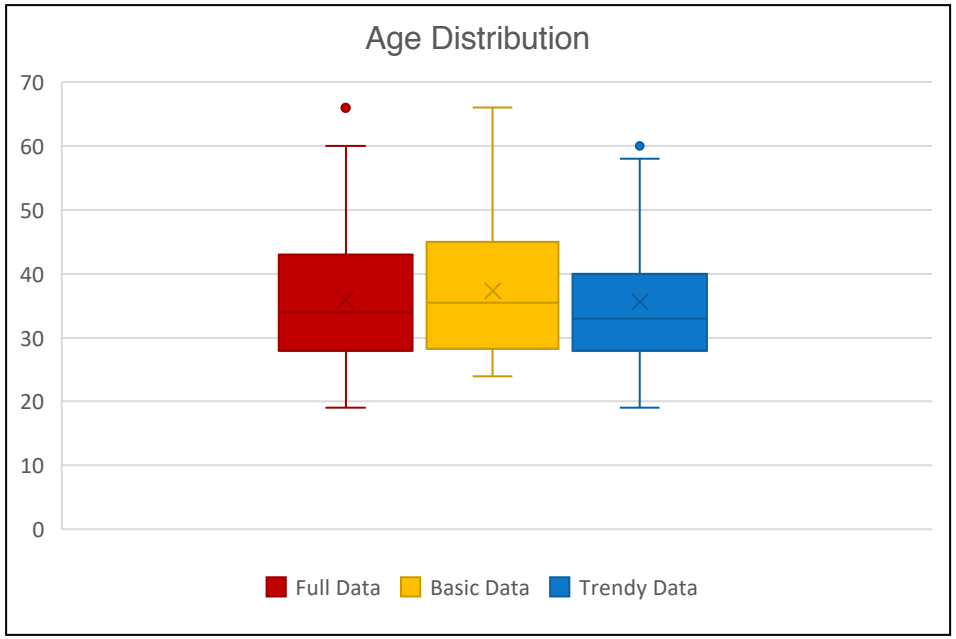
2. Experimental Question:

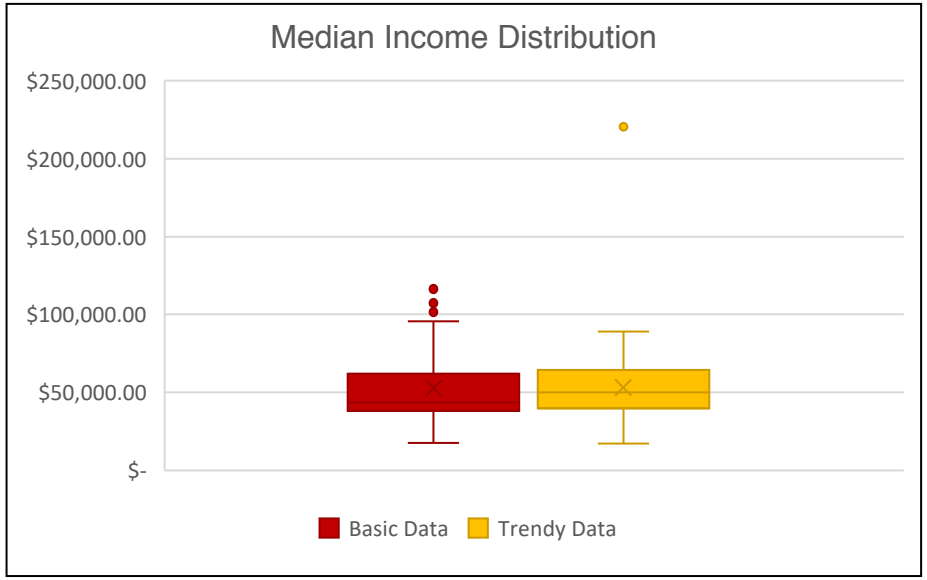
Imagine you are shopping online at your favorite fashion retailer.
You are purchasing a basic item (the latest trendy item) for $40.
You are ready to check out

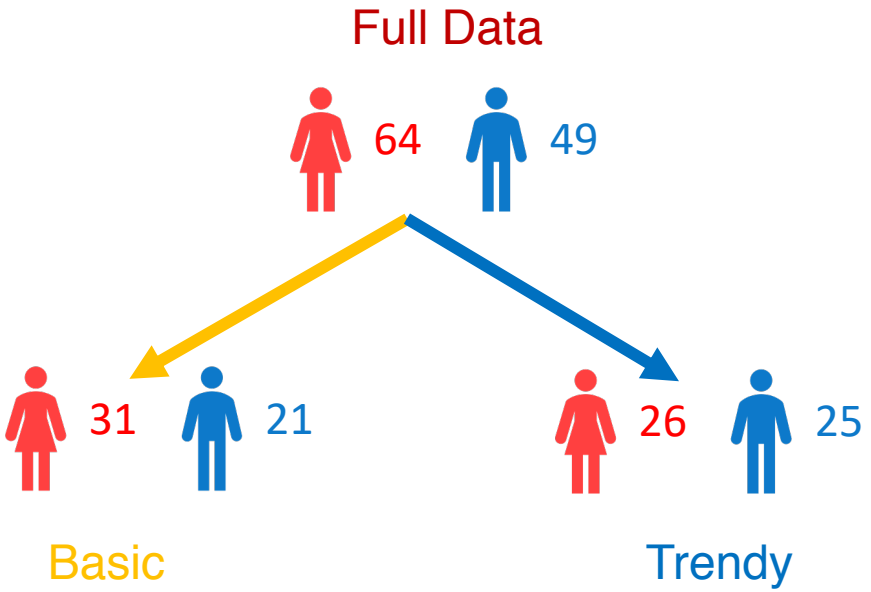
Standard Shipping (2 days)
No-Rush Shipping (7 days) (you will receive $5/$10 off your order)

3. Demographic Questions

Survey Data







The data was randomly split into two groups for analysis in Basic and Trendy Models.

Difference between the two groups was showed to be statistically insignificant with ANOVA:
F=1.63 < Fcrit=3.85
P=0.20 (tested at 0.05)

Customer Behavior Model: Linear Regression

Target Variable:
Lead Time

Experimental Variable:
Incentive

Control Variables:
Normal Shopping Frequency
Usual Shipping Lead Time
Gender
Employment Status
Age
Income

