Driving Change: How Workplace Benefits Can Nudge Solo Car Commuters Toward Sustainable Modes

By

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B.A.Sc. in Engineering Science
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Submitted to the Department of Urban Studies and Planning and the Department of Civil and Environmental Engineering in partial fulfillment of the requirements for the degrees of

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Abstract

This thesis investigates the role that employer benefits can play in encouraging commuters to use sustainable modes of transportation, motivated by the increasing cost of parking provision at urban workplaces and the broader potential for travel demand management strategies to mitigate traffic congestion and pollution.

In this research, case studies are conducted at two urban employers in Greater Boston. At the Massachusetts Institute of Technology (MIT) and at Partners HealthCare, employee transportation benefits were recently enhanced to encourage alternatives to driving. MIT, concerned about an upcoming reduction in parking supply, announced in 2016 that it would provide its more than ten thousand staff with a fully-subsidized local transit pass. In an agreement with the transit agency, MIT only pays for transit trips taken, thereby avoiding the expense of monthly passes for non-riders while providing universality of coverage. For drivers, MIT eliminated annual parking permits in favor of daily, pay-as-you-park pricing to encourage multi-modality. The net result was an eight percent reduction in parking demand in the first year, at a net cost to MIT of about $200 per employee. Transit agency revenue increased as ridership among MIT employees rose approximately ten percent.

Partners HealthCare was motivated to reduce its employee parking demand in the midst of consolidating fourteen administrative worksites to a new facility in Somerville, MA, and faced city-imposed parking restrictions. Like MIT, it introduced daily parking pricing, but tied the rates to employee income as an equity measure. Unlike MIT, it did not offer a universal transit pass, but increased monthly pass subsidies. With the new facility located along the MBTA Orange Line, there was a marked increase in transit ridership among employees who used to work in the suburbs, and today parking demand is well below anticipated levels.

The thesis supplements these case studies with a randomized controlled experiment on two thousand MIT car commuters, investigating how behavioral ‘nudges’ can further encourage reductions in driving. While no statistically significant reductions in parking were observed during the experiment, the combination of token monetary rewards and informational nudges appeared most effective at shifting travel behavior.

This research illustrates the potential for travel demand management strategies to influence commuter mode choice, but reinforces the importance of carefully considering implementation details such as cost salience and user experience. Long-term success appears dependent on building a constituency of support for such strategies among employer, commuter and government stakeholders.

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# Contents

1 Introduction 17  
1.1 Motivations .......................................................... 17  
1.2 Objectives ............................................................. 20  
1.3 Research Approach ................................................... 20  
1.4 Thesis Organization .................................................. 20  

2 Literature Review 23  
2.1 Travel Demand Management ......................................... 23  
2.1.1 Approaches to TDM .................................................. 24  
2.1.2 Employer Transit Benefits ......................................... 26  
2.1.3 Parking ............................................................... 27  
2.1.4 University Campus Programs ..................................... 29  
2.1.5 TDM in Cambridge, Massachusetts ................................ 30  
2.2 TDM and Behavioral Science ......................................... 33  
2.2.1 Theories of Behavior ................................................ 33  
2.2.2 Predictable Irrationality in Transportation ....................... 34  
2.3 Experimental Interventions ............................................ 35  
2.3.1 The Randomized Controlled Trial .................................. 35  

3 Transportation Policies & Programs at MIT 37  
3.1 Background and history ............................................... 37  
3.1.1 MIT Parking Pricing ............................................... 37  
3.1.2 Parking Infrastructure .............................................. 39  
3.2 Motivation for TDM at MIT ........................................... 39  
3.3 Overview of AccessMIT ............................................... 41  
3.3.1 Daily parking pricing .............................................. 42  
3.3.2 Free Transit Pass .................................................... 43  
3.3.3 Commuter Rail ....................................................... 43  
3.3.4 MBTA Station Parking Subsidy .................................... 44  
3.3.5 Online Commuter Dashboard ...................................... 44  
3.4 Policy Objectives and Strategy ....................................... 47  
3.4.1 Communication and Outreach ...................................... 48  
3.4.2 Leveraging Behavioral Science ..................................... 48  

4 Program Evaluation 53  
4.1 Evaluation Methodology ............................................... 53  
4.2 Employee Impacts ..................................................... 54
4.2.1 Benefits Usage .............................................. 55
4.2.2 Mode Choice .............................................. 57
4.2.3 Employee Parking Trends ................................. 62
4.2.4 Transit Usage .............................................. 68
4.2.5 Attitudes Towards Program ............................... 69
4.2.6 Employee Segmentation: Who Changed Behavior? .... 72
4.3 Institute Impacts ............................................. 74
4.3.1 Aggregate Parking Demand ............................... 74
4.3.2 West Garage Closure ..................................... 77
4.3.3 Transit Ridership .......................................... 79
4.3.4 Program Finances ......................................... 80
4.4 Discussion ....................................................... 83
4.4.1 Lessons ..................................................... 83
4.4.2 Tensions in Policy Design and Implementation .... 88
4.5 Conclusion ....................................................... 91
5 Randomized Controlled Trial ................................. 93
5.1 Introduction ................................................... 93
5.2 Background .................................................... 93
5.2.1 Experiment Motivation ................................... 94
5.2.2 Evaluating TDM Programs ............................... 94
5.2.3 TDM Experimentation at MIT ............................ 95
5.3 Methods ........................................................ 95
5.3.1 Developing the Research Sample Pool .................. 95
5.3.2 Treatment Groups ........................................ 96
5.3.3 Implementation .......................................... 100
5.3.4 Evaluation Metrics and Criteria ......................... 100
5.4 Results ........................................................ 101
5.4.1 Campaign Engagement ................................... 101
5.4.2 Change in Travel Behavior ............................... 101
5.4.3 Exit Survey Results ....................................... 105
5.5 Discussion ....................................................... 108
6 Case Study: Partners HealthCare ............................. 111
6.1 Overview and Background ................................... 112
6.1.1 Literature .................................................. 112
6.1.2 Assembly Row Development ............................ 113
6.1.3 Offices and Consolidation ............................... 114
6.1.4 Parking & Commuting Benefits ......................... 114
6.1.5 Employee Profile ......................................... 117
6.2 Impact of Relocation on Employee Travel Behavior .... 119
6.2.1 Changes in Commuting by Prior Office Location .... 120
6.2.2 Enhanced Commuter Benefits ............................ 131
6.2.3 Mode Choice .............................................. 131
6.2.4 Parking .................................................... 133
6.2.5 Transit ..................................................... 139
6.3 Discussion ....................................................... 142
6.3.1 Research Questions ...................................... 142
6.4 Conclusion

7 Conclusion

7.1 Overview

7.1.1 Summary of Interventions

7.1.2 Evaluation Strategy

7.1.3 Key Findings

7.1.4 Cross-Cutting Themes

7.1.5 Motivating the Stakeholders

7.2 Recommendations

7.3 Future Research

A AccessMyCommute Incentive Programs

B Promotional Materials for AccessMIT

C Survey Questionnaires

C.1 MIT 2016 Biennial Transportation Survey

C.2 MIT 2017 Sustainable Commuting Post-Experiment Survey

C.3 Partners HealthCare 2017 Employee Commuting Survey
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-1</td>
<td>Evolution of commuter mode shares in Cambridge, MA from 1990 through 2014 (Groll, 2016)</td>
<td>31</td>
</tr>
<tr>
<td>3-1</td>
<td>Drive-alone commuting mode share nationwide, citywide and among MIT employees. (US Census &amp; ACS; MIT Commuter Survey, 2004-2016)</td>
<td>38</td>
</tr>
<tr>
<td>3-2</td>
<td>Parking supply across MIT campus, divided into five administrative areas. Source: MIT Campus Planning</td>
<td>40</td>
</tr>
<tr>
<td>3-3</td>
<td>Recent, planned and potential losses in parking supply across MIT campus. Source: MIT Campus Planning</td>
<td>40</td>
</tr>
<tr>
<td>3-4</td>
<td>Multimodal trip planner showing travel time, cost, emissions and calories</td>
<td>45</td>
</tr>
<tr>
<td>3-5</td>
<td>Carpool matching tool showing a potential match. The dashboard indicates that such a pick-up would add an extra mile or 12 minutes to the driver’s commute</td>
<td>45</td>
</tr>
<tr>
<td>3-6</td>
<td>Dashboard homepage, indicating trip log and search portal to trip planner</td>
<td>46</td>
</tr>
<tr>
<td>3-7</td>
<td>Example of incentive program user interface</td>
<td>46</td>
</tr>
<tr>
<td>3-8</td>
<td>Example of a poster developed by a marketing firm to promote AccessMIT program. Others are shown in Appendix B</td>
<td>49</td>
</tr>
<tr>
<td>4-1</td>
<td>Home location of MIT employees by census tract, 2016</td>
<td>56</td>
</tr>
<tr>
<td>4-2</td>
<td>Reported primary mode choice, MIT employees (2004-16 biennial Transportation Survey)</td>
<td>58</td>
</tr>
<tr>
<td>4-3</td>
<td>Single-occupancy vehicle mode share by employee home location, aggregated by census tract (2016 survey)</td>
<td>59</td>
</tr>
<tr>
<td>4-4</td>
<td>Reported primary mode choice, all MIT employees (left) and new hires since 2014 (right)</td>
<td>61</td>
</tr>
<tr>
<td>4-5</td>
<td>Parking ratios from daily commute diary (2004-2016 Transportation Survey). The ratio is defined as the number of days a commuter drove to MIT divided by the number of days he or she reported coming to campus during the survey diary week</td>
<td>62</td>
</tr>
<tr>
<td>4-6</td>
<td>Stated mode shifts from 2015 (left) to 2016 (right) among survey respondents who reported changing their commuting modes. Continuity of the same mode implies a new secondary mode was chosen (not shown)</td>
<td>63</td>
</tr>
<tr>
<td>4-7</td>
<td>Stated mode shift among 2016 survey respondents who formerly drove to campus</td>
<td>63</td>
</tr>
<tr>
<td>4-8</td>
<td>Average days parked in MIT gated lots in 2016-17 academic year per employee by home census tract</td>
<td>66</td>
</tr>
<tr>
<td>4-9</td>
<td>Frequency distribution of average weekly parking frequency, before and after AccessMIT launch</td>
<td>67</td>
</tr>
</tbody>
</table>

11
4-10 Frequency distribution of average monthly transit billing on employee ID-embedded passes, 2016-17. Dotted lines indicated what it used to cost MIT employees to purchase a subsidized LinkPass through payroll deduction (left line), and what it would cost an employee to purchase a full-price LinkPass. 69

4-11 Average number of workdays using free MBTA subway/bus pass in 2016-17 academic year by employee home location, aggregated by census tract. 70

4-12 Comparison of commuter rail pass purchases before and after AccessMIT launch. 71

4-13 Responses to question: “For each of the following new AccessMIT benefits, how important is the benefit towards influencing your commuting methods, even on an occasional basis? Scale from 0 to 10. 72

4-14 Responses to question: “In general, how satisfied are you with MIT’s transportation services?” 72

4-15 Relationships between median household income by census tract and attributes of MIT commuters living in these census tracts. Only census tracts with at least 15 MIT employees are included. (Source: 2016 American Community Survey) 73

4-16 Proportion of 2016 Transportation Survey respondents who reported switching travel modes since 2015, mapped by employee home location at the census tract level. 76

4-17 Average weekday peak occupancy among gated lots, 2015-18 (interim). 79

4-18 Comparison of occupancy in five main parking areas during 2016-17 and early 2017-18, showing the impacts of the West Garage closure in September 2017. 79

4-19 Billing to MIT for MBTA transit passes plotted alongside the number of active passes each month (September 2016 through February 2018). 80

4-20 MIT employee parking fees and subsidies, 2005-2018. (a) Subsidy calculations after 2014-15 do not include a ‘space charge’ (which accounts for opportunity cost associated with the value of the land). (b) Missing subsidy data, shown hatched, is interpolated linearly. (c) The additional subsidy associated with leased spaces is shown where data exists after 2014-15. 81

5-1 Composition of experimental population and treatment groups. 96

5-2 Experiment timeline. 97

5-3 Samples of digest content (a-b) and rewards notification (c). 99

5-4 Plot of changes in mean parking frequency for all (left) and active (right) respondents. The downward trend among all groups can be attributed to seasonal variation. 103

5-5 Distribution of change in parking frequency by treatment arm. 105

6-1 Locations of prior PHS administrative offices (orange) and the new Assembly Row consolidated office (blue). 115

6-2 Top twenty cities and neighborhoods of home residence (Other: 2,402 staff, not shown). 118

