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Are Nudges for Alternative Transit Persistent?

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Abstract

The benefits of converting single-person drivers to alternative transit options are well-established. One option to accomplish this is for employers to provide alternative commute incentive programs. However, the research on the implementation of such programs is lacking. To provide a test, this research analyzes data obtained from a field experiment on daily alternative transit commute choices for a seven-month period. Participants are divided into four treatment groups in a two-by-two design for the first three-month period: incentives with either loss or gain framing, and messaging nudges with either the private or public benefits of alternative transit commute choices. The participants then continue in the field experiment for the remaining four-month period with all groups receiving only gain framing incentives and messaging nudges are discontinued. The results from the two time periods are compared. Loss framing and private messaging have the most significant effect on participants' decisions to revert back to single-person driving when nudges are discontinued, and thus nudges are not persistent. The incentive program did not provide enduring conversion to alternative transit options, but the results suggest employers who want to optimize their alternative transit incentive programs should utilize loss framing incentives and combine both private and public messaging into continuous nudges.

Keywords: Alternative commuting; Nudges; Framing; Loss aversion; Single-person driving; Experiment

1. Introduction

Transportation is necessary for people to travel between their residence and place of business, and they can choose from many options such as subways, buses, carpools, and non-motorized vehicles such as bicycles. However, Puentes (2017) summarizes the most recent U.S. Census Bureau statistics which reveals that over 75% of people still choose to commute as single-person drivers. The California Center for Jobs and the Economy (2016) also reports a growing trend towards single-person drivers despite the negative consequences such as the well-documented rising costs associated with traffic congestion. Thus, the problem that needs to be addressed is how to convert commuters from single-person drivers to alternative transit options to create benefits both for individuals and for society. One solution is for employers to nudge their employees towards alternative transit options with messaging them about the benefits. This thesis tests if this type of nudging is persistent.

Significant problems associated with single-person drivers include increasing traffic congestion, increasing personal transit-related costs, adding personal stress with the responsibility of being the driver, and contributing to the adverse effects of air pollution. These effects are well supported in the literature. For example, Anderson (2013) provides empirical research that demonstrates how public transportation decreases traffic congestion. He found that traffic congestion increased by 47% when public transit services ceased, thus supporting that public transportation has a critical positive impact on reducing traffic congestion.

Edlin and Karaca-Mandic (2003) provide additional evidence of the benefits of reducing single-person drivers with research that shows accident externalities are more

substantial in traffic-dense states. For example, an additional driver in California can increase total statewide insurance costs of other drivers by $1725-$3239 per year. Do and Jung (2018) find similar results in their research where they analyze the socio-economic costs and benefits of introducing a carpool service. They conclude that there are direct benefits of socio-economic cost-saving to the commuters, as well as indirect benefits such as less traffic jams and environmental pollution.

Further, Greener Journeys, a British group dedicated to encouraging environmentally sustainable travel choices, released an article in 2010 which assesses the relationship of increased stress with single-person driving. They explain a study that demonstrates biometric stress-indicators are reduced by one-third when commuters choose to take a public bus instead of single-person driving.[1] Antoun, et. al., (2017) confirm similar results in their study that shows single-person driving, as compared to alternative transit options, is correlated with increased stress as measured by at least one physiological outcome.

Finally, it is well established that cars are sources of pollution that include ozone, air toxins, and particle pollution that cause negative health effects[2]. Laumbach and Kipen (2012) summarize the abundance of research that exposes how air pollution from traffic is a major preventable cause of increased incidence and exacerbation of respiratory disease. They conclude that physicians can help reduce the risk of exposure to traffic-related air pollutants by providing both awareness and interventions to their patients. Sarnat, et. al., (2014) similarly find undesirable pulmonary and autonomic biomarkers in

[1] https://greenerjourneys.com/news/bus-travel-third-less-stressful-car/, accessed 3/6/2019
[2] https://www.epa.gov/transportation-air-pollution-and-climate-change/learn-about-air-pollution-transportation, accessed 3/6/2019

their subjects after a 2-hour highway commute, further supporting that traffic pollution is linked to adverse health effects. Finally, Ali, et. al., (2018) provide an updated systematic review that confirms that automobiles pollutants can lead to respiratory and cardiovascular problems, lung conditions such as cancer and asthma, and even death. Thus, the necessity to promote single-person drivers to choose alternative transit options is well-established.

Grant (2019) explores an option to reduce single-person drivers by conducting a field experiment with an employer who provided incentives and nudges to their employees to use alternative transit. She incorporated four treatment variables in her research: payment incentives to use alternative transit as a loss or as a gain, and informational nudges that provide either the public benefits or the private benefits of alternative transit. By organizing participants in a two-by-two design, she demonstrates that loss framing and private information are more effective in converting single-person drivers to alternative transit options. In addition, participants were more likely to use alternative transit options when they were sometimes using those options prior to the study.