Customer Behavior Model: Linear Regression Results

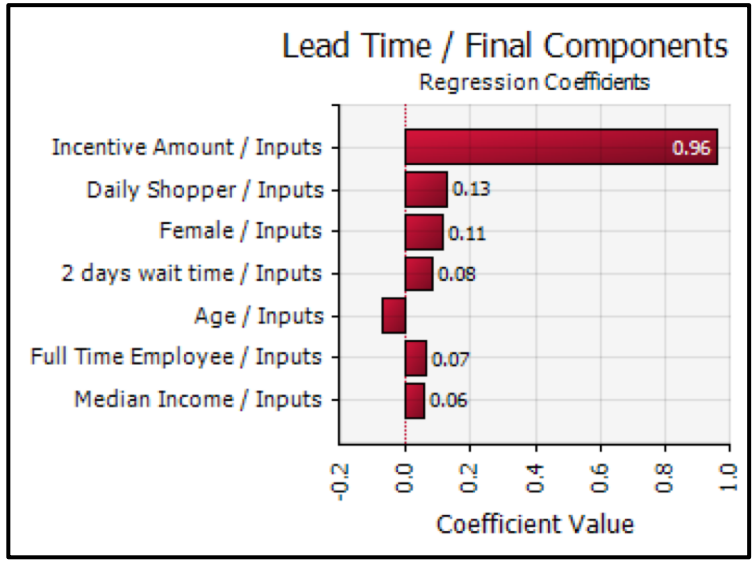
	Basic		Trendy	
	Coefficient	P-Value	Coefficient	P-Value
Days/$ incentive	0.85	1.125E-06	0.88	1.655E-07
Days for daily shopper	-1.32	0.146	-1.06	0.244
Days for weekly shopper	-1.27	0.143	-0.87	0.186
Days for biweekly shopper	-0.09	0.915	-0.19	0.725
Days for monthly shopper	-1.28	0.083	-0.08	0.871
Days for yearly shopper	-0.84	0.229	-0.01	0.989
Days for usual wait time of 2 days or fewer	-1.76	0.115	-1.44	0.041
Days for usual wait time of 3-6 days	-1.48	0.139	-0.15	0.793
Days for usual wait time of 7 or more days	-1.56	0.218	-0.62	0.291
Days for female	0.15	0.873	-0.80	0.161
Days for male	-1.31	0.135	-1.41	0.009
Days for full-time employees	0.58	0.353	1.46	0.091
Days for part-time employees	0.62	0.414	1.81	0.069
Days for students	2.12	0.031	1.87	0.133
Days for dependents	-1.35	0.008	0.72	0.205
Days/year	0.02	0.333	-0.02	0.458
Days/$ earned	2.08E-05	0.047	5.81E-06	0.531
Intercept	-1.16	0.496	-2.21	0.025
R^2	0.67		0.67	

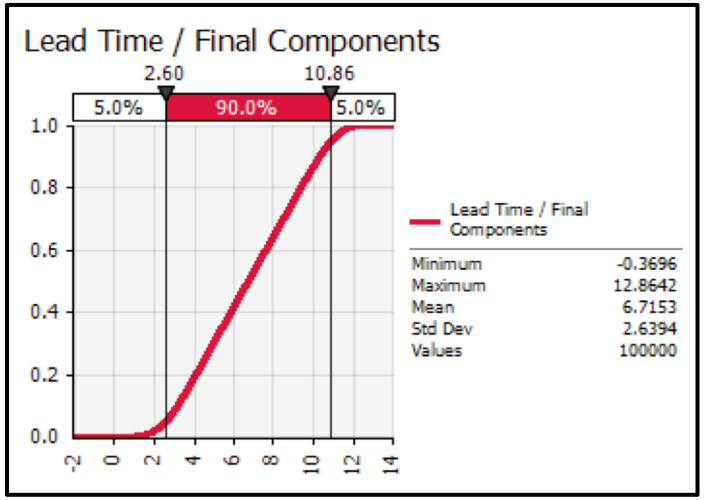
Basic Model:
0.85 days/$ = $1.18/day

Trendy Model
0.88 days/$ = $1.14/day

Sensitivity Analysis

Probabilistic model was developed and run for 100,000 iterations using Monte Carlo algorithm





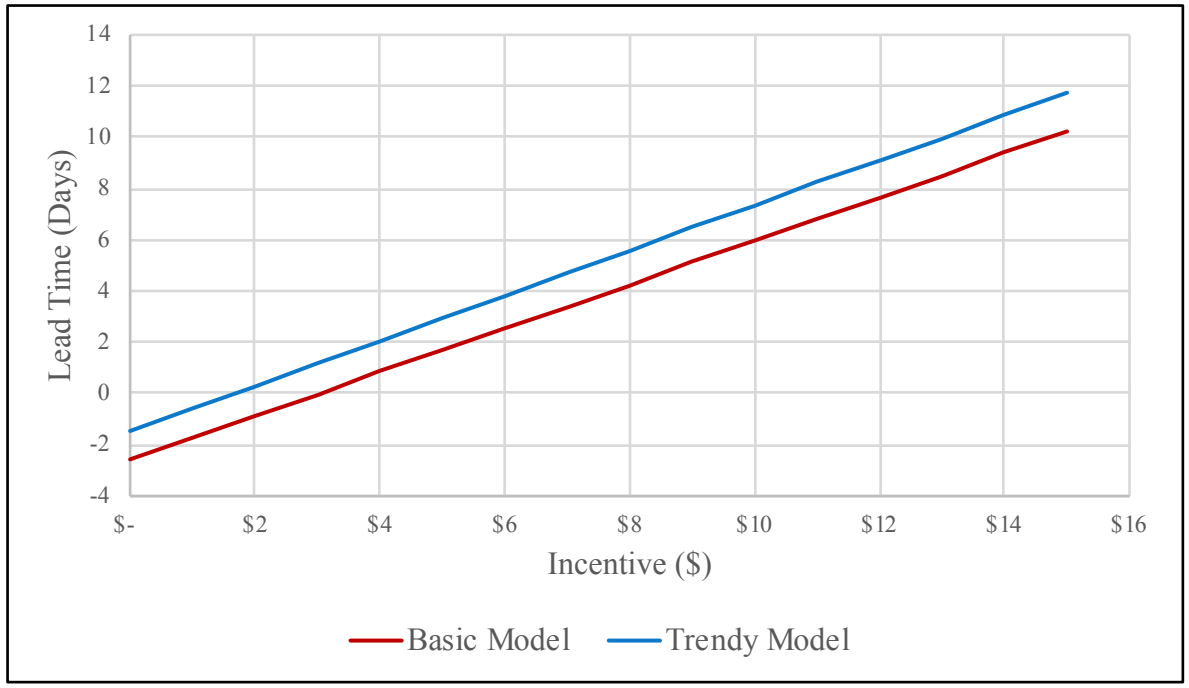
Incentive is the most sensitive input to the lead time.

People who shop more often are more responsive to monetary incentive.