6-3 Home location of PHS employee survey respondents, indicating primary mode choice. The upper map shows Greater Boston, while the lower map shows a zoomed-in perspective around Assembly Row. Location coordinates are approximated and scattered for privacy. 119
6-4 Self-reported influence of enhanced commuting benefits and workplace location, on a scale from 1 (least influence) to 5 (most influence). ........................................... 131
6-5 Drive-alone mode share at Assembly Row by age and sex ......................... 132
6-6 Stated mode shifts from before (left) to after (right) the move, among the 22% of survey respondents who reported changing their primary commuting mode. ........................................................................... 134
6-7 Daily and monthly peak occupancy, A.R. Garage and employee attendance counts, indicating under-capacity parking operations. .......................... 136
6-8 Parking frequency by income level. .......................................................... 137
6-9 Average calculated monthly parking frequency at A.R. Garage (September 2017 through February 2018) among employees formerly located at each worksite, derived from garage tap-in/tap-out data. Shaded bars indicate that these workers previously received free parking. .......................... 137
6-10 Average stated weekly parking frequency among employees formerly at each worksite, before and after the move. Locations 1, 8, 9 and 10, which had free parking, have the largest decreases. .................................................. 138
6-11 Average parking frequency at A.R. Garage (September 2017 through February 2018) by Walk Score, Transit Score, and Bike Score at employees’ place of residence. .................................................. 138
6-12 Self-reported change in parking frequency in the relocation to Assembly Row. 139
6-13 MBTA transit pass purchases by PHS employees. ................................. 139
6-14 Average monthly LinkPass usage among 700 PHS employees with available data. ................................................................. 140
6-15 Isochrones indicating areas accessible within one hour by MBTA transit (walk access). (a) shows current accessibility at Assembly Row, while (b) indicates the limited accessibility of the prior Wellesley site and (c) indicates the broader accessibility of the Prudential Center sites, especially to the south and west of downtown. Source: Conveyal Commute. 145
6-16 Contrast between hostile pedestrian environment to access the Schrafft’s PHS worksite from Sullivan Square Station (top) and the new office-adjacent Assembly Station (bottom). Source: Google Street View. 146
# List of Tables

3.1 Annual parking fees for regular commuter permits at MIT, 2001 through 2018 .......................................................... 38
3.2 MIT parking inventory (October, 2017) ...................................................... 39
3.3 New Daily Parking Pricing ................................................................. 42
4.1 Survey Representation ........................................................................ 55
4.2 Parking and Transit Benefits Participation .............................................. 57
4.3 Stated mode choice, MIT Commuting Survey (2014-16) ......................... 60
4.4 Stated reasons for mode shift (2016 Transportation Survey) ....................... 62
4.5 Parking Permit Purchases (2015-18) ...................................................... 64
4.6 Average Parking Frequency ............................................................... 67
4.7 Responses to question: “To what extent have the new AccessMIT commuter benefits influenced your commuting decisions?” .................................................. 71
4.8 Attributes of two-year employee panel. .................................................. 75
4.9 Highest five parking days, before and after launch of AccessMIT. ............... 77
4.10 Overall lot utilization across campus, 2015-17 ........................................ 78
4.11 MIT parking-related expenses and revenue, 2015-18 .............................. 82
4.12 Transit-related expenses to MIT and revenues to MBTA, 2015-18 ............... 84
5.1 Descriptive statistics of population sample ............................................. 97
5.2 Summary of Commuter Digest Email Campaign ..................................... 98
5.3 Change in Parking and Transit Usage ................................................... 102
5.4 Regression Analyses (Differences in Differences) ................................... 104
5.5 Selected Post-Experiment Survey Results ............................................ 107
6.1 Prior Office Locations .......................................................................... 115
6.2 New daily parking rates at Assembly Row Garage ................................... 116
6.3 Survey representativeness .................................................................... 117
6.4 Binary mode choice model (dependent variable: SOV (1) vs. non-SOV (0) primary mode choice). Percentages alongside dummy variables indicate the proportion at which the variable takes on a value of 1. ......................... 135
6.5 Scenarios of MBTA transit benefits offered to employees by PHS, including (1) existing benefits, (2) a universal pass, and (3) a hybrid structure. ...... 143
Chapter 1

Introduction

It has been said that in any urban transportation project, the public is concerned with the five W’s and H: who, what, when, where, why, and how much parking will be removed. The right to park one’s personal vehicle has seemingly been equated in North American culture with the lowest rung of Maslow’s Hierarchy alongside air and water, with the car as a symbol of mobility, freedom and status. Since the latter half of the twentieth century, the car’s place in urban society has begun to be questioned as cities reckon with the adverse impacts of automobile-oriented urban design and car-dependent lifestyles, but parking policy has remained the third rail of city politics.

This thesis is about transportation demand management (TDM) informed by behavioral science. It considers the importance of parking as a determinant of car usage, and aims to provide evidence-based, politically practicable techniques of discouraging solo driving using demand-side interventions. The evidence is drawn largely from a case study of employee travel behavior at the Massachusetts Institute of Technology (MIT). While known as a venerable institution of world-class researchers, its staff and faculty are no less tempted by the spoils of underpriced parking. This research unpacks why commuters make seemingly irrational travel decisions, and why workplace administrators choose ostensibly perverse incentive structures that reinforce sub-optimal commuting patterns.

Then, through the evaluation of MIT’s overhaul of commuting benefits, along with a randomized controlled trial of customized commuting nudges, the thesis tests the hypothesis that employer-based TDM can have a positive impact while remaining cost-effective. Moving beyond the MIT case study, this research also evaluates a similar suite of commuting benefits reforms at Partners HealthCare, putting forth lessons learned for policy-makers, employers and researchers looking for evidence on the efficacy of TDM.

1.1 Motivations

Much has been studied on the topic of TDM. Introduced in the USA in the 1970s in the nascence of air pollution regulations (most notably the Clean Air Act of 1970 (Meyer, 1999)), initiatives were aimed at mitigating such pollution experienced across American
cities as a result of increased car usage. While events like the 1973 oil crisis led to short-lived decreases in vehicle-miles traveled (VMT), the overarching trend has been a steady rise in traffic across the country owing to population growth, urbanization, vehicle affordability and the rise of the freeway guided by a belief that roadway capacity improvements would alleviate motor vehicle congestion.

The hypothesis that building and widening roads would alleviate traffic has long since been disproved, with the implications of induced demand now well understood (Cervero, 2002). While traffic so easily appears in the presence of capacity increases, so too will it dissipate if the right incentives are provided; this is where TDM can have its impact. Whether through structural interventions (like carpool lanes and parking pricing schemes) or psychological interventions (like marketing and promotional campaigns) (Fujii et al., 2001), a vast suite of options exist to modify the ‘choice architecture’ (Thaler & Sunstein, 2008) presented to travelers when planning their journey.

TDM programs may be motivated by a desire to reduce traffic congestion and its impacts including pollution, economic deadweight and worsened quality of life for travelers. In recent years, a newfound focus has been placed on the connection between transportation and public health, with studies linking the prevalence of driving with negative health outcomes including obesity and heart disease, while active modes and public transportation have shown links to improved health outcomes (She et al., 2017; MacDonald et al., 2010; Edwards, 2008).

While the social and environmental objectives of TDM programs are important, the reality is that many efforts to reduce driving and parking demand stem less from altruism and more from pressures on the balance sheet. Parking is expensive, and urban employers are faced with the need to provide, and often the pressure to subsidize, staff parking spaces. A paradigm shift in land use law has led to the reduction or elimination of minimum parking requirements in many progressive cities—sometimes replaced by parking maxima (Shoup, 2005). Nevertheless, developers, landowners and employers still often feel the need to provide ample parking to maintain real estate values and the perception of accessibility.

The Massachusetts Institute of Technology (MIT) is an employer facing these very pressures on its parking supply. Employing over 11,000 individuals, the Institute provides approximately 4000 parking spaces in an urban setting where real estate values and zoning regulations make additional parking provision difficult and exceedingly expensive1. As old parking structures reach the end of their useful life, the university administration recognized that a TDM program to reduce parking demand would be significantly more cost-effective than the reconstruction of parking garages, and would dovetail with the Institute’s sustainability and climate change objectives as a reduction in campus-associated VMT would reduce MIT’s carbon footprint.

A central motivation of this thesis is to evaluate MIT’s program as a guide for other employers facing a parking crunch, for municipalities designing their own TDM programs, and for public transit agencies seeking to build ridership through workplace-based pass

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1The cost of building new underground parking on campus is now estimated at close to $200,000 per space.
programs.

Beyond the case study of MIT, this thesis also presents an evaluation of commuting benefits reforms at the administrative headquarters of Partners HealthCare System. The firm consolidated fourteen offices spread across greater Boston into a centralized site along the MBTA Orange Line in the neighborhood of Assembly Row in Somerville, Massachusetts. In relocating the workforce of four thousand, Partners opted for a location outside the downtown core, and was concerned that the maximum number of parking spaces allowed by Somerville would not accommodate all the employees seeking to drive to work. In choosing a transit-accessible location and enhancing its suite of commuter benefits, Partners strove to mitigate the risk of a parking shortage. We surveyed Partners employees shortly after the move, tying their responses to parking and transit records, in order to understand how reformed parking pricing and transportation benefits could effect a shift away from solo car commuting in the midst of a change in work location.

A Note on the Future: Why Bother with Travel Demand Management?

One potential critique of the relevance of this thesis is that autonomous vehicles (AVs) are around the corner, alleviating the need for parking demand management since AVs may be able to drop off passengers and park effortlessly off-site. While this may someday come to fruition, the introduction of low-occupancy AVs will not eliminate the fundamental geometric problem of personal vehicles: they take up a lot of space. Even if AVs increase throughput capacity substantially, this unlocked capacity will hastily be consumed by induced demand. Travel demand management techniques, through combinations of structural and psychological techniques, will remain important in shaping how travelers choose amongst whatever options are available to them. Even in a utopia of automation, human behavior—and our ability to understand and nudge it—will determine the success or failure of mobility systems.

Furthermore, TDM is not exclusive to private automobiles. Many successful public transit agencies worldwide are facing growth in ridership, with passenger congestion jeopardizing rider comfort, on-time performance and safety. Just as this thesis employs techniques of behavioral science to nudge drivers out of their cars, the very same techniques can be applied to nudge passengers towards a different route or departure time. Halvorsen et al. (2016) offered a framework of public transit TDM approaches, and this thesis builds on such work.

Finally, with the federal government spending $7.3 billion per year subsidizing employees to drive to work through the federal income tax exclusion for parking (Transit Center, 2017), a key motivation of this thesis is to show that car-biased transportation benefits will invariably lead to overuse of the private automobile. As discussed in Section 1.2, a central goal of this thesis is to offer hope that simple reforms in workplace transportation benefits can have appreciably positive impacts on travel behavior and the reduction of its negative externalities.
1.2 Objectives

With these motivations in mind, the thesis seeks to accomplish three main objectives. First, it aims to present a thorough evaluation of how workplace TDM initiatives, specifically the use of parking pricing techniques and public transit benefits, can achieve a shift in commuter mode choice away from solo car trips towards more sustainable modes.

Second, in a transition from passive evaluation to active intervention, the thesis tests how behavioral ‘nudges’ in the form of targeted information and monetary rewards can extend the reach of traditional TDM policies. A randomized controlled experiment on two thousand MIT commuters examines these hypotheses.

Finally, the research aims to take a nuanced look at the policy challenges and opportunities associated with implementing and operating a TDM program using two case studies in the Boston area, and seeks to provide lessons learned for employers, transit agencies and government stakeholders on how to successfully achieve reductions in drive-alone commuting through fiscally responsible and politically practicable workplace incentives.

1.3 Research Approach

The methods employed within this thesis center around quantitative analyses of passive transportation data sources and survey-elicited attitudes among commuters, as well as a qualitative study through engagement with workplace stakeholders.

Passive data sources include employee records of parking lot entries and exits and MBTA pass usage at both MIT and Partners. In the MIT case study, biennial commuter surveys of all staff are tied to passive transportation records to build longitudinal profiles of travel behavior. A separate exit survey following the randomized controlled trial provides supplementary feedback. In the Partners case study, a post-relocation survey elicits responses on commuting patterns before and after the move, and is tied to employee parking and transit records.

Qualitative feedback is received through informal interviews with staff in MIT’s Parking & Transportation Office, Office of Sustainability and members of the Institute Committee on Parking & Transportation, along with correspondences with departmental parking coordinators. Perspectives at Partners are gained through communications with staff in the Workplace Services group and the Real Estate & Facilities group.

1.4 Thesis Organization

The thesis is divided into seven chapters. Chapter 2 provides an overview of relevant literature on TDM and its intersections with behavioral science. Chapters 3 and 4 present the case study of the transportation benefit reforms at MIT entitled AccessMIT, beginning with an overview of campus commuting policies and followed by an evaluation of
program reforms in 2016. Chapter 5 then discusses the randomized controlled trial conducted on MIT staff commuters in the spring of 2017, building off the early success of AccessMIT. Chapter 6 then shifts focus from MIT towards Partners HealthCare, another employer that enhanced its transportation benefits, with an evaluation of impacts on employee travel behavior. Finally, Chapter 7 offers concluding remarks and a summary of the research.
Chapter 2

Literature Review

In cities around the world, traffic congestion imposes a growing burden on economic productivity and quality of life. In American cities, increasing commuting times are costing over $100 billion annually in direct and indirect losses (Guerrini, 2014). While commuters have an inherent interest in reducing the disutility of their travel (in terms of travel cost, time and stress), employers may be similarly motivated to improve their workers’ commutes. This motivation can stem in part from a desire to attract and retain workers, or an altruistic concern for commuter wellbeing. More commonly, though, employers also face various systemic pressures from the perspective of minimizing costs and adhering to government policies.

In particular, the provision of staff parking often imposes a steep cost for workplaces, in the form of construction and operations costs of parking facilities and the opportunity cost of such land occupying valuable real estate. Workplaces tend to develop a culture around commuting (Hendricks, 2005), with some having established decades-long practices of offering free or highly subsidized parking as an employee benefit. Commuters that use public transit or other non-driving modes have long faced systemic inequities in the availability and amount of employer and government-provided transportation incentives.

This chapter provides background on TDM, including its origins and recent developments. First it explores the different approaches to demand management, from the perspective of governments, employers and universities in particular. Then, it delves into the theory of behavioral science and its applications in transportation. Finally, experimental interventions are introduced, including the randomized controlled trial (RCT), as background for the RCT experiment discussed in Chapter 5.