My thesis extends the framework of Grant's research to discern if nudges, given to the employees as informational emails about the benefits of alternative transit options, are persistent after their discontinuation. In addition, I explore how nudge persistence is affected by the four possible treatment groups. My thesis tests if nudges create habituation, a learning process in which the nudges become less able to provoke the expected responses and therefore are not persistent, or salience, whereby the recipients are more likely to be responsive to the importance of the nudges and consequently the

nudges are persistent. I will test the effectiveness of nudges by measuring the number of times commuters choose alternative transit options over single-person driving after the nudges have been discontinued compared to the first three months where nudges were present.

Understanding both the persistence and effectiveness of nudges will give employers information to conduct a cost-benefit analysis. In the example of Grant's study, the cost for the employer to administer the nudges includes the effort, time, cost, and manpower to construct and send the nudges. The benefit to the employer is for the nudges to have the desired effect of salience rather than habituation in reducing single-person drivers. This would outweigh the costs because the employer would enjoy an enhanced public image of promoting positive change to the environment, and they would also benefit from less stressed employees who therefore are more productive and happier in the work environment. This research is valuable because it can assist in future approaches to reduce single-person drivers. For example, Claremont McKenna College currently participates in a reimbursement-based program for its employees to encourage ridesharing in an effort to improve the air quality.[3] My thesis will help programs such as this one to improve their administration of nudges to maximize their employees use of alternative transit options.

[3] https://www.cmc.edu/human-resources/march-1-2019-rideshare-memorandum, accessed 3/6/2019

2. Experimental Design

In Grant's study, employees were sent an email inviting them to participate in a program that will give them a monetary incentive per commute trip that is other than a single occupancy car. Those that chose to participate were required to complete a survey of demographics and commuting behavior, and then they were randomly assigned into one of four groups. One group received nudges that emphasize the personal benefits of alternative transit of saving money on fuel, having more leisure time during the commute such as sleeping or reading, and reduced personal stress since the burden of being responsible as the driver is alleviated. Another group received nudges that emphasize the public benefits of alternative transit of reduced traffic, less likelihood of traffic collisions, and preventing air pollution which can cause both health issues and climate change.

To complete the 2 x 2 design, these two groups were then further randomly assigned into a loss or gain framing incentive group. In the loss framing incentive group, commute directions were calculated for the month, and participants were given the advance dollar amount equivalent to if they used alternative transit on each available commute direction for that month. For example, if there are 20 available work days in a month, that equals 40 commute decisions to choose non-single driver transportation at $1 per commute, and therefore this group would begin the month with $40. Next, $1 would be deducted for each time they did not choose an alternative transit option. In the gain framing incentive group, participants earned $1 per each alternative transit commute direction chosen, which would be added up and received at the end of the month. Finally, participants within all levels of the program were nudged with emails several times per month to remind them to log in their commute choices. Based on their random

assignment into the four groups, the emails contained different phrasing as shown in Table 1.

Table 1: Treatment message summary

	Gain Framing: For every alternative commute, you will receive…	Loss Framing: For every single-person driving choice, you will lose…
Private Benefits	An extra $1 while saving money on your gas, allowing more time for sleep, and reducing your stress.	$1 will be deducted from the total amount you receive at the beginning of the month, and you will miss out on saving gas money, time to sleep, and reducing your stress.
Public Benefits	An extra $1, and you will be helping to reduce traffic congestion, reduce toxic chemicals in the air that cause health issues, and reduce pollution associated with global warming.	$1 will be deducted from the total amount you receive at the beginning of the month, and you will not be helping to reduce traffic congestion, reduce toxic chemicals in the air that cause health issues, or reduce pollution associated with global warming

Grant collected the data of daily logs of the participants over the months of August, September, and October of 2013, at which time the participants were sent several reminders per month with the messaging benefits of alternative transit options. She analyzes the results to determine the effectiveness of the variables that were used to influence single-person drivers to convert to alternative transit options. She controls for each individual's demographics, such as gender, family size, age, their location and commute habits, their relative risk to aversion, and for the time-region varying covariates such as weather and gas prices. Grant also collected data from November, December, January, and February, a period in which participants were not sent any email nudges,

and all participants were given only gain framing incentives. This data is not yet examined, and I now analyze it to determine if the effectiveness of nudges for alternative transit is persistent.

For my experimental design, I evaluate Grant's initial intake survey from the participants and analyze age, gender, owns a car, number of children, and commute distance. I provide the mean and standard deviation for each participant for each of these covariates. In addition, I analyze the number of participants that were in each category of gain framing incentives, loss framing incentives, public messaging, and private messaging. I then calculate the number of responses of alternate transit commute choices during the final four months of the study.

Next, I calculate the data by regression analysis to determine if the participant's decision to use alternative transit is affected by the treatment groups and the covariates. I then compare my regression analysis from the final four months of the experimental trial to the regression results calculated by Grant for the first three months of the experimental trial.