Gender has an effect on the choice of lead time

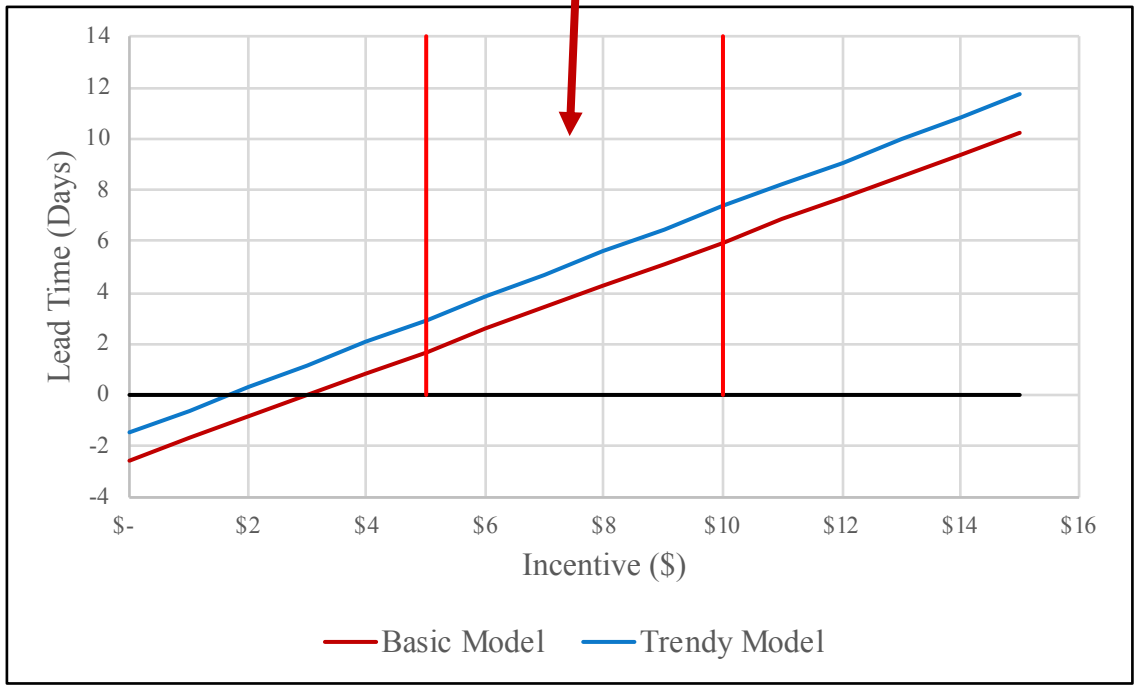
Older people respond less to monetary incentive.

Incentives for the Average Consumer

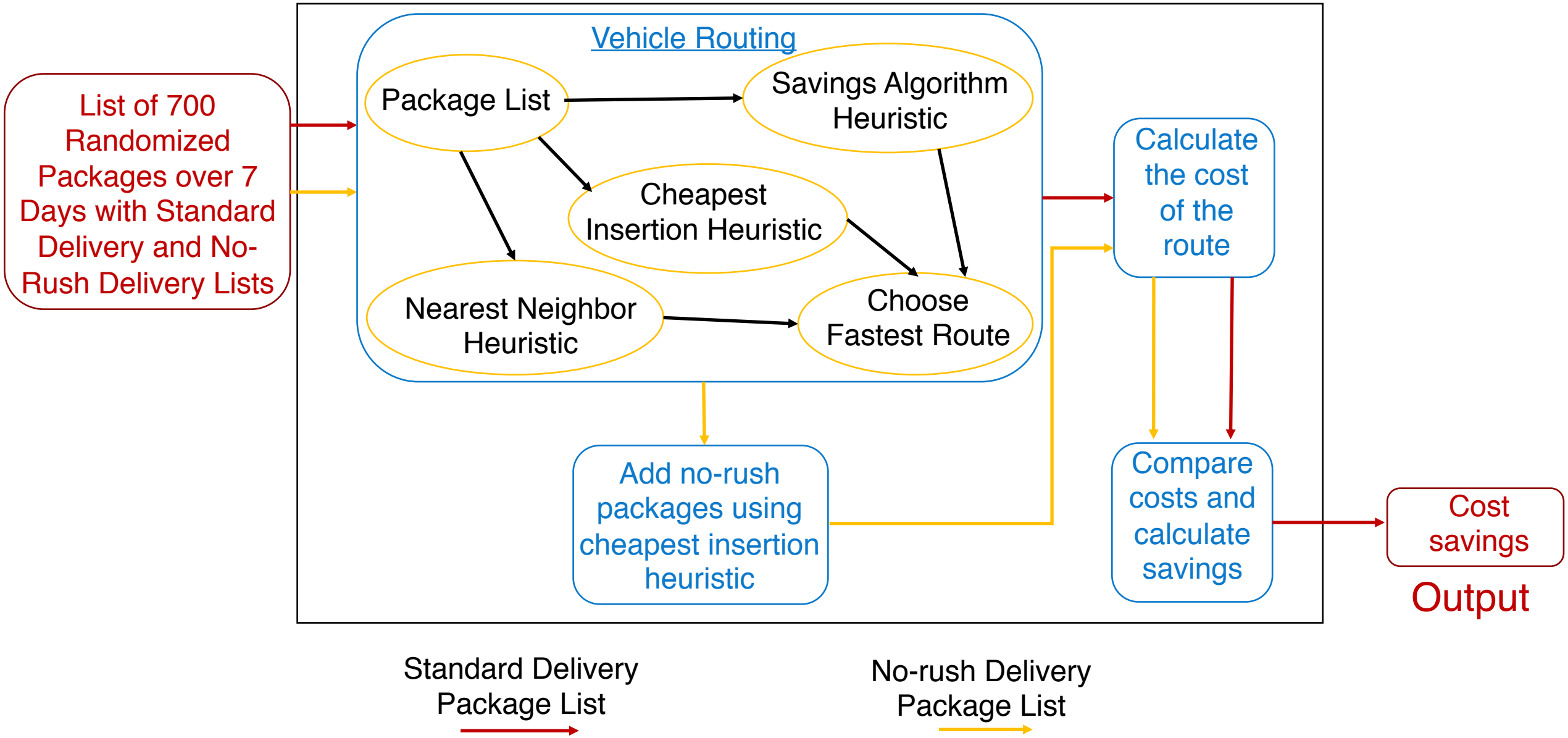


<u>Average Survey Respondent</u>:
-Female
-36 years old
-Works Full Time
-$53,120
-Has dependents
-Monthly Shopper
-Usually receives packages in 3-6 days

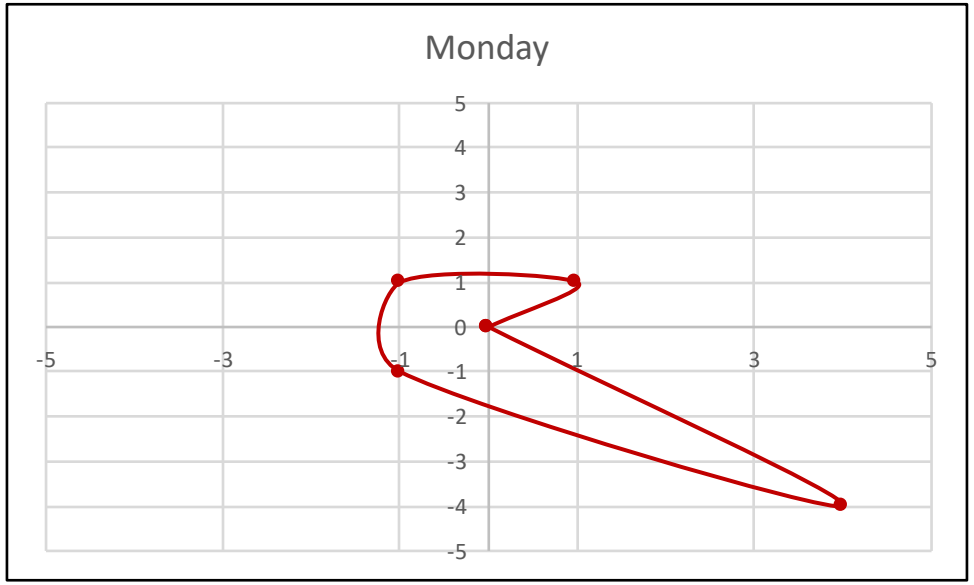
Most accurate range based on data collected