2.1 Travel Demand Management

The origins of TDM in the United States stem largely from federal government initiatives introduced in the 1970s and 1980s aimed at reducing air pollution (Meyer, 1999). Framed as “Transportation Control Measures” (TCM), such approaches were centered around traffic management through a combination of supply-side interventions (e.g. increasing road-
way capacity) and demand-side programs (e.g. early campaigns to encourage carpooling). The 1990 amendments to the Clean Air Act established a greater emphasis on the latter, with TCMs classified to include regulatory tools such as trip reduction ordinances, mobility improvements for non-auto modes, and market-based mechanisms such as road pricing (Cambridge Systematics, 1996). Most notably, the 1990 CAA amendments introduced mandatory employer trip reduction programs known as employee commute options (ECO). Although federal ECO mandate was later made voluntary, many regions opted to retain such requirements for employers (United States House Committee on Commerce, 1995; Dill & Wardell, 2007). The legislation acknowledged that employers are a central leverage point in influencing peak-period travel patterns, and that policies incentivizing or mandating workplace-based TDM measures could have an appreciable impact on air pollution.

2.1.1 Approaches to TDM

The toolkit of TDM techniques available to program managers—whether government or private employers—has evolved since the TCMs of the 1970s, albeit with similar fundamentals. At their core, TDM approaches generally seek to reduce demand for road space and parking, typically through the reduction in frequency and length of single-occupancy vehicle (SOV) trips in favor of fewer, shorter, and/or alternate-mode (carpool, transit, and non-motorized) trips. Among many techniques available, the Federal Highway Administration offers eight main approaches to TDM: road pricing, parking management and pricing, car sharing, pay-as-you-drive insurance, ridesharing and high-occupancy vehicle (HOV) lanes, transit incentives, transit improvements, and teleworking (Federal Highway Administration, 2012).

Kavta & Goswami (2018) present a framework of TDM approaches using five pillars: policy and planning reforms, land use and zoning, incentives, support programs, and transit improvements. In each category, ‘push’ and ‘pull’ approaches are contrasted across varying time scales. For example, they categorize parking pricing as a short-term push factor under incentives, while transit-oriented development is considered a long-term pull factor under land use and zoning. In the following sections, we focus on TDM initiatives encompassing all five pillars, whose goals are to promote of alternative travel modes to driving alone.

**Regional Programs**

TDM initiatives can be regionally implemented or site-based. Regional approaches tend to be incorporated into transportation and land use planning, and may be enshrined in municipal legislation through zoning and related ordinances. For example, the adoption of maximum parking allowances (as opposed to or in addition to minimum parking requirements) for developers can mitigate the over-supply of parking plaguing many urban developments (Shoup, 2005), while municipal parking and TDM ordinances like that of the City of Cambridge can provide a toolkit for individuals, workplaces and developers to help a city achieve overall mode share targets (Cambridge Municipal Code, 1998).

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1 TDM may encompass a broader definition to include the management of public transit demand, such as through peak-spreading initiatives like early-bird discounts (Halvorsen et al., 2017). This paper constrains the focus of TDM to private vehicle travel.
A majority of funding for regional TDM programs in the USA comes from the federal Congestion Mitigation and Air Quality (CMAQ) Program, introduced in 1991 by the Federal Highway Administration (FHWA) to support projects that reduce air pollution and mitigate traffic congestion (Federal Highway Administration, 2017). While CMAQ-supported projects have exhibited varying levels of success at influencing travel patterns, TransitCenter research found that travelers were less receptive to the CMAQ goals of reducing traffic and pollution, instead concerned primarily with their own travel time, travel time reliability and flexibility (Mackie, 2015). Indeed a common refrain among TDM program evaluations is that altruistic intentions tend to be dominated by individual traveler preferences. Guell et al. (2012) found that commuting is an "embodied and emotional practice", rendering it obstinate against extrinsic influences. As such, regional TDM approaches are found to be most effective when, rather than seeking to persuade, they involve reshaping the context in which travel decisions are made, such as by providing less parking, increasing the price of SOV travel, and reshaping long-term land use patterns.

Employer-Based Approaches
Complementary to regional initiatives, site-based TDM programs recognize the leverage offered by individual employers and institutions. Such initiatives may be motivated from regulatory requirements like a Trip Reduction Ordinance mandated by local or state laws. For example, the Washington State Commuter Trip Reduction Law, introduced in 1991, requires employers to take steps to reduce the drive-alone mode share (Washington State DOT, 1991).

Another key motivator for employers is the suite of tax incentives associated with employer-based transportation benefits. Changes to the US tax code since 1992 allow employers to deduct qualified transportation expenses from the taxable income of their employees while also reducing their payroll tax. Maximum monthly deductions for parking and transit were initially set at $155 and $60, respectively. (While this discrepancy suggests parking was valued more highly than transit, Block-Schachter (2009) notes that the initial transit deduction of $60 was likely set at this amount because most transit agencies at that time charged less than $60 for a monthly pass.) Over the years, the allowable deductions have increased, and now sit at $260 each for parking and transit expenses. Tax incentives are a TDM strategy that targets both employers and employees, since workers can only use such a benefit if their employer offers transit benefits. A 2014 nationwide survey found that commuters offered pre-tax transit benefits were five times as likely to use transit as those not offered such benefits (Transit Center, 2014). However, given that only 7% of the U.S. workforce is offered subsidized transit benefits, and only 2% actually claims them (Transit Center, 2017), the impact remains limited. The most significant limitation is that the transit benefit must be provided directly by the employer, meaning that employees at smaller firms (without sophisticated benefits management systems) cannot deduct out-of-pocket transit expenses from their taxable income.

Regulatory and tax incentives aside, employers may be intrinsically motivated to shift their commuters away from driving based on the cost of parking provision or to improve the trip quality of commuters. In discussing site-specific TDM strategies, the overwhelming...
ingly most influential factor is parking—the provision and pricing structure thereof—which has been found to account for up to 80% of the variation in the number of employees who drive alone to work (Dowling et al., 1991). Eliminating free parking in favor of paid parking or offering a parking cash-out (whereby employees can opt for cash in lieu of a parking benefit) are shown to be effective interventions (Shoup, 1997).

2.1.2 Employer Transit Benefits

Examples abound of cities that have adopted TDM programs to reduce car use through workplace-based ordinances. The regions of Southern California, Tuscon, Arizona, and Washington State are prime case studies due to their imposition of mandatory employer commute trip reduction (CTR) programs. In Southern California, the South Coast Air Quality Management District (SCAQMD) requires that employers with at least 250 employees must have a CTR, while in Tuscon, Arizona, employers with at least 100 employees must have implemented a trip reduction program. The CTR requirement in Washington State applies to employers with at least 100 employees in nine counties. In these three regions, little average change in transit ridership among participating workplaces was observed, though this varied significantly by employer. Evidence suggests that small employers, who are not subject to CTR regulations, were more likely to offer transit benefits (ICF & CUTR, 2005).

In a case study of New York and New Jersey employers, Bueno et al. (2017) found a significant impact of commuting benefits on employee mode choice. In an analysis of 22,000 commuters with varying benefits, the authors observed that transit benefits, including monthly passes and reimbursements, were the largest determinant of transit usage. Conversely, incentives for car use including free or subsidized parking were strongly associated with higher rates of driving.

In Washington, D.C., a requirement for federal employers to provide transit benefits led to a 29% increase in overall ridership, where three-fifths of the new transit riders were previously drive-alone commuters. Denver’s EcoPass, a universal pass program for employers, brought in 6,000 new transit riders while San Jose’s led to 16,000 new users. In both these cases, it was estimated that over 90% of the new riders previously drove to work (ICF & CUTR, 2005).

In Minneapolis, MN, a universal pass program for employers was generally successful at increasing ridership. A survey of the six largest participating employers found that those with the highest baseline transit mode share exhibited the largest increases, while those with fewer transit riders to begin with had more modest growth in ridership (ICF & CUTR, 2005). In Southern California, a similar trend among employers was seen where those with higher transit mode shares a priori were most likely to increase ridership upon implementation of a transit benefit. However, these employers also exhibited the largest decreases as well, with only a slightly positive average impact overall (0.1 new transit riders per 100 employees).

In Portland, OR, TriMet introduced a universal pass program in 1998. Participating employers provide a transit pass to all employees, and are charged only for the number of
rides taken (as estimated through employee surveys). From 1998 to 2012, participating employers experienced a growth in transit mode share from 8% to 22%. These 169 employers saw a 23% drop in drive-alone commuting as well. TriMet also offers a more traditional monthly pass program, popular among employers with a lower transit mode share. While more employers participate in the monthly pass program, overall fewer employees sign up (due to the fixed monthly cost) compared to the pay-per-use arrangement (Gates, 2015). In Portland’s Lloyd District, a high-density commercial neighborhood, a combination of increased parking pricing and reduced-cost transit passes led to a 19% decrease in SOV commuters. The Lloyd District saw transit mode shares increase from 21% in 1997 to 41% in 2008, alongside growth in carpool rates.

In Seattle, WA, two employer transit programs are offered: the ORCA Business Choice, and the ORCA Business Passport. The Business Choice program is a standard monthly pass program with no discount or universality requirements, and allows employers to access federal transit tax incentives. The Business Passport, conversely, is a universal pass in which all employees at a workplace would be enrolled. Companies are required to subsidize at least 50% of the cost of each pass, and bulk discounts are provided based on the location of the workplace. Over 450 employers make use of the Business Passport program, paying anywhere from $47 to $867 annually per employee depending on the location of the workplace, with more central and transit-accessible locations being charged more (King County Metro, 2018).

### 2.1.3 Parking

Regardless of transit benefits provided by an employer, the TDM literature is clear in its finding that parking pricing is the most important factor determining employee drive-alone commuting rates (Hamre & Buehler, 2014). Today, only about 5% of car commuters pay for parking in the US, and of these, costs are typically shared with the employer. Willson (1992) found that between 19% and 81% fewer cars are driven to work when free parking is eliminated, and Washbrook et al. (2006) found that parking costs were more influential than any other factor, such as the time and cost of alternative travel modes, in determining SOV rates.

The current federal tax code acts to encourage driving through a $7.3 billion per year subsidy of parking (Transit Center, 2017). According to the Transit Center report, the federal income tax exclusion for parking is responsible for an additional 820,000 drive-alone commuters adding a total of 4.6 billion additional miles every year. While a transit benefit can be claimed alongside the parking exclusion, the researchers estimate that it removes only a tenth as many vehicles as the parking benefit adds. This is due to the much more limited reach of the transit benefit. The authors recommend eliminating the commuter parking benefit, and consider adopting systems like those of Australia, Ireland, Sweden or Austria which tax the value of parking provided by employers. This could include a provision in which employers are mandated to list the value of employee parking as taxable income to the employee.

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3This is in contrast to the $1.3 billion spent annually on the commuter transit benefit.
Daily Parking

Beyond the decisions of whether or not to charge for parking and the amount of said charge, a key element to TDM program design is how parking fees are actually charged. Specifically, the frequency at which parking is paid for can significantly impact the salience of the cost. Recent research has highlighted the benefits of switching from annual or monthly parking towards daily or pay-as-you-park pricing, with two justifications. First, charging for each transaction makes the cost more noticeable than if it were charged less frequently; each time a driver decides to park, he or she must decide whether to swallow the charge. Second, the removal of an annual or monthly fee eliminates the sunk cost of parking prepayment. Rather than perceiving parking as a one-time expense wherein drivers subsequently feel the need to ‘get their money’s worth’ out of their permit, a daily charge no longer locks in a driver in the same way.

The City of Seattle included daily parking as part of its recommended package of TDM measures, and other cities have followed suit (Gates, 2015). In Seattle, for example, the Gates Foundation recently made headlines for its success at leveraging daily parking pricing to reduce SOV mode share among its 1,200 full-time staff. Starting with a drive-alone rate of 90%, the Gates Foundation was able to reduce it to only 34% through a series of TDM initiatives that centered around eliminating free parking in favor of a $12 a day fee to park (Gutman, 2017). In order not to penalize commuters who must drive every day and retain market-level pricing, the daily fees are capped at $120 per month. This means that drivers who park more than 10 days each month receive ‘free’ parking for the remainder of the month, but are re-incentivized each month to reduce their parking when the cap resets. After switching to daily parking, commuters regularly filled up only half of the Foundation’s owned and leased parking spaces.

In Singapore, employees at the Land Transport Authority (LTA) were transitioned from monthly to daily parking in 2013, and subsequent behavior changes were monitored in a study. Researchers observed that monthly parkers who switched to daily parking exhibited a four-day-per-month average reduction in parking frequency (Leong et al., 2018). The authors compared the results to a similar pilot at the Singapore Ministry of the Environment and Water Resources Headquarters (MEWR-HQ), and noted the relative effectiveness of the policy at the LTA over the MEWR-HQ, owing to two factors. First, parking at the LTA is charged directly at the parking gantry, wherein drivers immediately see the price they pay for parking. Conversely, at MEWR-HQ daily parking charges only appear on pay slips in the following month. The presence of an immediate behavioral feedback loop is posited to increase the effectiveness of the program. Second, Leong et al. note how workplace culture and benefits plays a role. At the LTA, there is more of a transit-oriented culture and staff receive a monthly credit for public transit fares, whereas at the MEWR-HQ no transit benefits are provided.

Before the advent of electronic and hands-free parking payment systems, the need for daily cash transactions hindered the practicality of daily parking schemes (Rodier et al., 2005)\(^4\). Today, however, with technologies offering seamless transaction management and workplace payroll integration, the barriers to daily parking pricing have been lessened.