I hypothesize that nudges will not be persistent, and the number of participants that choose to use alternative transit to commute will be lower during the final four months of the study versus the first three months of Grant's study. Further, Grant found that those participants that were in the loss framing and/or private messaging groups were the most likely to choose alternative transit to commute during the first three months of her study. Therefore, I predict these groups will show the most reversion to single-person driving during the second four months of my study when the nudges are discontinued and the loss framing incentive is changed to a gain framing incentive.

3. Data and Results

a. Summary

In the first phase of Grant's experimental design, emails were sent to nearly 500 employees. Those emails were approximately equally distributed with either public or private messaging benefits of alternative transit options. Eighty people replied affirmatively to participate and the responses were approximately equal between the public and private benefits messaging groups with 41 people from the private messaging group, and 39 people from the public messaging group. Eighty people represents a participation rate of approximately 16%.

Each participant was required to complete a survey regarding their commute behaviors and general demographics and this data is summarized in Table 2. Exactly 50% of the participants were assigned to the loss framing group, and 51.3% of participants received public benefits messaging. Males were 50% of participants, and 97.5% of participants owned their own car. Age and commute time was divided into bins as shown below Table 2, and the survey results show that the average age of participants was around 30 years old, and the average commute time to the workplace was around 22 minutes.

Table 2: Summary statistics from intake survey

	Mean	SD	N
Loss Framing	0.5	0.5	80
Public Benefits Message	0.513	0.5	80
Male	0.5	0,5	80
Age	2.388	1.055	80
Number of Children	0.225	0.547	80
Owns a Car	0.975	0.156	80
Commute Time	2.6	1.821	80
Alt. Commuted that Day	0.136	0.343	6,640

Participant chooses:	*Age (years):*	*Commute time to work(minutes):*
1 =	18-24	0-10
2 =	25-34	11-20
3=	35-44	21-30
4=	45-54	31-40
5=	55-64	41-50
6=	65-74	51-60
7=		61+

Notes: Table 2 shows the summary statistics results for the variable of interest, treatment variables, and covariates. Loss framing, Public Benefit Message, Male, Owns a Car, and Alt. Commuted that Day are all binary variables. There were 80 participants that participated in the intake survey. Their choice for treatment variables and covariates remained the same throughout the 7 months of the experiment. The only variable that changed each day was whether the participant chose alternative transit to commute on any given day. The table below Table 2 represents the bins participants selected based on their age and commute time to work.

The experimental design is a seven-month period divided into two time periods. The first time period is the first three months; August, September, and October 2013, whereby participants were given emails to encourage them to use alternative transit. The second time period is the following four months; November, December, January, and February, whereby the same participants were no longer given emails to encourage them to alternatively commute. Further, the participants that received gain-framing incentives during the first three months continued to be offered gain-framing incentives during the final four months. However, the participants that received loss-framing incentives during the first three months were converted to gain-framing incentives for the final four months. Thus, all participants were only offered gain-framing incentives to choose alternative transit to commute during the final four months of the study.

In the first three-month time period, there are 66 days of work and therefore 2 * 66 = 132 possible alternative transit decisions for each participant. However, because participants likely choose the same mode of transportation for each direction of their commute, one observation of alternative transit choice was counted per person for each day which equals 66 * 80 = 5,280 observations. In the second four-month period, there are 83 days of work and therefore 83 * 80 = 6,640 observations.

b. Post Nudge Analysis

Regression analysis is used to measure the within-participant treatment effects on covariates and tests for significance.

$$\text{Alt-Com}_{it} = \beta_0 + \beta_1 \text{loss}_i + \beta_2 \text{public}_i + \beta_3 \text{publoss}_i + X'\lambda_i + \varepsilon_{it} \quad (1)$$

Alt-Com is the choice to use alternative transit options other than single-person driving on any given day. The individual participants are represented by the subscript *i*. Subscript *t* captures the time variable of any given day. Participants in the private messaging group crossed with gain-framing incentives is set as the omitted constant, represented by β_0. $\beta_1$loss and β_2 public represent the coefficients for the treatment variables of loss-framing and public messaging. $\beta_3$publoss represents the coefficient for the interaction of the public messaging group with loss framing group. X represents the individual participant's characteristic as covariates that I chose to include in my regression. These are age, gender, owns a car, commute distance, and number of children. These covariates are represented in the vector λ. Lastly, ε represents the error term.

I ran multiple regressions with different variations of the covariates that I selected. The results can be seen in Appendix A, Table 5. In the first regression, shown in column 1, I withdrew all covariates to test the outcome of the treatment variables. In the second regression, shown in column 2, I withdrew the covariate 'number of children' and 'owns a car' because the average number of children was extremely low and the number of car owners was extremely high. However, I felt these were necessary covariates for my final regression outcomes, as shown in column 3.

Table 3 gives the numerical results for the post nudge months using ordinary least squares estimation. The results are in relationship to our omitted group which is the gain framing crossed with private messaging participants, which thus represents our constant. Table 3 shows the gain framing/private messaging group used alternative transit to commute 21.6% of the time. Compared to this group, the gain framing/public messaging group was shown to use alternative transit 1% less than our omitted group, however, this

was found to be not statistically significant. There was a statistically significant difference between our loss-framing groups compared to the omitted group. The loss framing/private messaging group commuted 11.4% less than the omitted group, or in other words, they only used alternative transit 10% of the days where they had the option. The loss framing/public messaging group commuted 8% more than the loss framing/private messaging group, however, this was still 3% less than our omitted group.