Delivery Cost Model



How it works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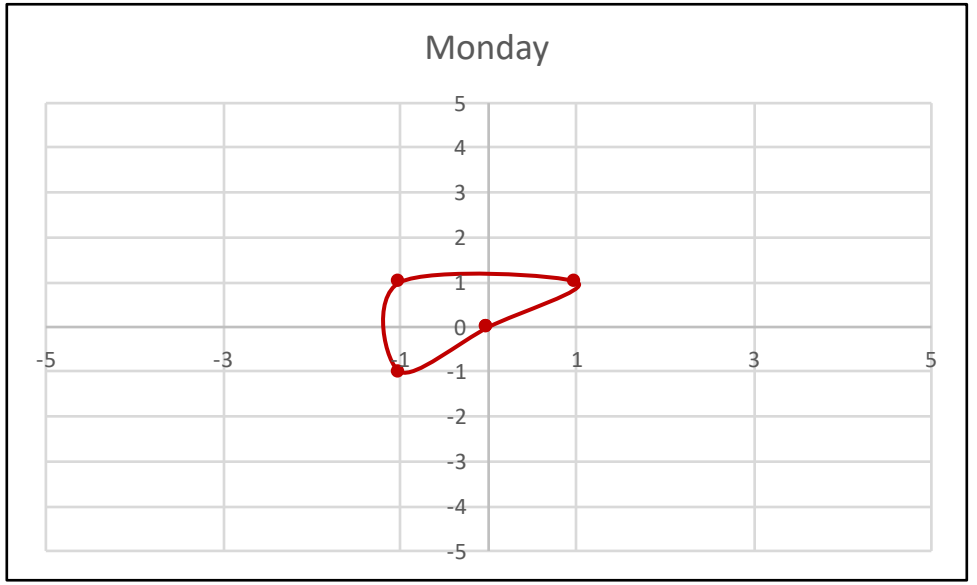
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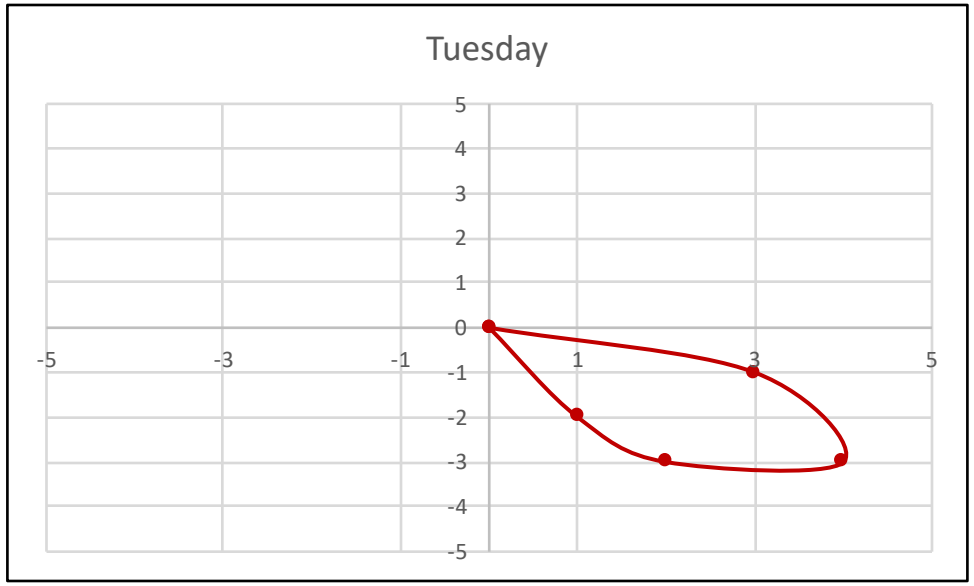
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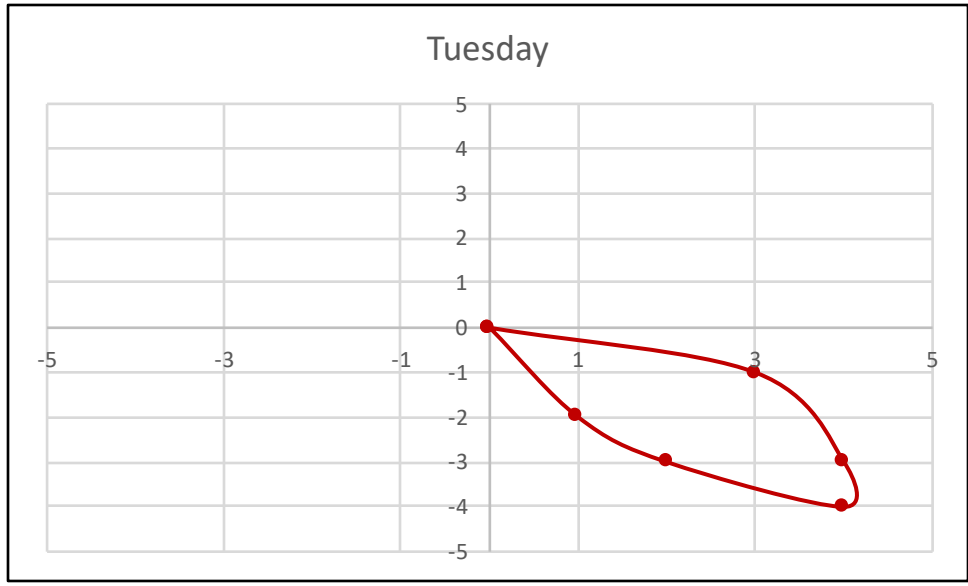
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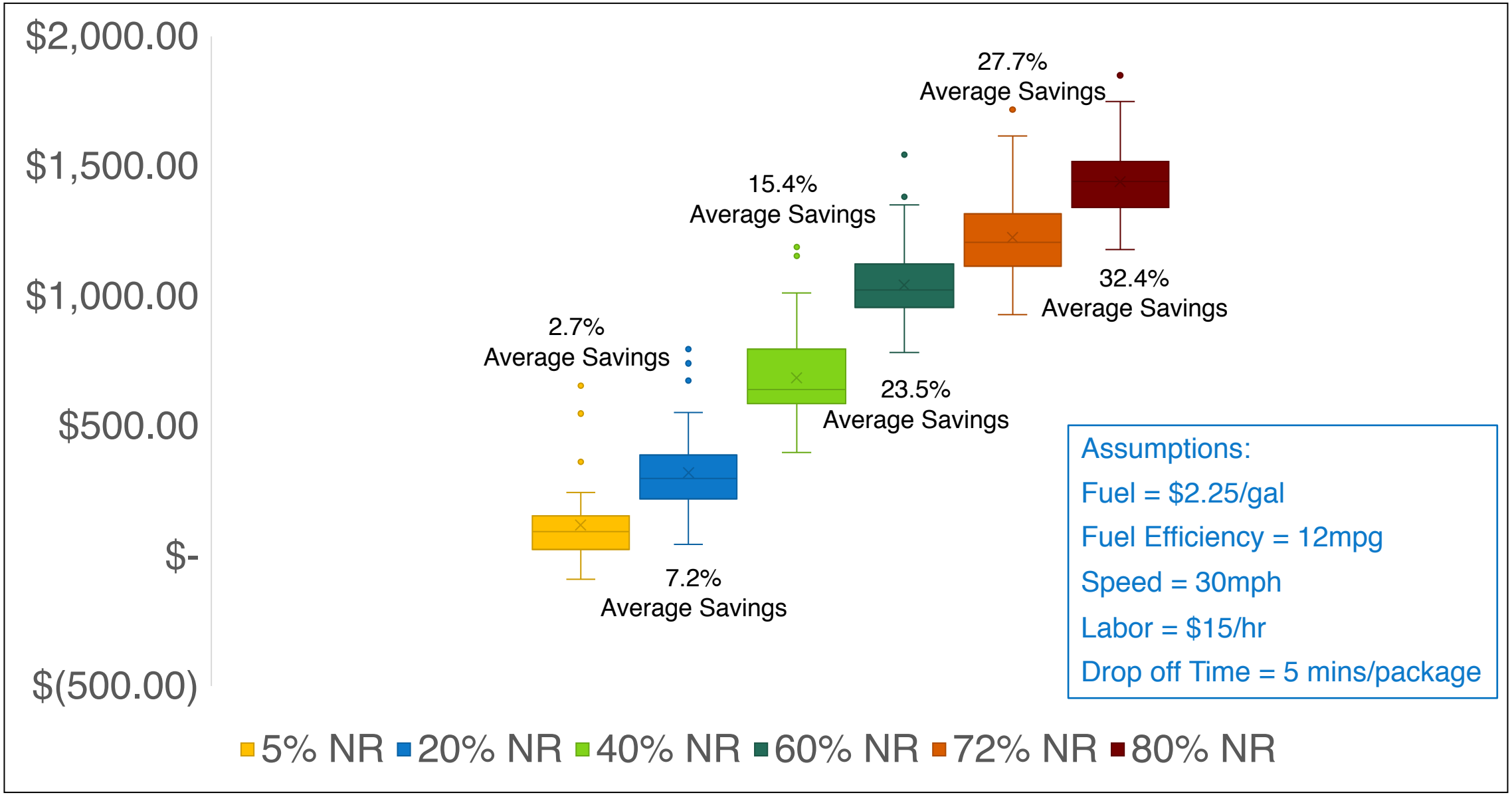
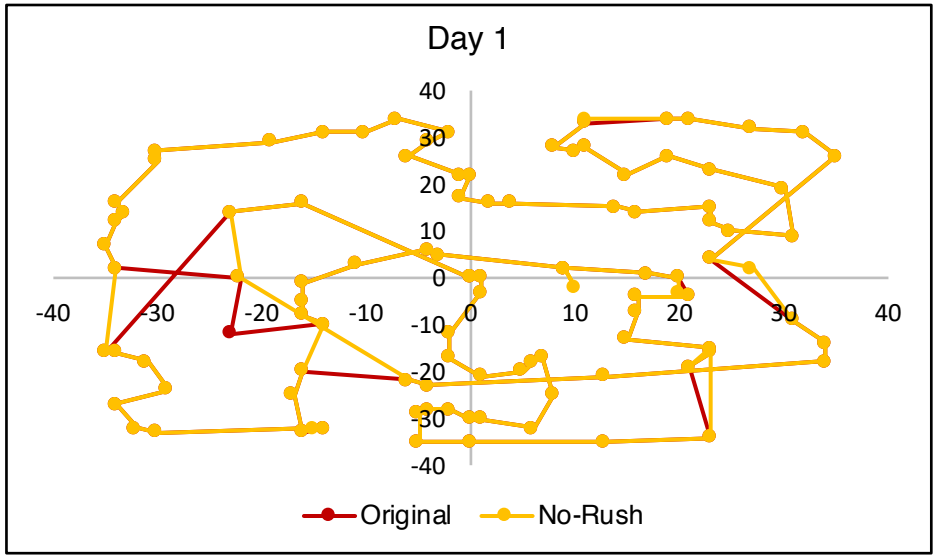
Distribution of Weekly Cost Savings Over 50 Trials