\(^4\)While cash transactions make daily parking pricing more difficult and costly to administer, they also maximize the salience of the transaction as compared to cashless payment media, and would perhaps be most effective at reducing parking demand.
Nonetheless, employers that lease parking from property owners are often tied to long-term space allocations, while other employers own ample amounts of parking; in either case, they may perceive little incentive to reduce parking demand if their spaces will only sit empty. As such, it is important to demonstrate that a long-term reduction in parking demand can result in financial savings achieved through a reduction in the number of leased spaces, or a re-purposing or sale of land formerly used for parking.

Carpooling

For many workplaces, especially those outside the service area of high-quality public transit, TDM strategies focus on increasing the occupancy of private vehicles through carpooling. Long seen as the “holy grail of transportation planning”, encouraging carpooling has been a TDM challenge for decades, largely unsolved given the low carpool mode shares across the country (Lien, 2017). Reasons for this stem largely from the reluctance of drivers to cede control or flexibility (Bonsall et al., 1984), and are consistent with the TDM literature that has found how psychological motivations often overpower instrumental reasons for/against car use (Lois & López-Sáez, 2009; Mokhtarian & Salomon, 2001; Steg, 2005). When TDM programs focus on carpooling with ‘carrots’ or ‘sticks’, the sticks (such as pricing) have been found to be more effective than carrots (such as reserved parking or carpool matching services), though when factoring in the political barriers to implementation, both approaches have merit (Hwang & Giuliano, 1990). In recent years, information and communication technology (ICT) has expanded the capability for dynamic and real-time carpool partner matching, and is being leveraged by companies such as Waze Carpool, RideAmigos, Luum, BlaBlaCar and other emerging firms.

2.1.4 University Campus Programs

University campuses are an environment in which TDM programs can often be especially effective. As outlined in Cherry et al. (2018), the effectiveness of campus-based TDM is owed to four factors. First, universities tend to have centralized planning frameworks steering campus development. Second, they tend to have direct control over their transportation and land use policies and infrastructure (e.g. shuttles, parking facilities, bicycle amenities, etc.). Third, campuses typically experience many-to-one travel patterns, meaning that the origin-destination matrix for commuters includes a common destination, mitigating the need to accommodate complex travel flows. And fourth, universities tend to keep rich datasets on the campus community, including surveys and home locations.

Depending on their size and location within an urban context, universities may employ various strategies to manage staff and student travel demand with objectives of minimizing parking provision, reducing campus carbon footprint, enhancing the attractiveness of the employee or student experience, and managing costs. Strategies may include ‘carrots’ like a parking cash-out, transit subsidies and incentive campaigns, alongside ‘sticks’ like increased parking pricing.

A 2016 white paper by the U.S. Federal Highway Administration profiled the TDM strategies of six university campuses, all of which achieved drive-alone mode shares of under fifty percent. It identified five key lessons learned for generalization of their findings. First, active parking management through pricing, incentives and full life cycle accounting is a
key aspect of most successful programs. Second, leveraging centralized employer communication channels can expand the reach of TDM-related social marketing. Third, partnerships with local transit agencies can yield benefits of customized subsidy programs and/or service provision. Fourth, the integration of mobility options into a single package can ensure that benefits are not perceived to favor a particular mode or geography. Finally, regional, state, and local policies and partnerships provide important context upon which TDM programs should be designed (FHWA, 2016).

Stanford University, which had an SOV mode share of 49% in 2014, implemented a “Commuter Club” program which uses incentives to reduce driving (FHWA, 2016). Employees are offered cash to use alternative modes, including up to $300 in “Clean Air Cash” or “Carpool Credits” in exchange for not purchasing a parking permit. Prior to these incentives, a research project called CAPRI (Congestion and Parking Relief Incentives) used incentives and gamification to reduce peak period congestion, and was estimated to shift approximately 15% of peak period commuters towards off-peak hours (Zhu et al., 2014; Prabhakar, 2013).

At University of California (UC) Berkeley, staff SOV mode share declined from 60% in 1990 to 43% in 2014, with walking and cycling rates growing as the most common mode of transportation to campus. With only 0.1 spaces per registered student, staff and faculty member, the campus has an extremely limited parking supply. Parking permits are still sold on an annual basis, although the university is exploring daily pricing alternatives. Personalized trip planning assistance was piloted where transportation staff developed individualized commuting programs for employees, but the initiative was found to be prohibitively time consuming and ineffective at switching commuters to alternative modes (FHWA, 2016).

At the University of Washington, the ORCA Business Passport (introduced in Section 2.1.2) was branded as the U-Pass for the UW community and launched in 2011. Mandatory to all students and optional for faculty and staff, the discounted pass (currently costing $150 per quarter for employees) has been instrumental in reducing SOV mode share from 34% in 1990 to only 18% as of 2014. For the university, the pass program requires few administrative resources as billing is processed through a centralized system and multiple transit providers (bus, light rail and commuter train) are all included on the same pass.

### 2.1.5 TDM in Cambridge, Massachusetts

The City of Cambridge, located across the Charles River from Boston with a population of 111,000, has experienced tremendous growth over the past several decades. Kendall Square, in particular, has become a world center of biotech, entrepreneurship and the knowledge economy, bringing in thousands of new jobs into the area adjacent to MIT. Between 2000 and 2014, Kendall Square added 5% more residents and 6% more jobs with a total of 6.5 million square feet of new development, yet traffic volume decreased slightly on local streets. As no new road capacity has been added to the city, new trips to the area were mostly comprised of non-SOV modes. As shown in Figure 2-1, between 1990 and 2014 the drive-alone mode share for Cambridge-bound commuters declined from 51% to 45%, while transit and cycling trips grew and walking trips remained steady. Carpool
rates, as per the nationwide trend, have been on the decline. For residents, the SOV mode share dropped from 38% in 1990 to only 29% as of 2014 (Groll, 2016).

Like Washington State’s Commute Trip Reduction Law, Cambridge has its own regulatory framework helping it achieve reductions in SOV travel. The Cambridge Parking and Transportation Demand Management (PTDM) Ordinance was introduced in 1998 as a tool to manage growth in vehicular traffic and as a response to air quality concerns. The ordinance requires that small developments with at least five new parking spaces, or large developments with at least 20 new spaces, take measures to promote alternatives to SOV commuting, and negotiate a contract with the city on specific mode share requirements; a large project generally requires that SOV mode shares be at least 10% below the 1990 Census levels. Beyond a one-time development approval, there is an ongoing monitoring and reporting regime that must be followed. This includes: (a) annual reports submitted to the city with employee survey results on travel behavior including SOV mode share; (b) biennial counts of car and bike parking and driveway ins/outs; and (c) a status update to the city on PTDM measures taken by the property owner (Cambridge Community Development Department, 2011).

The PTDM Ordinance does not mandate specific measures, but rather provides a toolkit from which participants can choose. The current series of measures includes (Cambridge Community Development Department, 2011):

- Charging of market-rate parking to employees
- Transit subsidy
- Shuttle buses
- Daily rather than monthly parking rates
• Transportation information provision
• Emergency ride home program
• Bus shelters
• Having an on-site TDM coordinator
• Bicycle parking above minimum required by zoning
• Carpool/vanpool matching
• Showers and lockers for cyclists
• Hiring of Cambridge residents
• Priority parking for carpools
• Monetary incentives for walking and cycling
• Membership in a Transportation Management Association (TMA)

The last item, membership in a TMA, has been adopted by a number of employers across Cambridge. In 1995, twenty-five companies founded the Charles River Transportation Management Association (CRTMA) which, among several new TDM initiatives, consolidated fifteen employer shuttle programs into a unified bus route called EZ Ride, connecting Kendall Square employers with Boston’s North Station (Gates, 2015). The CRTMA, funded in large part by MIT, also administers an Emergency Ride Home program, allowing participating employees who use non-SOV commuting modes to submit a taxi or Uber/Lyft receipt for reimbursement in the event of occasional unexpected trips.

In all, the PTDM Ordinance has proven to be generally successful at its objective of accommodating growth in Cambridge while mitigating the negative impacts of traffic congestion and excessive parking provision. The ordinance, along with a progressive zoning code and other regional transportation initiatives, has meant that despite a 40% increase in institutional and commercial space in Kendall Square from 2002 to 2012, traffic volume has actually decreased around 14% over the same period (Moskowitz, 2012). The ordinance has been recognized as a nationwide “best practice” in TDM (Cambridge Community Development Department, 2013).

Despite this progress, the ordinance is not all-encompassing. One shortcoming is that many employers do not participate. If their parking facilities pre-dated the 1998 law, and no new parking was added since, then they are grandfathered in with no requirement to adopt TDM programs. Further, many employers whose office lease is bundled with parking have no incentive to reduce their commuters’ parking demand, so there can be a mismatch of incentives. As well, residential and accessory parking is not included in the ordinance, meaning that parking minimums for residential and commercial developments still lead to new parking space construction.

Nonetheless, the ordinance is a model for legislation across the country. It has proven to induce successful shifts in commuter travel patterns, and also provides crucial data from employer surveys for research such as this thesis.
2.2 TDM and Behavioral Science

Over the past several decades, transportation research has undergone a paradigm shift from the study of queues and flows towards the study of human behavior and decision-making. Today, it is recognized that while traffic flow can be modeled using principles of fluid dynamics, the individual persons that comprise such traffic are better understood through concepts of psychology and behavioral economics. The latter is a relatively young field, introduced by economist Herbert Simon (1955) and advanced through the work of leading psychologists Amos Tversky, Daniel Kahneman and others in the latter half of the twentieth century.

Behavioral economics, and the broader field of behavioral science, centers around the recognition of human irrationality and the shortcomings associated with applying a rational utility-based framework to predict behavior. In short, humans do not behave in ways that strictly maximize their utility (e.g. satisfaction, wellbeing, etc.), but rather use predictable heuristics to simplify choices and reduce cognitive burdens.

In transportation, our improved understanding of behavioral science may lead us to question traditional travel behavior models, which have often relied on basic assumptions that travelers always seek to minimize travel time and cost, and will do so in a rational manner. Recent research by Metcalfe & Dolan (2012) has more formally brought together the fields of behavioral science and transportation. The authors collected evidence from years of field experiments to argue that market failures in transportation can be addressed through a better understanding of the transaction costs and informational barriers associated with travel decisions.

This section explores some of the foundational literature in behavioral science, with a focus on transportation impacts, laying the groundwork for the case studies featured later in this thesis.

2.2.1 Theories of Behavior

Many models of human behavior have been developed to try and understand the way we consider options, make decisions and maintain a chosen course of action. Ajzen’s Theory of Planned Behavior, one of the most well-known frameworks, underpins much of our understanding of the formation of intentions and their translation to behavior. Ajzen’s model, which builds off his earlier Theory of Reasoned Action, maps how attitudes, subjective norms and perceived behavioral control inform intentions, which are the key predictor of choice (Ajzen, 1991).

The Social Learning Theory is another influential theory of human behavior, developed by Albert Bandura, which focuses on how behavior stems from the observation of others. Behavior are adopted from observing the behavior in others, or by witnessing the consequences or rewards of such behavior (Bandura, 1977).

More recently, research has shown that past behaviors—or habit—are a stronger predictor of behavior than are current attitudes or preferences (Gärling et al., 2001; Hoang-Tung et
al., 2017). Strength of habit is found to be an intermediary between intention and behavior, and leads to choices that may not be predicted by a rational choice model. In transportation, for example, a typical commuter does not consider an entire matrix of travel options each morning; instead, choice heuristics are used to simplify otherwise complex decisions.

### 2.2.2 Predictable Irrationality in Transportation

Extending and challenging classic theories of behavior, the burgeoning literature on behavioral economics can help us understand how people make travel decisions. Ariely (2010) argues in “Predictably Irrational” that humans are invariably irrational beings, but this irrationality is reliable and consistent\(^5\).

Further, it is well established that rewards and penalties are interpreted as entirely different concepts, as opposed to levels on a continuous spectrum. Kubanek et al. (2015) found that the magnitude of a reward scaled closely with the desire to receive it, while penalties were sought to be avoided at a flat rate regardless of their magnitude.

Ariely (2010) described the difficulty of incentivizing behavior through monetary rewards in comparison to appealing to social or moral norms. He provides examples to argue that once a decision is interpreted in terms of market norms (e.g. monetary benefit or cost of a choice), an appeal to basic values or ethics is rendered less effective, and irrevocably so even after market incentives are removed. "Money, as it turns out, is very often the most expensive way to motivate people. Social norms are not only cheaper, but often more effective as well." (Ariely, 2010) In the transportation literature, clustering of population segments based on their affinity for differing incentives can be helpful in designing TDM programs to reach their target population. For example, Anable (2005) identified six clusters of travelers (e.g. malcontented motorists, aspiring environmentalists, etc.) and argued that TDM strategies must be designed with these distinct psychographic groups in mind. A moral appeal may be effective for the environmentalist, just as aggressive pricing may work for the ‘die hard drivers’. Metcalfe & Dolan (2012) developed a mnemonic, MINDSPACE, as a framework to summarize nine major tools of behavior change, drawing on behavioral economics. These include (1) Messenger: we are influenced by the source of a message, not only its content; (2) Incentives: we respond to predictable mental shortcuts; (3) Norms: we are influenced by our peers’ actions; (4) Defaults: we tend to accept default choices; (5) Salience: we make decisions based on what seems novel or relevant; (6) Priming: we are influenced by sub-conscious cues; (7) Affect: our emotions shape our actions; (8) Commitments: We seek consistency with our public promises; and (9) Ego: We want to feel better about ourselves. (Metcalfe & Dolan, 2012) This framework is applied to MIT’s TDM program in Section 3.4.2.