Further information on Table 3 shows that most of the covariates are statistically significant, and these include gender, age, owns a car, and commute time. Males used alternative transit 11% more than females. This is a valuable result because this study had an equal number of males and female participants which allowed for accurate measures.

Age was categorized into six bins ranging from 18 to 74 years old. For each age bin that a participant moved up, that participant was a little over 4% less likely to use alternative transit. This might be due to the fact that the majority of participants were in the younger three age bins, from ages 18 to 45 years old.

Participants that owned a car were 6.7% less likely to use alternative transit. However, since 97.5% of participants reported that they owned a car, this finding is not very meaningful due to the limitation of data.

Finally, analysis of commute times shows that for every bin that participants had moved up, which was ten minutes longer to commute further from home to work, they were about 3% more likely to choose alternative transit.

The only covariate that was not statistically significant was the number of children reported in the participant's household. I believe this was not significant because the average number of children reported by participants was only .225, indicating that

most of the participants did not have children. Therefore, there was very little data to analyze this covariate.

Table 3: Percentage of participants that alternatively commuted

Variables	(1) All	(2) November	(3) December	(4) January	(5) February
Constant	0.216*	0.341*	0.410*	0.223*	-0.108
	(0.031)	(0.063)	(0.062)	0.055	(0.065)
Loss Frame	-0.114*	-0.094*	-0.123	-0.09*	-0.153*
	(0.012)	(0.024)	(0.024)	(0.021)	(0.025)
Public	-0.010	-0.013	-0.072*	-0.005	0.047
	(0.012)	(0.024)	(0.024)	(0.021)	(0.025)
Public Loss	0.081*	0.083**	0.081**	0.088*	0.07**
	(0.017)	(0.035)	(0.034)	(0.03)	(0.036)
Male	0.113*	0.137*	0.069*	0.132*	0.109*
	(0.008)	(0.017)	(0.017)	(0.015)	(0.017)
Age	-0.042*	-0.042*	-0.042*	-0.038*	-0.045*
	(0.004)	(0.009)	(0.008)	(0.007)	(0.009)
Number of Children	-0.014*	-0.024	-0.014	-0.025	0.011
	(0.008)	(0.017)	(0.016)	(0.014)	(0.017)
Owns a Car	-0.067**	-0.208*	-0.21*	-0.104**	0.258*
	(0.027)	(0.056)	(0.055)	(0.048)	(0.057)
Commute Time	0.029*	0.033*	0.027*	0.021*	0.038*
	(0.002)	(0.005)	(0.005)	(0.004)	(0.005)
Observations	6,640	1680	1520	1840	1600
R-Squared	0.09	0.10	0.09	0.09	0.12
Alt. Commute AVG.	0.136	0.15	0.125	0.115	.155

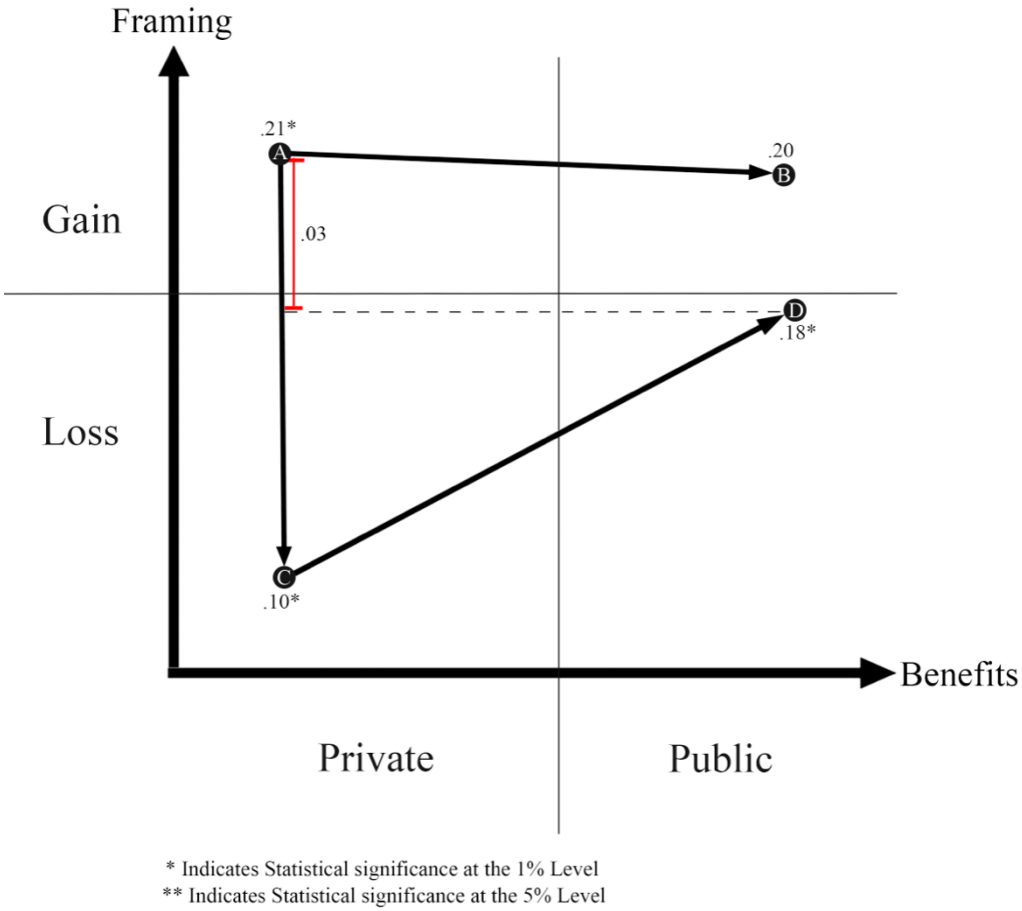
* Indicates Statistical significance at the 1% Level
** Indicates Statistical significance at the 5% Level