Impact of No-Rush Shipping on Vehicle Routing

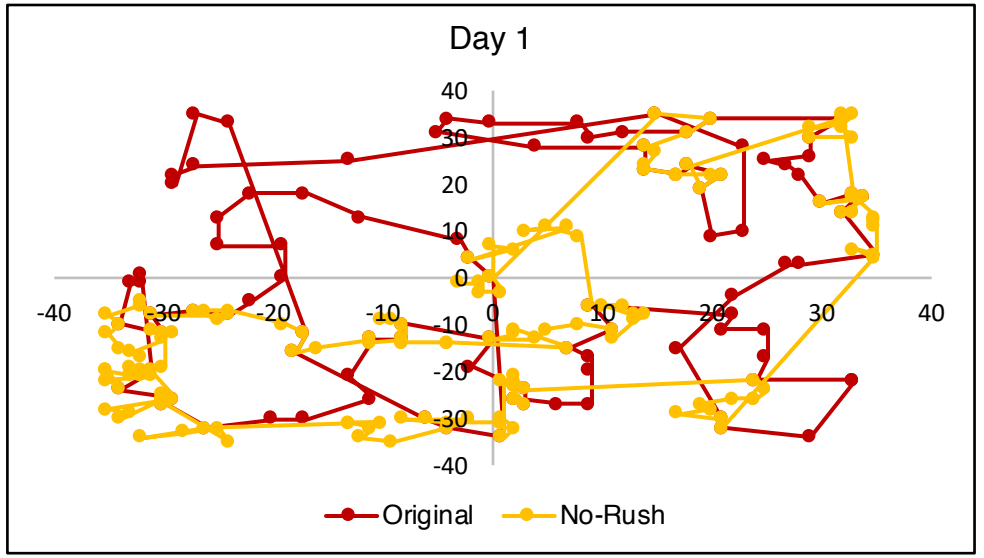
5% No-Rush



Day 1	Original	No-Rush
Distance (miles)	808	730
Time (hours)	35.1	36.9

Full Week	Original	No-Rush
Distance (miles)	5,960.00	5,814.00
Time (hours)	257.00	252.13
Cost Savings Per Order	$ -	$0.14
Trucks Needed	3	3