\(^5\)Ariely explains how people make radically different decisions based on whether something is free or whether it costs a small or even trivial amount. One particularly salient example: When Amazon introduced free shipping, it induced greater sales almost everywhere. The one anomaly was in France, where $0.20 shipping was offered instead, and the expected increase in sales was not observed.
2.3 Experimental Interventions

TDM initiatives are often implemented on a large scale, with many strategies simultaneously employed to maximize impact. While the ‘kitchen sink’ approach may increase the chances that at least one of the interventions will work, it makes determining causality difficult; what intervention is responsible for what change in behavior, if any? For this reason, methods of causal inference are used to tease out cause-and-effect relationships. The gold standard of causal inference is the randomized controlled trial (RCT). Below we discuss experiments designed to explore the effectiveness of TDM initiatives.

2.3.1 The Randomized Controlled Trial

Campbell and Stanley, in their seminal 1963 book on research design, discuss the merits of various experimental frameworks, evaluated on the basis of internal and external validity. They explain that internal validity—whether an experimental treatment had an effect—can be confounded by such issues as selection bias, systematic error and statistical regression. External validity—whether results are generalizable beyond the experiment, and usually the key uncertainty for experiments of rigorous internal validity—can be confounded by interaction effects, reactive effects and further selection biases (Campbell & Stanley, 1963).

In the transportation literature, a sparse number of truly randomized and controlled experiments have been conducted, mostly on small samples of commuters or households, given the difficulty of producing such an experimental environment. Yang et al. (2010) identified twenty-five studies of interventions to promote cycling, two of which were RCTs, while Ogilvie et al. (2007) identified nineteen RCTs studying interventions to promote walking, generally from a public health perspective, and noted a dearth of similar research from the transportation sector. Graham-Rowe et al. (2011) reviewed 77 studies specifically on car use reduction, finding that most used relatively weak methodological foundations. Their review included six RCTs. More recently, Petrunoff et al. (2016) conducted a review specifically of workplace-based RCTs and controlled longitudinal studies. Their review found that ten out of twelve studies reported positive results, though many were at risk of significant bias.

Some of these studies showed successful results of interventions. For example, Garvill et al. (2003) conducted an RCT using psychological interventions in which they provided information during the trip planning phase and found a reduction in car use amongst frequent drivers. Bamberg (2006) examined whether residential relocation was an opportune time to intervene and reduce car use, and found that a combination of information provision and a day of free public transit was enough to elicit a reduction in car trip frequency. Similarly, Jakobsson et al. (2002) used a combination of financial disincentives for driving alongside an informational campaign and found a reduction in distance and frequency of car trips, though once the financial incentive was removed, effects were unlikely to be sustained.

Many more studies using an RCT framework found no significant impact of the measured
interventions. Fujii & Kitamura (2003) used monetary interventions in their RCT by providing a one-month free bus pass to university students and found no reduction in car use, while Eriksson et al. (2008) had participants fill out a prospective car diary for future trips, and found the intervention group had no significant reduction compared to the control. Tertoolen et al. (1998) leveraged psychological interventions including information, feedback and commitment, and found no significant effect after controlling for subject characteristics.

Among such experiments in the transportation and public health literature, relatively few had statistically robust methodologies and those that did were often limited by small sample sizes. Of the studies mentioned above, many used double-digit sample sizes, with some reaching several hundred participants such as Tertoolen et al. (1998).

Chapter 5 seeks to contribute to the literature with a fully randomized and controlled experiment on a population of two thousand MIT commuters.
Chapter 3

Transportation Policies & Programs at MIT

This chapter builds on the work of Hartnett (2016), Gates (2015), Block-Schachter (2009) and earlier theses to establish context on the transportation policies and TDM programs administered by MIT. It provides a background and history of commuting programs at the Institute in Section 3.1, followed by a motivation for recent policy reforms in Section 3.2. The AccessMIT program is subsequently introduced in Section 3.3, followed by a summary of policy objectives and strategy in Section 3.4. This chapter lays the foundation for Chapter 4, an evaluation of the TDM program reforms at MIT.

3.1 Background and history

In comparison to the United States as a whole, the City of Cambridge and MIT in particular have relatively low drive-alone commuting mode shares. As shown in Figure 3-1, while the nationwide SOV mode share is now over 75% and increasing, MIT has seen its drive-alone rates decrease as public transit mode share has grown.

3.1.1 MIT Parking Pricing

Limited parking supply has been a major factor in constraining the growth of SOV commuting to MIT. A 1973 cap on non-residential parking by the U.S. Environmental Protection Agency and the City of Cambridge meant that the Institute could not provide parking spaces to more than 36% of its staff (Block-Schachter, 2009). Demand continued to grow, as did the administrative costs of providing parking, leading to campus administrators introducing a $5 annual administrative fee for parking in 1975. In 1990, the fee increased to $10, and by 2001, the fee was raised to $400 per year, and no longer considered purely 'administrative'. Since then, parking rates have increased at approximately 11% per year, as shown in Table 3.1, and were set at $1,900 for the 2017-18 academic year.
Table 3.1: Annual parking fees for regular commuter permits at MIT, 2001 through 2018.

<table>
<thead>
<tr>
<th>Academic Year</th>
<th>Annual Fee</th>
<th>Percent Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001-2002</td>
<td>$400</td>
<td></td>
</tr>
<tr>
<td>2002-2003</td>
<td>$444</td>
<td>11%</td>
</tr>
<tr>
<td>2003-2004</td>
<td>$466</td>
<td>5%</td>
</tr>
<tr>
<td>2004-2005</td>
<td>$518</td>
<td>11%</td>
</tr>
<tr>
<td>2005-2006</td>
<td>$575</td>
<td>11%</td>
</tr>
<tr>
<td>2006-2007</td>
<td>$638</td>
<td>11%</td>
</tr>
<tr>
<td>2007-2008</td>
<td>$708</td>
<td>11%</td>
</tr>
<tr>
<td>2008-2009</td>
<td>$786</td>
<td>11%</td>
</tr>
<tr>
<td>2009-2010</td>
<td>$872</td>
<td>11%</td>
</tr>
<tr>
<td>2010-2011</td>
<td>$968</td>
<td>11%</td>
</tr>
<tr>
<td>2011-2012</td>
<td>$1,074</td>
<td>11%</td>
</tr>
<tr>
<td>2012-2013</td>
<td>$1,192</td>
<td>11%</td>
</tr>
<tr>
<td>2013-2014</td>
<td>$1,323</td>
<td>11%</td>
</tr>
<tr>
<td>2014-2015</td>
<td>$1,455</td>
<td>10%</td>
</tr>
<tr>
<td>2015-2016</td>
<td>$1,600</td>
<td>10%</td>
</tr>
<tr>
<td>2016-2017</td>
<td>$1,760</td>
<td>10%</td>
</tr>
<tr>
<td>2017-2018</td>
<td>$1,900</td>
<td>8%</td>
</tr>
</tbody>
</table>

While the annual ‘regular commuter’ permit remained the most common permit type for many years, the MIT Parking & Transportation Office began offering more permit types to accommodate a diverse range of parking needs. As of 2016, there were 31 types of permits available, with different rates for staff, students, contractors, professors emeritus, low-emissions vehicles, carpoolers, and many others. The two main categories for staff, however, are (1) annual parking permits, and (2) daily parking permits. The daily permit consists of a reduced annual fee ($89 in 2015-16, raised to $100 for 2016-17 and 2017-18)
and a rate charged daily ($8.50 in 2015-16, raised to $10 in 2016-17 and 2017-18). An additional first-time parker fee of $100 was introduced in 2016\textsuperscript{1}.

A carpool permit is offered as a sub-category of annual permits. Staff who register their permit with one or more carpool partners are eligible to receive a permit at half-price (e.g., $950 in 2017-18). While multiple vehicles may be associated with the same carpool permit, a single hangtag is shared amongst the carpool group, and must be displayed while parked to prevent multiple drivers from each bringing their car on the same permit.

In the 2016-17 academic year, parking permit distribution policies were reformed as part of AccessMIT, as discussed in Section 3.3. While the permit types and costs above were retained, the key change was a compulsory switch from annual to daily permits for the vast majority of staff drivers.

### 3.1.2 Parking Infrastructure

As of October 2017, there are approximately four thousand parking spaces available for the MIT community. The Institute owns the vast majority of its parking facilities, spread across fifty locations mapped in Figure 3-2 (including underground, above-ground and surface lots). As shown in Table 3.2, 73\% of the spaces are in gated facilities, wherein parkers must tap their ID card upon entry and exit. This allows for real-time pricing and automatic permit enforcement. In the other 27\% of spaces, which includes areas without entry/exit gates (typically due to small lot size or site configuration constraints) and leased spaces (in which parking gate data is not available to MIT), parking is limited to those with annual permits and compliance is enforced by staff inspection.

The Parking & Transportation Office is in the midst of transitioning all non-gated spaces owned by MIT to be tracked using license plate recognition (LPR) technology, allowing for all MIT spaces to be monitored automatically on a daily basis, thereby permitting the daily billing of parking at all facilities managed by the Institute.

<table>
<thead>
<tr>
<th>Category</th>
<th>Spaces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gated (MIT owned)</td>
<td>3,040</td>
</tr>
<tr>
<td>Non-gated (MIT owned)</td>
<td>839</td>
</tr>
<tr>
<td>Leased</td>
<td>295</td>
</tr>
<tr>
<td>Total</td>
<td>4,194</td>
</tr>
</tbody>
</table>

### 3.2 Motivation for TDM at MIT

Several motivations led MIT to revamp its commuting benefits beginning in the 2016-17 academic year. Most pragmatically, the Institute was concerned with the deteriorat-

\textsuperscript{1}This fee has since been discontinued; see Section 4.4.2 for details.
ing state of its above-ground parking structures, and the costs associated with repairing and/or rebuilding these facilities. The Office of Campus Planning noted that every land parcel currently occupied by a surface lot or above-ground garage has alternative future development plans. Further, there is a regulatory motivation to avoid constructing new above-ground garages because, unlike underground lots, elevated lot square footage counts against the City of Cambridge’s maximum floor area ratio (FAR) permitted under zoning rules (J. McDonald, 2002). Figure 3-3 shows recent reductions in parking supply as well as planned and potential loses in parking associated with future development and garage end of life.

Figure 3-3: Recent, planned and potential losses in parking supply across MIT campus. Source: MIT Campus Planning.

Given zoning regulations and development pressures, the only place where future parking facilities will likely be constructed is in underground garages associated with new building
construction. The Stata Center underground garage, with 688 spaces, was constructed at a capital cost of $100,000 per space in 2004 (Block-Schachter, 2009), and the garage underneath the new building for the Sloan School of Management, built in 2010 with 417 spaces, had similar capital costs. New construction at Kendall Square, which replaces five surface lots with 500 spaces for academic use, is anticipated to cost on the order of $175,000-$200,000 per space. When including operations, maintenance and depreciation, the per-space cost increases even further.

The Institute therefore has ample motivation to build less parking, but is concerned with the welfare of its commuting population. Despite the hefty annual percent increases in parking permit fees, MIT still subsidizes a substantial proportion of the cost of parking (see Section 4.3.4). These subsidies help ensure that parking remains affordable for lower-income staff, and are a part of MIT’s objective to provide competitive employee benefits. Nevertheless, in recent years annual parking rate increases have been chosen with the purpose of reducing this subsidy and recouping more of the cost of providing parking.

In addition to financial motivations, MIT has been vocal in its commitment to fighting climate change, including by reducing the carbon footprint of its own campus. While emissions associated with employee commuting are considered indirect or ‘Scope 3’, they are still within the influence of MIT policies and strategies. MIT’s Office of Sustainability, established in 2013, is a key stakeholder in developing strategies to help the Institute reach carbon neutrality, and has been a partner in the rollout and promotion of new employee commuting benefits.

### 3.3 Overview of AccessMIT

The new commuting benefits for employees, branded as ‘AccessMIT’, are comprised of five pillars:

1. Daily parking pricing
2. Free universal bus and subway transit pass
3. Increased commuter rail monthly pass subsidy
4. New parking subsidy at transit stations
5. Online commuter dashboard

These were implemented in addition to the suite of existing commuter benefits including subsidized bike share and car share memberships, an emergency ride home program, campus shuttles and others.
3.3.1 Daily parking pricing

As introduced in Section 3.1.1, MIT previously offered parkers a choice of either an annual parking permit (for those who park regularly) or an ‘occasional/evening’ permit (for those who only park intermittently). Starting in fall 2016, the policy was changed to force most parkers into purchasing ‘occasional/evening’ permits, which incur an annual fee of $100 plus a charge of $10 per parking day. The maximum annual charge for daily parking is capped at the price of an annual permit (shown in Table 3.3).

The rationale behind this switch from annual to daily parking pricing is primarily to eliminate the sunk cost associated with parking. Annual or monthly permits lead to a psychological motivation to ‘get your money’s worth’ out of the parking permit, whereas a daily charge rewards the commuter each day he or she chooses not to drive. Put differently, daily pricing introduces a non-zero marginal cost.