Notes: Table 3 shows the regression results of the post nudge incentive months. The variable of interest, Alt. Commute, is days a participant chose to use alternative transit to commute. All coefficients are in percentages corresponding to the decision to alternatively commute. The constant represents the omitted group which were participants that were in the gain framing and private messaging group. Column 1 shows the regression results of all post nudge incentive months for all covariates. Columns 2, 3, 4, and 5 represent each individual months results on the participant's choice to alternatively commute in the post nudge months. The average choice to commute on any given day during these months was 13.6 %. For more regression analysis, please see appendix A for regressions with different covariates.

Figure 1 shows the trends of our participants for the combined post-nudge months and is a visual representation of how our participants differed by their treatment groups. Our gain framing/private messaging group is represented by point A, which shows they chose alternative transit to commute 21.6% of the time during the post-nudge months. Point B represents the gain framing/public messaging group which chose alternative transit 20.6 % of the time. This was not statistically different from the gain framing/private messaging group. Point C represents the loss-framing/private messaging group which commuted 11.4% less than the gain framing/private messaging group, which was statistically significant. Finally, Point D represents the loss-framing/public messaging group which used alternative transit 18.3% of the time. This was 8.1% more than the loss framing/private messaging group.

After the initial regression analysis, I then calculated a lincom function to compare the loss framing group to the loss framing/public messaging group, also shown in Figure 1. This was statistically significant at the 1% level, and it shows a 3% decrease of alternative transit commute decisions from the gain framing/private messaging group and the loss framing/public messaging group. This is shown from point A to point B by the red bar on the graph.