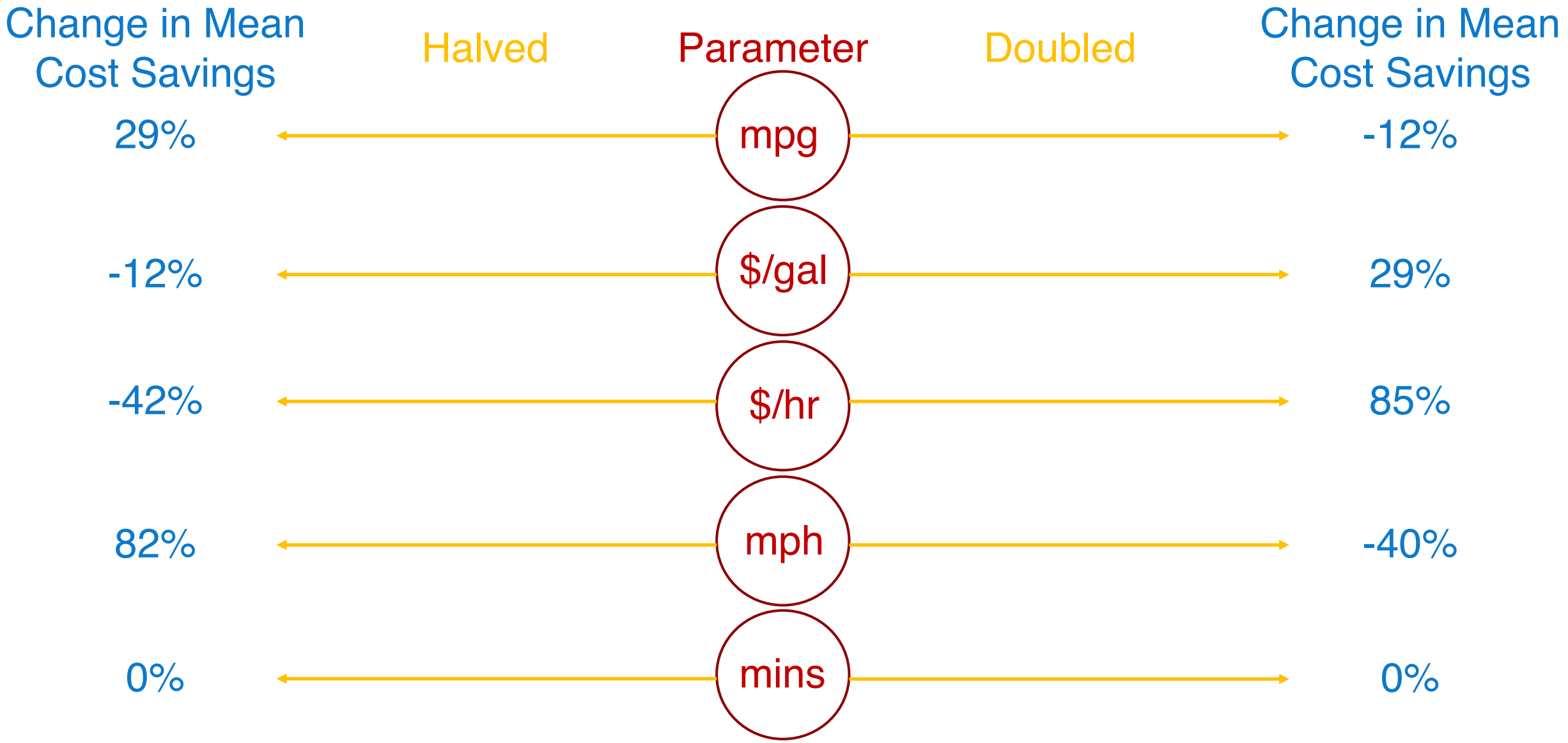
80% No-Rush



Day 1	Original	No-Rush
Distance (miles)	764	772
Time (hours)	33.6	34.2

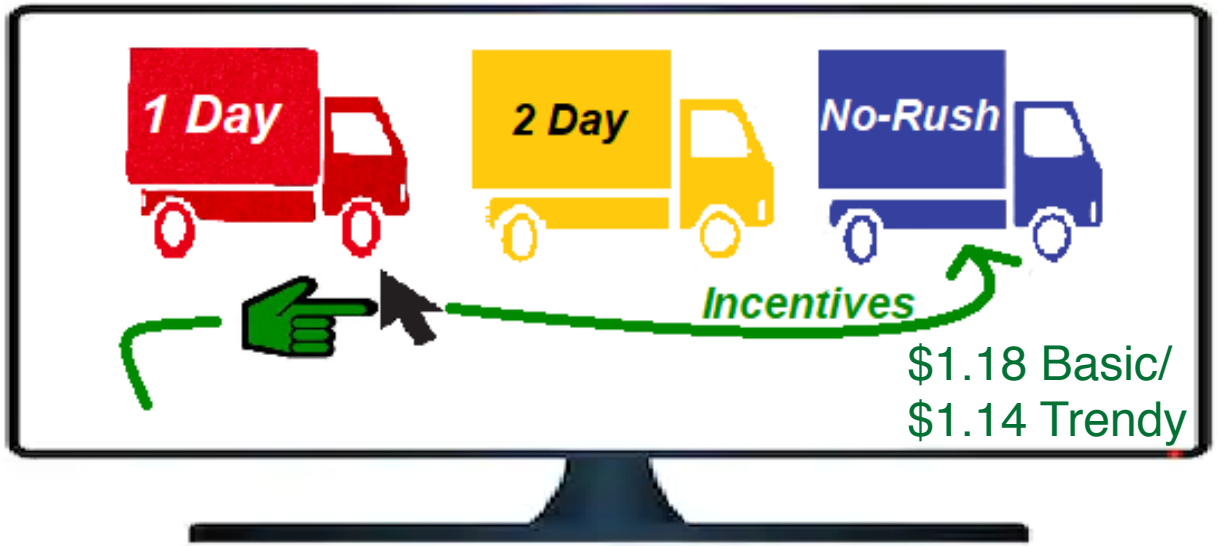
Full Week	Original	No-Rush
Distance (miles)	5,898.00	3,800.00
Time (hours)	254.93	185.00
Cost Savings Per Order	$ -	$2.06
Trucks Needed	3	2

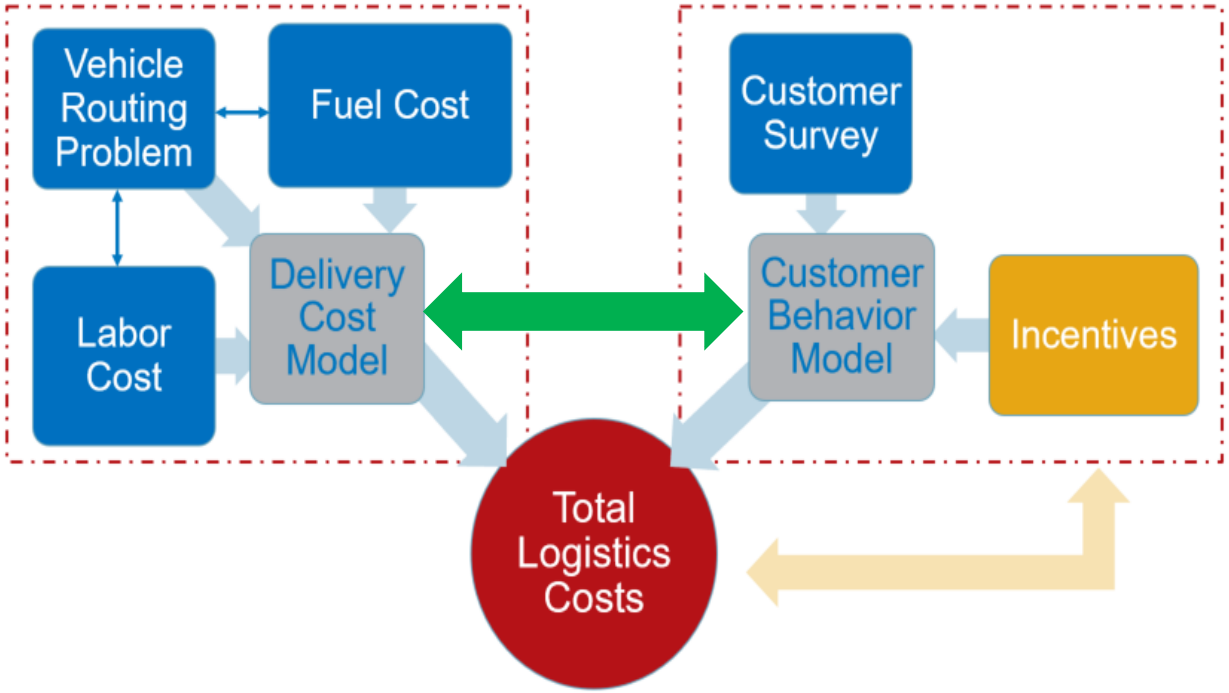
Delivery Cost Model: Parameter Variation