The annual cap on fees was introduced in recognition that a substantial proportion of drivers will not be able or willing to reduce their parking significantly, and would be unduly harmed by daily pricing (which would cost up to $2,500 annually given 250 business days, significantly more than the $1,760 annual permit fee in 2016-17). As shown in Table 3.3, any driver who parked each business day would hit the cap after only 34 weeks in 2016-17, and would therefore enjoy free parking for the remainder of the school year after mid-May (given the permit year begins mid-September). An analogous metric is that a commuter who parked at least 3.3 days a week in 2016-17 would reach the cap, and thus have no parking-related economic impetus to reduce their driving (that is, if the commuter did this calculation).

In negotiations to set the 2017-18 parking rates, it was decided that the daily rate would remain fixed at $10, while the cap would increase from $1,760 to $1,900. The rationale was to provide a much sought-after freeze in daily parking rates, while increasing the proportion of parkers that would fall beneath the cap. Since the cap increase, any driver who parks less than 3.6 days per week will benefit from marginal savings, rather than 3.3 days the year before.

Because 27% of parking spaces are non-gated or leased, daily pricing is not currently feasible for all parkers. An annual permit option is still available for commuters assigned to these lots, and the permit assignment is based on locational proximity to commuters’ place of work.

Table 3.3: New Daily Parking Pricing

<table>
<thead>
<tr>
<th>Year</th>
<th>Daily Rate</th>
<th>Annual Cap</th>
<th>Cap Date for Everyday Parkers*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-17</td>
<td>$10</td>
<td>$1,760</td>
<td>34.5 weeks (mid-May)</td>
</tr>
<tr>
<td>2017-18</td>
<td>$10</td>
<td>$1,900</td>
<td>37.5 weeks (early June)</td>
</tr>
</tbody>
</table>

*Refers to date at which everyday parkers will hit the annual cap, reset each September 15. The $100 annual fee counts toward the cap.
3.3.2 Free Transit Pass

MIT has historically offered students and employees partial subsidies for monthly MBTA local bus and subway passes. Beginning with a $10 discount in 1996, the subsidy was subsequently raised to 50% for the LinkPass (an unlimited use pass for subways and all buses except a few express services). In 2016, as a core element of the AccessMIT program, the 50% pass subsidy was increased to a 100% complete subsidy for employees. The student subsidy remains at 50% for monthly passes.

Two changes accompanied this rollout. First, instead of employees having to pick up a CharlieCard from the MIT Parking & Transportation (P&T) Office, CharlieCard chips were integrated into new MIT employee ID cards. While staff were not required to swap their ID cards, a widespread campaign was launched to encourage ID swap-outs during the summer of 2016. P&T staff visited each department to facilitate this process, whose metrics were tracked using an internal dashboard. By the end of September 2016, the campaign achieved a 75% swap-out rate. Some employees were not eligible for the free CharlieCard ID, including: (a) part-time and contract workers not covered under the full MIT benefits plan; and (b) commuters who purchased a commuter rail pass, which already includes local transit access.

The second change was that rather than purchasing LinkPasses (at a monthly cost of $84.50 in 2016) and re-selling them to commuters at a discount, MIT negotiated an agreement with the MBTA to be billed for employee transit trips on a pay-per-use basis (while still branding the pass as an unlimited use LinkPass to the end user). Employees who never use their pass would thus not incur any charge to MIT, save for a $0.50 per month service fee for each active card. The implications are that MIT could afford to provide transit passes to all its employees, given that a sizable portion of staff are not expected to actively use their pass (e.g. everyday drivers). There was some concern within the MBTA that this arrangement might adversely impact transit pass revenue, given that fixed-price monthly pass purchases were being substituted with variable billing depending on employee transit usage. However, as presented in Section 4.3.4, revenue to the MBTA has held approximately constant.

3.3.3 Commuter Rail

The subsidy for commuter rail monthly passes was increased from 50% to 60% as part of AccessMIT. As a result, subsidies now range from a $50 per month discount on Zone 1A passes (local travel) to a $185 per month discount on Zone 9 passes (reaching Rhode Island). Water shuttle and express bus service is also included in this subsidy. The pass is offered pre-tax through payroll deduction.

Unlike local transit, however, commuter rail subsidies are offered only for monthly passes. This is primarily due to the current MBTA fare collection system, which mostly relies on train conductors manually inspecting tickets and passes. A mobile app provides a pay-by-phone option, and MIT is considering future integration with the app. By 2021, the entire CharlieCard system is expected to be phased out, and the “AFC 2.0” (automated fare collection) system will provide tap-on/tap-off functionality for fare cards, smart phones and
contactless credit cards (Bregman, 2017). This will allow MIT to consider broadening the suite of subsidy options for all MBTA services.

3.3.4 MBTA Station Parking Subsidy

In a bid to entice drivers living away from transit to use MBTA service, MIT has begun offering a subsidy on parking fees at all MBTA transit stations, including commuter rail and subway stations. The subsidy is 50% up to $100 per month. The MBTA owns and operates 100 lots containing over 44,000 spaces, with daily rates ranging from $4 to $15 and monthly rates from $70 to $200 (MBTA, 2018).

This aspect of the AccessMIT program is very popular in that it changes the economics of the primary mode choice for those living beyond walking distance to public transportation. It also enhances the sustainability impacts of the program by removing cars from the most congested urban road segments. However, by providing discount parking, it may be perceived to tacitly encourage driving for a small portion of commute trips. Further, the MBTA is facing capacity constraints at its garages, where utilization rates often exceed 99% on a regular basis (Dungca, 2015).

3.3.5 Online Commuter Dashboard

Paired with the pricing and subsidy reforms of AccessMIT, the Institute also launched an internal employee web portal to help commuters plan and track their travel. MIT partnered with software vendor RideAmigos to provide the website AccessMyCommute, integrated with the Atlas employee self-service portal through a single sign-on system. The dashboard includes four main features. First, it includes a multimodal trip planner (Figure 3-4), illustrating the time, cost, directions and carbon emissions associated with different travel modes. Second, it includes a carpool matching tool (Figure 3-5), allowing MIT employees to search for and contact colleagues with whom they could form a carpool. The map-based interface optimizes routing and allows filtering by schedule and driver/passenger preferences. Third, it incorporates a travel log (Figure 3-6), automatically populated with transit trips (through the ID-integrated CharlieCard), driving trips (through the gated lot data interface), and walking or cycling trips (through a third-party GPS tracer app called Moves). Self-reporting of trips is also permitted. Finally, the dashboard features an advanced incentive system for MIT to administer points programs and competitions to promote its TDM programs (e.g., Figure 3-7), using the travel log as a means for employees to track their trips.

Customization of the platform introduced several challenges. For example, there was a need to balance ease of trip reporting with the mitigation of potential self-reporting fraud, especially during incentive campaigns. It was decided to allow self-reporting, but non-SOV trips would be preempted by a driving trip if any parking activity was detected. Further, there were concerns about privacy related to the carpool matching tool. These concerns were addressed using an opt-in framework, only showing first names and an approximate home location, and withholding any contact information. Tucker (2016) outlines the development and implementation of the dashboard in full detail.
Figure 3-4: Multimodal trip planner showing travel time, cost, emissions and calories.

Figure 3-5: Carpool matching tool showing a potential match. The dashboard indicates that such a pick-up would add an extra mile or 12 minutes to the driver’s commute.
Figure 3-6: Dashboard homepage, indicating trip log and search portal to trip planner.

Figure 3-7: Example of incentive program user interface.
The largest challenge was, and continues to be, establishing a sustainable model for management of the AccessMyCommute dashboard within the MIT administration, especially given the annual expense of subscription to RideAmigos. While researchers led the rollout of several incentive campaigns, it remains to be seen whether administrators at MIT will continue to leverage the early success of the dashboard with continued promotion and incentives. While 1,200 users logged on at the launch of the spring 2016 ‘Commuting Contest’, today the site only attracts single-digit views each day.

3.4 Policy Objectives and Strategy

The overarching objective of AccessMIT is to provide MIT staff with flexible, affordable and low-carbon commuting options, with a focus on reducing drive-alone commuting.

Flexibility is central to the design of the program, which does not seek to penalize or restrict driving; rather, it aims to shift the mindset of commuters from single-mode travelers (i.e. a full-time driver) to multi-modal ones, who are freed of financial constraints locking them into a specific mode. Changes in federal tax benefits for commuting have helped facilitate this shift, with parking and transit benefits no longer being mutually exclusive. From a policy standpoint, five-day-a-week drivers who decide to take transit even once weekly are considered to have made promising shifts in behavior.

Affordability is similarly key to the success of the initiative. It is in MIT’s interest to ensure commuting to campus remains affordable for all tiers of employees, and given over a decade of consecutive 11% increases in parking costs, many employees felt squeezed by such costs. While the cap in parking rates continued to increase at similar levels, complementing the shift to daily pricing with a free transit pass and increased subsidies helped alleviate the cost burden, and the perception thereof.

Finally, reducing the Institute’s carbon footprint is part of a larger initiative related to the MIT Plan for Action on Climate Change. While emissions related to workplace commuting are considered indirect (or ‘Scope 3’), there was nonetheless pressure from within the community for MIT to ‘walk the talk’ on climate change and introduce substantive reforms regarding its own carbon footprint. The MIT Office of Sustainability has been a primary partner working alongside researchers and senior administration to implement and evaluate the program.

The specific target of AccessMIT was to reduce parking demand by 10% over the first two years of the program (2016-17 and 2017-18). This threshold was established by reviewing prior TDM literature as well as the results of the 2010 Mobility Pass pilot, in which a select subset of staff drivers were provided with free transit passes and a 4% reduction in parking was achieved (Kamfonik, 2013). A broader set of policy reforms was predicted to achieve larger gains, estimated using models of mode share elasticity that predate this research.

Paired with this target was the objective of ensuring employee satisfaction did not deteriorate as a result of the program. In the biennial Transportation Survey, staff are asked about how satisfied they are with MIT’s parking and transportation programs, and trends
in responses over time were analyzed to measure attainment of this goal.

3.4.1 Communication and Outreach

A third party marketing firm was hired to prepare promotional materials to raise awareness of AccessMIT. The campaign included a series of print posters, digital display materials for public screens across campus, and other miscellaneous promotional materials distributed to department parking coordinators. An example of the posters is shown in Figure 3-8, and the series highlights a diverse set of faculty and staff with testimonials about how the program positively impacted their commute and quality of life. Narratives included appeals to environmental sustainability, stress reduction, increased productivity, and time and monetary savings. A complete set of promotional materials is shown in Appendix B.

Further marketing was done through direct emails from the Executive Vice President and Treasurer who introduced the program, and from materials on the home page of the ‘Atlas’ employee self-service web portal.

The target audience of the marketing was limited to employees, specifically full-time staff who were eligible for the benefits. Students, who are not currently eligible for the zero-cost transit pass, were not included.

3.4.2 Leveraging Behavioral Science

The design of the AccessMIT program was informed by a wealth of research on behavioral economics. As discussed in Chapter 2, various conceptual frameworks have been developed to provide a structure around how people respond to TDM incentives and how their behavior deviates from the perceived rationality of classical economic theory. In this section, the MINDSPACE model (introduced in Section 2.2) is used to frame the rationale behind program design elements.

Messenger
The source of the policy reform may be almost as important as its content. The program was launched through an announcement from the Executive Vice President and Treasurer (EVPT) of MIT, potentially a voice of higher authority and legitimacy as compared to if it came directly from the Parking & Transportation (P&T) Office. Conversely, those who have negative associations with the MIT administration may be less likely to hold the message in high regard.

On the opposite end of the spectrum, some staff may have learned about the program from their departmental ‘parking coordinator’ who serves as a liaison to the P&T Office. While some coordinators have held their position for decades and are well-versed with commuting programs, others are temporary employees who may not even know they hold the position. As a result, there are a variety of messengers and this may lead to a breadth of perceptions of the program among staff who learn about it from their parking coordinator.
I’m in climate action mode.

See how Access MIT’s new, flexible commuter benefits can benefit you and make a positive impact on the planet.

John Sterman
Jay W. Forrester Professor of Management,
MIT Sloan School of Management

John puts sustainable practices to work every day by biking to the T.

Your commute counts. Switch it up.

- Take the T for free with your new MIT employee ID
- Park & Ride with a 50% parking subsidy at MBTA stations
- Don’t drive...don’t pay! With pay-per-day rates in gated lots
- Grab a Hubway with MIT’s special $25/yr membership

web.mit.edu/accessmit

Figure 3-8: Example of a poster developed by a marketing firm to promote AccessMIT program. Others are shown in Appendix B.
Incentives
AccessMIT places incentives at the core of its design. Rather than simply using a larger ‘stick’ each year in the form of increased parking prices, the free transit pass is presented as a ‘carrot’ to counterbalance the increase in the annual parking fee cap. But where behavioral economics comes into play is in how the economic incentives are framed, using fundamentals of human psychology. For example, the daily parking paired with free transit resets the mental ‘reference points’ against which costs are compared. The marginal cost of transit becomes zero with a free pass, while the marginal cost of parking becomes $10-a-day compared against a $0-a-day alternative. The ‘power of free’—the idea that a 100% subsidy triggers a drastically different behavioral outcome than a 50% or even a 99% subsidy—is also used to further the reach of the transit incentive (Ariely, 2010).

Norms
Prior studies on energy consumption found that highlighting good behavior as the norm is more effective than simply chastising bad behavior (e.g., prior research found that informing hotel guests that prior guests in their room reused their towels helped encourage towel recycling (Cialdini, 2003)). Applying this to MIT’s case, as shown in Figure 3-8, the marketing campaign promoting AccessMIT attempted to establish a norm that regular employees, whether faculty, administrators, support staff or others, are making the most of their new benefits. It tried to relate the norm to the target audience, acknowledging that the target is drivers who are not likely to make a radical shift to bicycling everyday, but rather who have potential to occasionally switch their commute.