Figure 1: Alternative commute choices by treatment group for post-nudge months

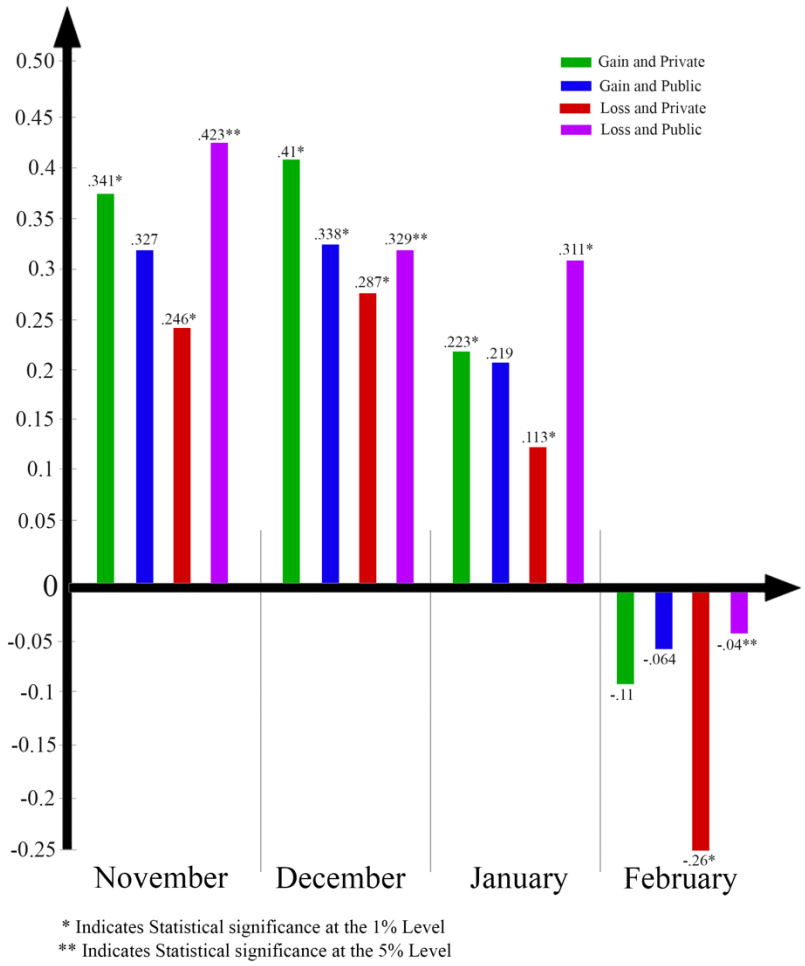


Notes: Figure 1 splits the treatment variables into 4 boxes. Points A, B, C, and D represent the choice to use alternative transit to commute by treatment variable group. These values are found by subtracting the treatment group's coefficient from the constant. The red line indicates a reversion to single-person driving of the participants that were in the loss framing group during the first 3 months and were changed to the gain framing group for the final four months.

Figure 2 gives a visual representation for the individual differences of the coefficients for each month. Each month shows that participants in the loss framing/private messaging group were less likely to choose alternative transit commute options than the gain framing/private messaging group. I also find that participants in the loss framing/public messaging group used alternative commute options more of the time

than the participants in the loss framing/private messaging group. I see these exact trends in Table 3 for the combined coefficients of all months. However, although the data for February shows the same trend, I do not find this data to be useful in my conclusion. This is because it was the last month of data collection, and the participants were less likely to be responsive to the surveys and submit information. Therefore, it has an unusual negative coefficient as seen in Figure 2.

Figure 2: Percent of alternative commute choices by month



Notes: Figure 2 shows the percent chance a participant chose to commute on any particular day. The percent chance of using alternative transit is calculated by subtracting the treatments group's coefficient from the constant. It has been divided into all 4 post nudge incentive months and separated by the treatment variable group they were in. February shows negative results as there was weak data for this time period.

C. Pre vs Post Analysis

Comparison of the first three months when nudges were present to the final four months when nudges were discontinued is done by the following regression analysis.

$$\text{Alt-Com}_{it} = \propto_0 + \propto_1 \text{loss}_i + \propto_2 \text{pub}_i + \propto_3 \text{publoss}_i + \beta_0 + \beta_1 \text{loss}_i + \beta_2 \text{public}_i + \beta_3 \text{publoss}_i + X'\lambda + \varepsilon_{it} \quad (2)$$

All 7 months of the treatment variables are represented by the coefficients $\propto$. The coefficients β represents the treatment variables in the final four months. All treatment variables represented by β include the interaction with the post-nudge months, as indicated by the term Pnudge shown in Table 4. Alt-Com, X, ε, the vector λ, and the subscript *i* and *t* represent the same information as in Equation 1.

Table 4 shows the regression results of Equation 2. This table is divided into three regressions. The first regression is shown in column 1 which displays the results with no covariates. Column 2 includes all covariates except 'number of children' and 'owns a car'. These covariates were omitted due to the limited variation in their data distribution. Finally, column 3 is the regression results with all covariates.

Table 4 shows that the omitted group, the gain framing-private messaging group, alternatively commuted 33.7% of the time. However, their decision to use alternative transit dropped by 3.7% in the post-nudge months. The decision to use alternative transit by the loss framing-private messaging group also dropped by 5.2% in the post-nudge months. These results are all statistically significant and are consistent with the prediction that participants will choose alternative transit to commute less often once nudges are discontinued. The other treatment groups of gain framing-public messaging and loss

framing-public messaging shows a slightly opposite trend, but the results are not statistically significant.

These results are consistent with Grant's results because in her study, loss framing and private messaging were the most effective motivators for alternative transit. Thus, it is predictable that the participants with the most highly motivating treatment variables would show the most reversion to single-person driving once the nudges were discontinued. In contrast, an assumption can be made that the public messaging groups that chose alternative transit to commute during the first three months are motivated by altruism for the environment. Therefore, and as expected, there is not significant reversion to single-person driving in the post-nudge months for these groups.

The regression results in Table 4 for the covariates show the same trends that were explained in Table 3, and the 'number of children' becomes statistically significant. For every child that a participant has, that participant was 3.1% less likely to choose alternative transit. This is an expected result, as the demands of a child's schedule might necessitate less options for the participant to choose alternative transit.

Table 4: Percentage of alternative commute decisions in nudge vs. post nudge months

Variables	(1)	(2)	(3)
Constant	0.228*	0.229*	0.337*
	(0.011)	(0.015)	(0.027)
Loss Frame	-0.068*	-0.071*	-0.072*
	(0.015)	(0.014)	(0.014)
Public	-0.048*	-0.036**	-0.041*
	(0.015)	(0,014)	(0.014)
Public Loss	0.034	0.054*	0.055*
	(0.02)	(0.02)	(0.02)
Pnudge	-0.034**	-0.034**	-0.037**
	(0.015)	(0.014)	(0.014)
*Loss*Pnudge*	-0.05*	-0.055*	-0.052*
	(0.019)	(0.019)	(0.019)
*Pub*Pnudge*	0.025	0.015	0.018
	(0.019)	(0.019)	(0.019)
*PubLoss*Pnudge*	0.035	0.048	0.045
	(0.027)	(0.026)	(0.026)
Male		0.125*	0.133*
		(0.006)	(0.007)
Commute Time		0.022*	0.02*
		(0.002)	(0.002)
Age		-0.053*	-0.047*
		(0.003)	(0.003)
Number of Children			-0.031*
			(0.006)
Owns a Car			-0.113*
			(0.022)
Observations	11,688	11,688	11,688
R-Squared	0.015	0.079	0.083
Alt. Commute AVG.	15.4	15.4	15.4