Conclusions

Consumer behavior can be influenced by incentives





It is critical to combine the study of consumer behavior with the logistics cost model to determine the effectiveness of incentives to drive cost savings

Conclusions

There is a potential to achieve an average of 3% to 32% weekly logistics costs savings, depending on the percent of customers who choose no-rush delivery

Limitations

Survey

Assumptions of Delivery Cost Model

Simulated Package Data

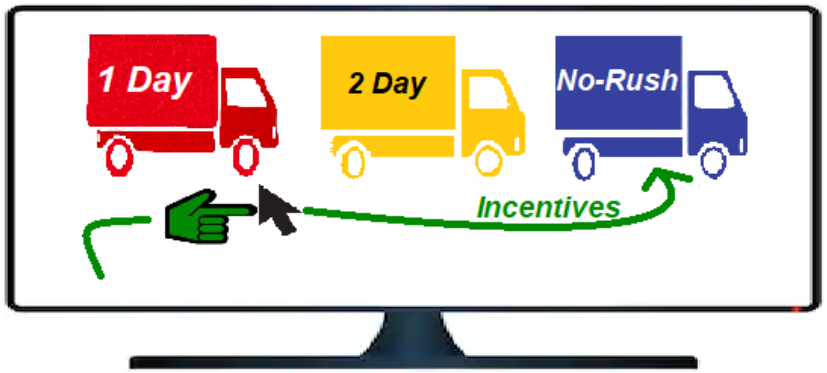
Future Work

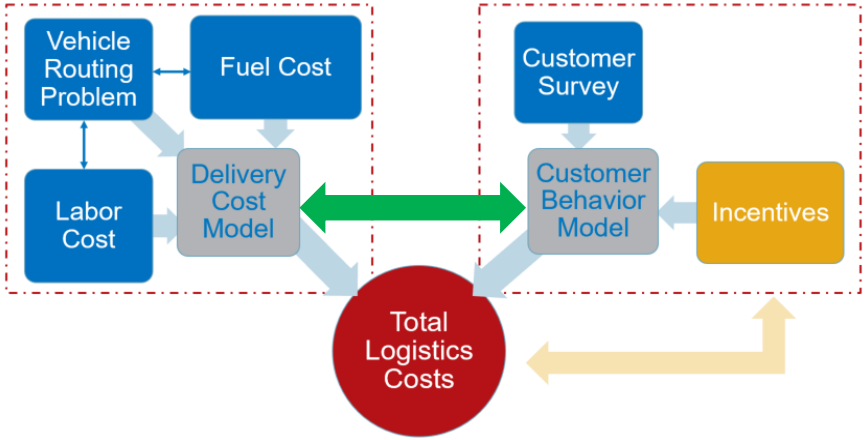
Field study with retailer – incentives offered at point of sale, actual package data

Develop delivery cost model with actual distribution network of a retailer

Expand framework to other industries

Questions?


1 Day
2 Day
No-Rush
Incentives


Vehicle Routing Problem
Fuel Cost
Labor Cost
Delivery Cost Model
Customer Survey
Customer Behavior Model
Incentives
Total Logistics Costs

Backup Slides

Consumer Survey

Respondents were randomly asked
Question A or Question B.
All respondents were asked Question C

Imagine you are shopping **online** at your favorite fashion retailer. You are purchasing a **basic** item such as a plain white shirt for $40. You are ready to check out.

Question A

Please select from the following shipping options:

- ○ Standard Shipping (2 days)
- ○ No-Rush Shipping (7 days) (you will receive $5 off your order)

Question B

Please select from the following shipping options:

- ○ Standard Shipping (2 days)
- ○ No-Rush Shipping (7 days) (you will receive $10 off your order)

Question C

Why did you choose this shipping option?

Imagine you are shopping **online** at your favorite fashion retailer. You are purchasing the latest **trendy** item from the cover of this week's fashion magazine for $40. You are ready to checkout.

Question D

Please select from the following shipping options:

- ○ Standard Shipping (2 days)
- ○ No-Rush Shipping (7 days) (you will receive $5 off your order)

Question E

Please select from the following shipping options:

- ○ Standard Shipping (2 days)
- ○ No-Rush Shipping (7 days) (you will receive $10 off your order)

Question F

Why did you choose this shipping option?

Respondents were randomly asked
Question D or Question E.
All respondents were asked Question F

ANOVA Showed no significant difference between 2 groups of Survey Data

Source of Variation	SS	df	MS	F	P-value	F crit
Sample	59030673	1	59030672.6	1.629189729	0.201970494	3.846337168
Columns	297311788302	17	17488928724	482.6775944	0	1.628126381
Interaction	1004142687	17	59067216.86	1.630198315	0.049553912	1.628126381
Within	69132846414	1908	36233148.02			
Total	3.67508E+11	1943				

Customer Behavior Model

$$LT_{Basic} = \alpha x_1 + \beta_1 x_2 + \beta_2 x_3 + \beta_3 x_4 + \beta_4 x_5 + \beta_5 x_6 + \gamma_1 x_7 + \gamma_2 x_8 + \gamma_3 x_9 + \delta_1 x_{10} + \delta_2 x_{11} + \zeta_1 x_{12} + \zeta_2 x_{13} + \zeta_3 x_{14} + \eta x_{15} + \theta x_{16} + \kappa x_{17} + \varepsilon$$

$$LT_{Trendy} = \alpha x_1 + \beta_1 x_2 + \beta_2 x_3 + \beta_3 x_4 + \beta_4 x_5 + \beta_5 x_6 + \gamma_1 x_7 + \gamma_2 x_8 + \gamma_3 x_9 + \delta_1 x_{10} + \delta_2 x_{11} + \zeta_1 x_{12} + \zeta_2 x_{13} + \zeta_3 x_{14} + \eta x_{15} + \theta x_{16} + \kappa x_{17} + \varepsilon$$