On the AccessMyCommute online dashboard, a departmental leaderboard was designed to indicate which departments at MIT had the most active participation on the dashboard (e.g. logging trips), with the objective of tapping into social norms and friendly competition to encourage further uptake.

Defaults
It has been well-established in the behavioral science literature that default choices play an important role in steering how we make decisions. Famous examples include increasing organ donation rates (Johnson & Goldstein, 2003) and encouraging regular deposits into retirement savings plans (Madrian & Shea, 2001). In the case of AccessMIT, it was recognized that an opt-in transit pass might not be of particular interest to everyday drivers, and that daily parking pricing may not sound appealing to those who park everyday. However, by placing the transit pass on employees’ ID cards and making the switch to daily parking the default for most drivers (unless a non-gated lot was actively requested due to locational proximity), being a part of AccessMIT became a non-decision for most employees.

Salience
Kahneman & Thaler (2006) explain how our attention is typically drawn towards stimuli that are novel, and that such shifts in attention influence our behavior. When it comes to the impact of money on decision-making, it is not the dollar amount that determines the magnitude of its impact, but rather the perception of said dollar amount. The more noticeable or salient a cost is, the more likely it will influence behavior. Comparing transit fares with automotive costs is a common example in transportation: while a transit fare is highly salient (a rider must physically interact with a payment device upon each
ride), costs associated with driving tend to be much more hidden (car purchase, insurance, maintenance and gasoline tend to be intermittent and removed from the act of driving each day).

With AccessMIT, this discrepancy in cost salience is turned on its head. The cost of riding transit is removed (in salience and in actual dollars), while the cost of parking is made noticeable and incurred immediately. The screens at the parking gates, which used to simply welcome the parker, now show the $10 charge upon exit.

**Priming**

The idea of priming is that prior information or stimulus, even if beyond the realm of conscious awareness, may influence future behavior. Metcalfe & Dolan (2012) note that priming is perhaps the least understood element of the MINDSPACE phenomena, and that many primes are subconscious and go unnoticed. For AccessMIT, a potential prime may have been the announcement that parking garages on campus were reaching the end of their lifespan and that, at a point in the near future, there would be less parking on campus. Even if this was purely a cautionary message for the distant future, it may have bolstered the decision for employees to begin considering alternative commuting methods.

In the second year of AccessMIT (fall 2017), a garage was indeed closed and parkers were re-accommodated. This is discussed in Section 4.3.2.

**Affect**

Affect or emotion plays a large part in decision-making. Parking tends to be an emotionally charged issue, and decisions on the part of drivers (who are concerned about a lack of parking) and facility administrators (who are concerned about the political fallout of such a capacity constraint) may be driven as much by emotion as by data and rationality.

The advertising campaign launched alongside AccessMIT made an emotional appeal to drivers that their peers have made improvements to their quality of life by choosing not to drive to work. A series of video interviews curated by the Office of Sustainability further profiled employees who told heartfelt stories about how their improved commute has brought them closer with their family, friends and colleagues.

**Commitment**

People often struggle to remain committed to their own goals, and rely on commitment devices to help them meet their own interests. In the case of MIT, the commitment challenges relate perhaps most to the process of having the administration sign onto the AccessMIT program. Much had been talked about with respect to climate change and reducing the Institute’s carbon footprint, but less action had been taken on Scope 3 carbon emissions like employee travel. Introduction of the program was seen as MIT making a formal commitment to its employees, and to the broader community, that it was serious about ‘walking the talk’ on climate change. Common sense dictates that once MIT provides a free transit pass to all employees, it is all but guaranteed not to be revoked in future years.

**Ego**

Finally, human behavior is inextricably linked to our desire to create and reinforce a positive self-image. Framing the AccessMIT program around our communal obligation to re-
duce the campus carbon footprint and contribute less to local traffic congestion could be seen as an appeal to the community’s moral obligations, and a desire to cultivate a positive collective self-identity.
Chapter 4

Program Evaluation

Given the investment in new and enhanced employee commuting benefits, it is imperative to measure the effectiveness and efficiency of each new policy in order to ensure that Institute funds are being used responsibly and that the community reaps tangible benefits. This chapter discusses the methodology and results of this evaluation effort. Section 4.1 introduces the approach to evaluation. Section 4.2 presents changes in travel behavior and attitudes at the disaggregate level, then Section 4.3 discusses aggregate metrics of change. This is followed by a discussion in Section 4.4 on lessons learned.

4.1 Evaluation Methodology

In assessing the impact of a TDM program, the Transit Cooperative Research Program Report 107 outlines five key elements of success to be measured (ICF & CUTR, 2005):

1. **Awareness**: Whether employees know about the programs
2. **Participation**: The extent to which employees use the programs
3. **Behavior change**: How employees shift travel patterns since program introduction
4. **Transit agency impacts**: How the program impacts agency costs, revenues and ridership
5. **Regional impacts**: Impacts on vehicle travel and greenhouse gas emissions

While the fourth and fifth elements are of lesser material concern to MIT program administrators, this evaluation will address all five aspects in an effort to provide generalizable results to inform potential future implementation at other workplaces and institutions.

Specific evaluation objectives for this study are three-fold. First, it seeks to measure program impacts through comparison of travel behavior metrics before and after rollout, including mode choice, parking, and travel expenditures. Quantitative impacts are evaluated
predominantly with revealed travel behavior metrics while qualitative impacts are assessed using a series of surveys and stakeholder interviews. Second, the evaluation seeks to examine potential causality between interventions and any correlated behavioral changes. Because a suite of initiatives were launched simultaneously, there is risk of confounding the impacts of one program element with another. Third and finally, the evaluation aims to identify lessons learned for MIT on its provision of commuter benefits, as well as broader lessons on the potential for parking and TDM measures to effect positive changes in travel behavior and commuter welfare.

Commuter travel behavior and attitudes are measured through a multi-faceted data framework. MBTA subway and bus ridership is monitored using the ‘CharlieCard’ chip integrated into staff ID cards, providing researchers with disaggregated usage data. Parking is monitored at MIT’s gated facilities, wherein parkers tap their staff ID card to enter and exit the lot. Non-gated and leased lots, comprising 27% of parking supply, are not able to be monitored daily and cannot provide individual commuter usage data. Stated attitudes and preferences towards commuting are gauged using a biennial transportation survey issued by the MIT Institutional Research Office, which collects responses from at least 50% of staff and students every other year. Finally, participation in incentive programs is tracked through the AccessMyCommute dashboard and its back-end analytics.

In addition to employee behavior and attitudes, the success of the program is predicated on several criteria from the perspective of MIT and the MBTA. Increased transit subsidies by MIT require additional short-term financial outlays. Conversely, reductions in parking demand reduce operations, maintenance and capital costs, and may free up land for alternative development, unlocking real estate previously allocated to parking. While difficult to measure, enhanced perceptions of MIT as an institution of higher education and employment can translate to other net gains for the Institute in the form of employee happiness and productivity, and ultimately attraction and retention of top talent. For the MBTA, the switch from monthly pass products towards pay-per-use billing is associated with revenue uncertainties, so the transit agency is concerned with how fare revenue has changed as a result of MIT’s arrangement. This may inform future viability of such an arrangement both for MIT and other potential corporate partners.

4.2 Employee Impacts

To understand how employees responded to changes in commuting benefits, the biennial MIT transportation survey was amended to include several questions about changes in travel behavior related to the AccessMIT program. Of the 10,500 staff eligible to take the survey, a response rate of 54% (N=5,700) was achieved during the November 2016 survey period. As shown in Table 4.1, the sample corresponds generally well to the overall population of MIT employees by demographic cross-sections, albeit with slight overrepresentation of administrative staff and underrepresentation of academic and service staff.

The survey was amended in 2016 to incorporate questions regarding awareness and attitudes relating to the AccessMIT program. For the sake of comparability, most of the existing survey was kept consistent, although the general mode choice question was modi-
Table 4.1: Survey Representation

<table>
<thead>
<tr>
<th></th>
<th>Survey</th>
<th>All MIT Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>5,700</td>
<td>10,500</td>
</tr>
<tr>
<td>Female</td>
<td>49%</td>
<td>44%</td>
</tr>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 40:</td>
<td>40%</td>
<td>41%</td>
</tr>
<tr>
<td>40-59:</td>
<td>32%</td>
<td>34%</td>
</tr>
<tr>
<td>60+:</td>
<td>16%</td>
<td>18%</td>
</tr>
<tr>
<td><strong>Staff type</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administrative</td>
<td>35%</td>
<td>25%</td>
</tr>
<tr>
<td>Faculty</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Other Academic</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>Service</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>Sponsored Research</td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>Support</td>
<td>18%</td>
<td>13%</td>
</tr>
<tr>
<td>Medical</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td><strong>Parking permit</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pay-per-day</td>
<td>33%</td>
<td>37%</td>
</tr>
<tr>
<td>Annual</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>Carpool</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>None</td>
<td>59%</td>
<td>54%</td>
</tr>
<tr>
<td><strong>Distance to campus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;2 mi</td>
<td>18%</td>
<td>22%</td>
</tr>
<tr>
<td>2-5 mi</td>
<td>26%</td>
<td>26%</td>
</tr>
<tr>
<td>5-10 mi</td>
<td>23%</td>
<td>22%</td>
</tr>
<tr>
<td>&gt;10 mi</td>
<td>33%</td>
<td>30%</td>
</tr>
</tbody>
</table>

Table 4.1 was modified to also allow respondents to include a secondary mode; this change was made to capture the reality that many staff use multiple modes to commute, and that the program explicitly encourages multi-modality by design. The complete survey can be found in Appendix C.

Figure 4-1 shows where MIT employees live across Greater Boston. MBTA subway and commuter rail lines are overlaid. Staff tend to live in Cambridge and Somerville and in the areas to the north and west of MIT campus.

4.2.1 Benefits Usage

Table 4.2 compares staff participation in parking and transit benefits between the 2015-16 academic year, before AccessMIT was launched, and 2016-17, its first year of implementation. Parking permit sales were reduced overall by 5% in the first year and an additional 8% in the second year, while the share of daily permits increased dramatically from under half to four fifths of all permits. The overall reduction can be partially attributed to an increase in the annual permit fee (and the short-lived $100 first-time parker fee) designed to dissuade occasional permit purchases amongst staff. The continued sale of some annual permits...
MIT Employees per Census Tract

Figure 4-1: Home location of MIT employees by census tract, 2016.
permits was required due to a quarter of MIT’s remaining parking facilities being located in non-gated locations, where daily billing was not feasible. Nonetheless, the reduction in annual permit sales in Year 2 can be attributed in part to parkers requesting a move to daily billing (some of whom had not heard about the daily option in Year 1). Parking & Transportation Office staff noted anecdotally that awareness grew in the second year about the savings associated with daily parking.

Local transit pass usage increased by 63%, as measured by the difference between the number of passes purchased prior to AccessMIT and the number of free passes actively used once AccessMIT was introduced. Pass usage increased throughout the 2016-17 academic year as more staff swapped their old ID card for a new one with a built-in pass and began using MBTA services. While the number of active passes increased by 10% throughout the year, the total monthly fare billed to MIT remained relatively consistent around $290,000 per month. This indicates that most of the heavy transit users were among the early adopters, and subsequent growth in pass usage is attributable to intermittent use. Individual usage of transit passes are discussed further in Section 4.2.4.

Considering other new and increased subsidies, commuter rail pass purchases did not increase in the first year despite an increase in subsidy from 50% to 60%, indicating the enhanced subsidy did not have an initial behavioral effect. The second year, however, saw a 4% increase in commuter rail pass purchases. The new MBTA station parking subsidy was seen as an early success given its use by 5% of staff, although some of these claimants were already transit riders.

### 4.2.2 Mode Choice

Employee mode choice is measured in the biennial survey using two sets of questions. The first asks about general mode choice: “What are your current commuting method(s) to MIT?” The second asks the respondent to specify their mode of travel for each day of the prior week (i.e. a trip diary). These two questions are asked in tandem to understand how employees self-identify as commuters, while simultaneously eliciting a ‘ground truth’ comparable year-to-year.
General Mode Choice
As shown in Figure 4-2, general mode choice trends indicate a marked decrease in SOV mode share, the first appreciable drop since 2008. Drive-alone mode share declined from 41% in 2004 to only 24% in 2016, balanced by increases in public transit and active modes (walking and cycling). Figure 4-3 shows the reported SOV mode share mapped by employee home location, indicating that areas to the south and northwest of campus have particularly low drive-alone mode shares (largely tracking the MBTA Red Line). Despite the launch of a new carpool trip planning tool and the continuation of a 50% discount on carpool parking, rates of carpooling decreased slightly, consistent with long-term nationwide trends. While these trends would suggest a sizable drop in parking demand, two mitigating factors should be acknowledged: first, the overall number of employees at MIT has increased 2-3% annually in recent years, meaning that while the share of drivers has decreased, their absolute numbers have not dropped as much; and second, response biases may slightly skew the trends (e.g. in 2016, with the new transit benefits, commuters who alternate between driving and transit may be more likely to list transit as their primary mode due to the novelty of the benefit or a desire to appear eco-conscious). For the latter reason, the 2016 survey introduced a new question asking respondents for their secondary mode (prompted as optional “during nice weather, flexible hours, etc.”) alongside their primary mode.