* Indicates Statistical significance at the 1% Level
** Indicates Statistical significance at the 5% Level

*Notes: Table 4 shows the regression results of all 7 months of the study. The variable of interest is Alt. Commute, which is days a participant chose to use alternative transit. Column 1 represents the regression of Equation 2 with no covariates. Column 2 shows the regression with two omitted covariates. And finally column 3, the regression of interest, shows the regression with all covariates. The treatment variables interacted with "*pnudge" are represented by β in Equation 2. The average choice to commute for any given day in all 7 months by a participant was 15.4 percent.*

4. Conclusions

Participants that were in the loss framing groups during the first three months of Grant's study were more likely than the gain framing groups to choose alternative transit. However, these same participants then exhibited the most reversion to single-person driving in the post-nudge months when their loss framing incentives were changed to gain framing incentives. This proves that nudges for commuters to choose alternative transit are not persistent. This also demonstrates that loss framing with nudging is a strong motivator and should be utilized by employers who wish to maximize their employees' choice to use alternative transit.

Participants that chose to use alternative transit to commute during the first three months in the gain framing incentive groups were less affected by the discontinuation of nudges during the final four months. This trend is logical because the incentive of gain framing remained constant. However, since Grant demonstrates that gain framing is less effective than loss framing as a motivator towards alternative transit choices, I would not recommend gain framing as the preferred incentive program.

Next, my results show that nudges are less persistent with private messaging than public messaging in the loss framing groups for the post-nudge months. The loss framing-private messaging participants were the most likely group to revert to single-person driving compared to all other groups, and they were 8% less likely to choose alternative transit than the loss framing-public messaging groups after the nudges were discontinued. This is interpreted that the loss framing-public messaging participants were partially motivated by the altruism associated with the public messaging, and therefore, when the loss-framing became gain framing and the nudges were discontinued, they

remained pro-environmentally motivated to choose alternative transit to commute. However, since this result was not statistically significant and Grant demonstrates that public messaging is less effective than private messaging to motivate employees to choose alternative transit, it should be concluded that public messaging by itself is not an adequate motivator to change commute behaviors.

Of the covariates that I evaluated, the results regarding the covariate of gender provides the most useful information for employers to improve their alternative transit incentive programs. My study shows that men are more likely than women to choose alternative transit to commute, and this was consistent with Grant's study of the first three months. A theory to explain this result is that men have less safety concerns regarding ride sharing with strangers or traveling on public transportation. One suggestion for employers to decrease this barrier for women is to offer company-sponsored social opportunities for employees to meet each other prior to carpool agreements. Additionally, employers can provide safety information about the public transportation options incorporated into their messaging nudges.

In summary, and just as Grant found, the most significant treatment variables to change behavior were loss framing and private messaging. Further, these two treatment variables had the most effect on the participants commute decision to revert from alternative transit back to single-person driving when nudges were discontinued. Furthermore, nudges were not persistent in converting single-person drivers to alternative transit options.

The most obvious explanation for these results is that the commuters did not discern enough pro-individual benefits. In addition, single-person driving is acceptable and

common, and thus, there is not enough social pressure for individuals to want to change this behavior. This hypothesis is supported by the research of Tyers (2017) where he examines nudges to change a pro-social behavior of voluntary carbon offsetting for air travel. He hypothesizes that the nudges are ineffective because the behavior to be changed does not have observable negative connotations and is not uncommon. He further explains that nudges are more successful if the desired change will benefit an individual rather than a social group and concludes that there are certain behaviors that are beyond the influence of nudges. My research confirms his conclusion because I found that choosing alternative transit options was similarly a behavior beyond the influence of nudges once they were discontinued. The benefit of converting to alternative transit options did not present enough pro-individual change, and the behavior of single-person driving did not have enough negative social connotations to warrant continued change.

A suggested future study would be to duplicate Grant's study with increased pro-individual benefits. For example, it would be significant to calculate how the results would change if the incentive program offered increased personal compensation, such as the ability to earn time off from work for choosing alternative transit to commute. Additional suggestions for future research would be to include multiple employers from different geographic regions, obtain a larger sample size, and collect data for a longer period of time.

A final question to be posed for future research is whether there is a type of messaging that would be more effective than just presenting the public and private benefits of alternative transit. Seyedabrishami, et al., (2012) use a stated preference survey technique to mathematically demonstrate that carpooling would increase by 30

percent if commuters were given carpooling websites that could identify suitable rideshare programs. Thus, an additional treatment variable that could be explored is adding carpool website data to the nudges.