$LT = chosen\ lead\ time\ (days)$
$x_1 = incentive\ (\$)$
$x_2 = daily\ shopper\ \{0,1\}$
$x_3 = weekly\ shopper\ \{0,1\}$
$x_4 = biweekly\ shopper\ \{0,1\}$
$x_5 = monthly\ shopper\ \{0,1\}$
$x_6 = yearly\ shopper\ \{0,1\}$
$x_7 = usual\ wait\ time: 2\ or\ fewer\ days\ \{0,1\}$
$x_8 = usual\ wait\ time: 3-6\ days\ \{0,1\}$
$x_9 = usual\ wait\ time: 7\ or\ more\ days\ \{0,1\}$
$x_{10} = female\ \{0,1\}$
$x_{11} = male\ \{0,1\}$
$x_{12} = employed\ full\ time\ \{0,1\}$
$x_{13} = employed\ part-time\ \{0,1\}$
$x_{14} = student\ \{0,1\}$
$x_{15} = dependents\ \{0,1\}$
$x_{16} = age$
$x_{17} = median\ household\ income\ (\$)$

Correlation Analysis of Basic Model

	LT	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}
LT	1.00																
x_1	0.66	1.00															
x_2	-0.18	-0.12	1.00														
x_3	0.05	0.13	-0.10	1.00													
x_4	0.22	0.14	-0.11	-0.14	1.00												
x_5	-0.18	-0.24	-0.21	-0.26	-0.29	1.00											
x_6	0.07	0.11	-0.19	-0.24	-0.26	-0.49	1.00										
x_7	-0.02	-0.01	-0.12	-0.15	0.14	-0.09	0.18	1.00									
x_8	-0.11	-0.07	0.00	0.21	-0.03	0.14	-0.19	-0.74	1.00								
x_9	0.16	0.10	0.19	-0.10	-0.11	-0.06	0.12	-0.12	-0.50	1.00							
x_{10}	0.11	-0.17	-0.06	-0.07	0.21	0.19	-0.22	0.03	0.07	-0.06	1.00						
x_{12}	-0.03	0.04	-0.03	-0.04	0.24	-0.17	0.01	-0.05	-0.07	0.11	0.06	1.00					
x_{13}	-0.02	-0.18	0.08	0.01	-0.17	0.14	-0.05	-0.18	0.25	-0.12	0.24	-0.48	1.00				
x_{14}	0.02	-0.09	-0.09	0.09	-0.13	0.04	0.07	0.04	-0.11	0.15	-0.40	-0.37	-0.14	1.00			
x_{15}	-0.30	-0.20	0.11	0.08	0.24	-0.08	-0.25	0.06	0.02	-0.18	0.21	0.22	-0.05	-0.10	1.00		
x_{16}	0.08	-0.03	0.07	0.05	0.04	0.08	-0.17	0.05	0.09	-0.19	0.34	-0.22	0.21	-0.18	0.14	1.00	
x_{17}	0.16	0.01	0.07	0.20	-0.02	-0.03	-0.10	0.09	-0.19	0.23	0.03	-0.13	0.07	0.00	0.09	-0.03	1.00

Correlation between incentives and lead time

Correlation between variables describing usual shopping frequency

Correlation between variables describing variables describing usual wait time for package delivery

Correlation between variables describing employment status

Correlation Analysis of Trendy Model

	LT	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{12}	x_{13}	x_{14}	x_{15}	x_{16}	x_{17}
LT	1.00																
x_1	0.62	1.00															
x_2	-0.06	0.13	1.00														
x_3	-0.01	-0.13	-0.08	1.00													
x_4	-0.12	-0.15	-0.17	-0.13	1.00												
x_5	-0.01	0.03	-0.26	-0.20	-0.44	1.00											
x_6	0.17	0.10	-0.17	-0.13	-0.29	-0.44	1.00										
x_7	-0.19	-0.34	0.18	0.09	0.20	-0.30	-0.03	1.00									
x_8	0.14	0.28	-0.20	-0.01	-0.12	0.24	-0.02	-0.70	1.00								
x_9	0.02	0.01	0.07	-0.09	-0.07	0.02	0.06	-0.18	-0.57	1.00							
x_{10}	0.20	0.10	-0.01	0.19	-0.03	-0.03	-0.03	-0.01	0.20	-0.26	1.00						
x_{12}	0.00	-0.09	-0.17	0.01	0.11	-0.02	0.02	-0.15	0.00	0.17	0.13	1.00					
x_{13}	0.08	0.13	0.12	-0.08	-0.17	0.13	-0.02	0.01	0.08	-0.12	0.12	-0.43	1.00				
x_{14}	-0.01	-0.18	-0.11	0.17	-0.05	0.07	-0.05	0.13	-0.14	0.04	-0.32	-0.48	-0.11	1.00			
x_{15}	-0.26	-0.36	0.02	0.21	0.19	-0.05	-0.26	0.12	0.06	-0.23	0.31	0.23	0.02	-0.17	1.00		
x_{16}	0.20	0.21	-0.11	-0.08	-0.07	0.13	0.04	-0.25	0.37	-0.22	0.25	0.04	0.19	-0.33	-0.08	1.00	
x_{17}	0.12	0.10	0.19	0.06	0.02	-0.02	-0.16	-0.03	-0.02	0.06	0.08	-0.24	0.12	-0.07	-0.04	-0.07	1.00

Correlation between incentives and lead time

Correlation between variables describing usual shopping frequency

Correlation between variables describing variables describing usual wait time for package delivery

Correlation between variables describing employment status

References

Agatz, N., Campbell, A. M., Fleischmann, M., van Nunen, J., & Savelsbergh, M. (2013). Revenue management opportunities for Internet retailers. Journal of Revenue and Pricing Management, 12(2), 128–138. https://doi.org/10.1057/rpm.2012.51

Asdemir, K., Jacob, V. S., & Krishnan, R. (2009). Dynamic Pricing of multiple home delivery options. European Journal of Operational Research, 196, 246–257.

Bell, D. R., Gallino, S., & Moreno, A. (2014). How to Win in an Omnichannel World. MIT Sloan Management Review, 56(1), 44–53. https://doi.org/10.1287

Campbell, A. M., & Savelsbergh, M. W. P. (2005). Decision Support for Consumer Direct Grocery Initiatives. Transportation Science, 39(3), 313–327. https://doi.org/10.1287

Campbell, A. M., & Savelsbergh, M. (2006). Incentive Schemes for Attended Home Delivery Services. Transportation Science, 40(3), 327–341. https://doi.org/10.1287

Chintagunta, P. K., Chu, J., & Cebollada, J. (2009). Quantifying Transaction Costs in Online/Offline Grocery Channel Choice. Marketing Science, 31(1). https://doi.org/10.2307/41408452

Gilmore, D. (2018, June 21). State of the Logistics Union 2018. Retrieved May 16, 2019, from http://www.scdigest.com/firstthoughts/18-06-21.php?cid=14356

Rabinovich, E., Sousa, R., Park, S., & Golara, S. (2018). Omnichannel Retailing as a Balancing Act between In-Store and Home Fulfillment (SSRN Scholarly Paper No. ID 3113878). Retrieved from Social Science Research Network website: https://papers.ssrn.com/abstract=3113878

Sheffi, Y., & Blanco, E. (2018). Balancing green: when to embrace sustainability in a business (and when not to). Cambridge, MA: The MIT Press.

SSSD, A. M. R. (2019). US Census Bureau Monthly & Annual Retail Trade. Retrieved May 3, 2018, from https://www.census.gov/retail/index.html#ecommerce