Although I have suggested avenues for future research, my data is valuable for current employers who wish to start or improve their alternative transit incentive programs. My results indicate that employers should offer programs with loss framing incentives and they should try to maximize the value of incentives offered. Further, I recommend combing public and private benefit messaging with carpooling/mass transit websites into a single form of messaging nudges. Finally, my research proves that the nudges should be continued throughout the incentive program, or their effect of salience will not be persistent.

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Appendix A

Table 5: Regression analysis of different combinations of covariates

Variables	(1)	(2)	(3)
Constant	0.192*	0.152*	0.216*
	(0.009)	(0.012)	(0.031)
Loss Frame	-0.049*	-0.034*	-0.114*
	(0.012)	(0.011)	(0.012)
Public	-0.023	-0.01	-0.01
	(0.012)	(0.012)	(0.012)
Public Loss	-0.069*	-0.081*	0.081*
	(0.009)	(0.017)	(0.017)
Male		0.109*	0.113*
		(0.008)	(0.008)
Commute Time		0.031*	0.029*
		(0.002)	(0.002)
Age		-0.044*	-0.042*
		(0.004)	(0.004)
Number of Children			-0.014*
			(0.008)
Owns a Car			-0.067**
			(0.027)
Observations	6,640	6,640	6,640
R-Squared	0.02	0.08	0.09
Alt. Commute AVG.	0.136	0.136	0.136

*Notes: Table 5 shows the regression results of the post nudge incentive months using different combinations of covariates. Alt. Commute represents the variable of interest and is the days that a participant chose to use alternative transit. * indicates statistical significance at the 1% level. ** indicates statistical significance at the 5% level. Column 1 represent Equation 1 with no covariates. Column 2 represents the regression with 2 covariates omitted. Column 3 represents the regression with all covariates included.*

Appendix B

Stata Commands

Do File for the commands used in Stata.

Omitted Stata commands include many dropped variables from Grant's data set that were not relevant for my study.

1. gen pnudges =1
2. replace pnudges = 0 if month==8
3. replace pnudges = 0 if month==9
4. replace pnudges = 0 if month==10

** Generate a variable that indicates the Post Nudge incentive months.

5. drop if altday==.

** Drop any data points of no value for the variable of interest.

6. Sum

** Summary statistics for all variables: Not included in this paper because the primary focus was on the post nudge incentive months. See next step for summary statistics.

7. Sum if pnudges==1

** Summary statistics of variables in the post nudge months. See Table 2 for results.

8. sum if pnudges==1 & month==11
9. sum if pnudges==1 & month==12
10. sum if pnudges==1 & month==1
11. sum if pnudges==1 & month==2

** Individual post nudge month summary to confirm correct data for strong regressions to follow.

12. reg altday lossframe pub publoss male age numchild commutetime if pnudges==1
13. reg altday lossframe pub publoss male age numchild commutetime if pnudges==0

** Regression for all variables for the first three months with nudge incentives, and the final 4 months with no nudge. Regression for first three months was of no significance to this paper, but interesting to view the results to see trends. Regression results for the finals four months can be seen in Table 3. A visual representation of the findings can be seen in Figure 1.

14. lincom lossframe + publoss

** A lincom regression to compare the significance between the loss framing group and the public loss framing group. Visual representation can be seen as the red line on Figure 1.

15. reg altday lossframe pub publoss male age numchild ownscar commutetime if pnudges==1 & month==11
16. reg altday lossframe pub publoss male age numchild ownscar commutetime if pnudges==1 & month==12
17. reg altday lossframe pub publoss male age numchild ownscar commutetime if pnudges==1 & month==1
18. reg altday lossframe pub publoss male age numchild ownscar commutetime if pnudges==1 & month==2

** Regressions for individual months of the post month nudges. The results can be found in Table 2 and visual results can be shown in Figure 2.

19. reg altday lossframe pub publoss if pnudges==1
20. reg altday lossframe pub publoss male age commutetime if pnudges==1

** Alternative regressions with different covariates. Results can be found in column 1 and column 2 of Table 5 in Appendix A.

21. ssc install distinct
22. distinct date if pnudges==1

** Used to find the unique "work days" used in the post nudge months where participants logged information.

23. gen losspnudge= lossframe*pnudges
24. gen pubpnudge= pub*pnudges
25. gen publosspnudge= publoss*pnudges

** Generating new treatment variables for post nudge months. This is to be able to run a regression to evaluate the first 3 months of nudges against the final 4 months of no nudges.

26. reg altday lossframe pub publoss male age numchild ownscar commutetime pnudges losspnudge pubpnudge publosspnudge
27. reg altday lossframe pub publoss male age commutetime pnudges losspnudge pubpnudge publosspnudge
28. reg altday lossframe pub publoss pnudges losspnudge pubpnudge publosspnudge

**Final regressions show the results of the first 3 months of nudge incentives against the final 4 months of no nudges. Results can be found Table 4.