Figure 4-2: Reported primary mode choice, MIT employees (2004-16 biennial Transportation Survey)

Table 4.3 shows a breakdown of responses to this question, in contrast with the 2014 primary mode. It yields new insights into the occasional travel patterns of commuters; for example, 62% of commuters selected a secondary mode of travel other than working from home. The most common secondary modes were walk-accessed public transportation among drivers and vice versa. Taxis and transportation network companies (e.g. Uber and Lyft),

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1Between 1980 and 2010, the average carpool mode share has halved across the United States from 20% to under 10% (Census, ACS 2010).
while essentially never listed a primary mode, were selected as the secondary mode for 500 staff. Among primary-mode drivers, 41% listed a secondary mode, and half of these
drivers listed public transit. Conversely, 16% of transit riders listed driving as their secondary mode.

Hartnett (2016) found that newer employees tended to be less auto-oriented, and the most recent biennial survey corroborates this finding. For new hires since 2014, the drive-alone mode share (12%) is less than half that of all staff, while active modes and transit were both significantly higher (see Figure 4-4).

<table>
<thead>
<tr>
<th>Mode</th>
<th>2014 Primary</th>
<th>2014 Secondary</th>
<th>2016 Primary</th>
<th>2016 Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bicycle</td>
<td>9%</td>
<td>11%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>Bicycle and take public transportation</td>
<td>3%</td>
<td>2%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Drive alone the entire way</td>
<td>28%</td>
<td>24%</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>Drive alone, then take public transportation</td>
<td>6%</td>
<td>8%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Dropped off at work</td>
<td>0.3%</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5%</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Ride in a vanpool (5 or more commuters) or private shuttle (e.g. TechShuttle, SafeRide)</td>
<td>0.5%</td>
<td>1%</td>
<td>1%</td>
<td></td>
</tr>
<tr>
<td>Ride in a private car with 2-4 commuters</td>
<td>1%</td>
<td>1%</td>
<td>0.3%</td>
<td></td>
</tr>
<tr>
<td>Ride in a private car with another person</td>
<td>5%</td>
<td>4%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Share ride/dropped off, then take public transportation</td>
<td>3%</td>
<td>4%</td>
<td>2%</td>
<td></td>
</tr>
<tr>
<td>Take a taxi or ride service (e.g., Uber, Lyft)</td>
<td>0.2%</td>
<td>0.4%</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Walk</td>
<td>9%</td>
<td>10%</td>
<td>9%</td>
<td></td>
</tr>
<tr>
<td>Walk, then take public transportation</td>
<td>30%</td>
<td>33%</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Work at home</td>
<td>0.2%</td>
<td>0.3%</td>
<td>6%</td>
<td></td>
</tr>
<tr>
<td>No secondary mode</td>
<td>-</td>
<td>-</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td><strong>N</strong></td>
<td><strong>6,335</strong></td>
<td><strong>5,563</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Daily Commute Diary**
Survey respondents were asked to “indicate how you commuted to campus each day last week.” As introduced in Hartnett (2016), the “parking ratio” is a metric used to convert the diary responses into a proportion of days parked (i.e. between 0 and 1). It is defined as the number of days a commuter listed as driving divided by the total number of commutes reported that week. As shown in Figure 4-5, the parking ratio among all staff has declined concomitantly with the decrease in reported SOV mode share (both dropping approximately 40% from 2004 to 2016), serving to validate the general mode choice question against the daily diary. It is also apparent that the parking ratio among those who identify as drivers has not decreased to the same degree (e.g. 2008 and 2016 parking ratios among drivers is the same), meaning that we have not observed a drop in parking fre-
Figure 4-4: Reported primary mode choice, all MIT employees (left) and new hires since 2014 (right).

quency among those continuing to use their car as a primary mode. Nonetheless, the 5% drop in parking ratio among drivers between 2014 and 2016 is appreciable. Section 4.2.3 shows a similar trend in revealed parking frequency among parking permit holders.

The daily commute diary also reinforces the multimodality of MIT commuters, especially drivers. Of the parking permit holders who filled out the 2016 diary (N=1,611), only 27% reported taking the same mode to work all five days that week. The overwhelming majority reported at least one day of using another mode (or working from home), speaking to the importance of designing commuting benefits that align with employee work and commuting preferences.

Mode Shifts
Survey respondents were asked if they used different commuting methods in the academic year prior to the survey (2015-16, the period immediately before the new commuting benefits were offered). Of those who worked at MIT during this period, 15% reported changing their mode of travel. Figure 4-6 shows mode shifts among these commuters, indicating a significantly larger portion of SOV commuters switching to transit (17%) than vice versa (8%). Overall, a third of these commuters were formerly drivers, and their new mode choices are shown in Figure 4-7. A slight majority of the former drivers (N=231) converted to using public transit, while just over a quarter reported continuing to drive while adopting a new secondary mode. The other 17% switched to shared rides, walking or cycling. We also observe that 12% of the changers were former pedestrians and cyclists who converted to transit use as their new primary mode, indicating an unintended consequence of the transit benefit.

Respondents who answered ‘yes’ to having switched modes since last year were subsequently asked why they did so. As shown in Table 4.4, the most common reasons were a change in home location, followed by the new commuting benefits and ‘other’ reasons (of
Figure 4-5: Parking ratios from daily commute diary (2004-2016 Transportation Survey). The ratio is defined as the number of days a commuter drove to MIT divided by the number of days he or she reported coming to campus during the survey diary week.

which the majority listed the free local transit pass). After aggregating the latter two reasons based on comments provided, almost half of those who shifted did so because of the benefits. Implicit in residential relocation is that new commuting options play a role, so the reality is that many more shifts were likely due to the benefits package.

4.2.3 Employee Parking Trends

While the questionnaire results described earlier suggest a marked drop in parking demand on campus, it is important to compare this against actual parking lot in/out activ-

<table>
<thead>
<tr>
<th>Reason for mode shift</th>
<th>Percentage selected*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moved place of residence</td>
<td>37%</td>
</tr>
<tr>
<td>New MIT commuter benefits</td>
<td>24%</td>
</tr>
<tr>
<td>Life event (e.g. family structure)</td>
<td>18%</td>
</tr>
<tr>
<td>Changed jobs/hours</td>
<td>7%</td>
</tr>
<tr>
<td>Availability of a vehicle (e.g. purchased a car)</td>
<td>7%</td>
</tr>
<tr>
<td>Other</td>
<td>26%</td>
</tr>
</tbody>
</table>

*Percentages add up beyond 100% due to multiple selection.
Figure 4-6: Stated mode shifts from 2015 (left) to 2016 (right) among survey respondents who reported changing their commuting modes. Continuity of the same mode implies a new secondary mode was chosen (not shown).

Figure 4-7: Stated mode shift among 2016 survey respondents who formerly drove to campus.
Table 4.5: Parking Permit Purchases (2015-18)

<table>
<thead>
<tr>
<th>Permit Type</th>
<th>2015-16 Pre-AccessMIT</th>
<th>2016-17 Year 1</th>
<th>2017-18* Year 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular commuter (annual)</td>
<td>2,147</td>
<td>678</td>
<td>598</td>
</tr>
<tr>
<td>All lots (annual)</td>
<td>43</td>
<td>18</td>
<td>15</td>
</tr>
<tr>
<td>All lots reserved (annual)</td>
<td>6</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Carpool sticker (annual)</td>
<td>304</td>
<td>273</td>
<td>283</td>
</tr>
<tr>
<td>Economy commuter (annual)</td>
<td>274</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Medical (annual)</td>
<td>4</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Emeritus with compensation (annual)</td>
<td>11</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>Emeritus without compensation (annual)</td>
<td>85</td>
<td>86</td>
<td>78</td>
</tr>
<tr>
<td>Regular commuter with smartway discount (annual)</td>
<td>48</td>
<td>19</td>
<td>28</td>
</tr>
<tr>
<td>Economy/Occasional (daily)</td>
<td>297</td>
<td>463</td>
<td>416</td>
</tr>
<tr>
<td>Occasional/Evening (daily)</td>
<td>1,951</td>
<td>3,282</td>
<td>2,992</td>
</tr>
<tr>
<td>Occasional/Evening all lots (daily)</td>
<td>0</td>
<td>48</td>
<td>50</td>
</tr>
<tr>
<td><strong>Total annual</strong></td>
<td>2,618</td>
<td>829</td>
<td>744</td>
</tr>
<tr>
<td><strong>Total daily</strong></td>
<td>2,248</td>
<td>3,793</td>
<td>3,458</td>
</tr>
<tr>
<td><strong>Total carpool</strong></td>
<td>304</td>
<td>273</td>
<td>283</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>5,170</strong></td>
<td><strong>4,895</strong></td>
<td><strong>4,485</strong></td>
</tr>
<tr>
<td><em>Change from 2015-16</em></td>
<td>-</td>
<td>-5%</td>
<td>-13%</td>
</tr>
</tbody>
</table>

*Through April 2018

In measuring changes in parking demand on campus, the most reliable source is the disaggregate parking lot entry/exit records across gated facilities on campus. This section presents changes in parking permit acquisition and parking frequency among MIT employees. Aggregate statistics on overall lot utilization and peak occupancy are discussed in Section 4.3.1.

Parking Permits

Table 4.5 summarizes the permit types offered to MIT employees, and the associated number of purchases during the year prior to AccessMIT benefits (2015-16) and the two years since its launch (2016-17 and 2017-18). While there are twelve types of permits available to various staff, the most relevant distinction is whether each is charged annually or monthly.

Permit purchases dropped 5% in the first year of AccessMIT, followed by another drop of 8% through most of the second year. The proportion of individual (non-carpool) permits billed on a per-day basis increased from 46% to 82%, given that most staff faced a compulsory switch to such a permit. The 18% that remain with annually-billed permits continue to do so because of the presence of non-gated lots, where payment is enforced by intermittent permit sticker inspections but no daily charge is feasible.
Employee Parking Transactions
As a measure of overall parking activity on campus, the total number of days parked among all employees is summed up and compared year-over-year. Total transactions (or person-parking-days) reflect workday parking activity during revenue hours (8:30 am through 2:30 pm). This statistic is calculated by combining gated lot data, for which a precise record of parking activity is known, with non-gated lot data, for which manual counts were taken intermittently over the last several years. As such, the total is an estimate.

In 2015-16, before AccessMIT, this statistic is estimated at 437,700 transactions; after Year 1 of AccessMIT, it decreased to 400,700, an 8% drop. Extrapolation of parking trends in Year 2 (based on interim transactions from September through April of each year) indicate an estimated 405,000 transactions to occur in 2017-18, an uptick of 1% since Year 1 (albeit smaller than the 2% growth in employee population).

In comparing parking activity among subsets of employees, a group of parkers was identified with parking records before and after the launch of AccessMIT. Among this subset, those observed to use their transit pass frequently (at least one workday a week) exhibited a decrease in transactions from 35,000 to 24,000 (a 31% drop), while the remainder did not exhibit any appreciable reduction in parking (289,000 to 288,000, a 0.4% drop).

Parking Frequency
Moving to a fully disaggregate measure of parking activity, individual commuting patterns were analyzed by counting the weekly frequency of parking per employee. As shown in Table 4.6, the frequency of parking among all staff at MIT, including drivers and all others, is a little over one day per week. This statistic decreased by almost 9% across the first year of AccessMIT. Benefits-eligible employees, who receive the free transit pass, tended to park slightly more to begin with, and decreased their parking frequency by approximately the same proportion. Among parkers using their permits actively (defined as parking at least 20 days during the year), parking frequency increased slightly from 2.63 to 2.65 days per week, though the number of such employees dropped by 7%.

A map of Greater Boston shown in Figure 4-8 illustrates that the highest parking frequency is observed among employees living farther away from campus, and concentrated in areas poorly served by the core MBTA subway and bus system.

Figure 4-9 shows the distribution of parking frequency among staff parkers. The distribution exhibits a clear bimodal trend. Many drivers park on campus either once every two to three weeks, or almost every weekday. Comparing the distribution of parking frequency between the academic years before and after launch of AccessMIT, a negligible change is observed among parkers, although the prior frequent parkers do exhibit a slight increase as shown by the elevated right tail of the curve. However, considering the decrease in the overall number of parking permit holders combined with a 2% growth in employment, the overall average parking frequency normalized among all staff decreased by 11%.

This finding suggests that the switch to daily parking did not have the anticipated result of encouraging commuters to purchase a parking permit and park less often; instead, widespread reductions were seen among commuters who stopped purchasing a permit altogether.
Figure 4-8: Average days parked in MIT gated lots in 2016-17 academic year per employee by home census tract.
Table 4.6: Average Parking Frequency

<table>
<thead>
<tr>
<th></th>
<th>2015-16</th>
<th>2016-17</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>All staff at MIT</td>
<td>1.25</td>
<td>1.14</td>
<td>8.7% decrease</td>
</tr>
<tr>
<td>(N=11,002)</td>
<td>(N=11,283)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All benefits-eligible staff at MIT</td>
<td>1.35</td>
<td>1.23</td>
<td>8.8% decrease</td>
</tr>
<tr>
<td>(N=9,666)</td>
<td>(N=9,913)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active parking permit holders (20+ transactions per year)</td>
<td>2.63</td>
<td>2.65</td>
<td>0.5% increase</td>
</tr>
<tr>
<td>(N=3,218)</td>
<td>(N=3,007)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4-9: Frequency distribution of average weekly parking frequency, before and after AccessMIT launch.
Annual Cap on Daily Parking Fees
As described in Section 3.3, the parkers who were switched from annual billing to daily pay-as-you-park pricing were charged $100 at the beginning of the year, then $10 per workday parked. This fee was capped at $1,760 in 2016-17, equal to the price of an annual permit (and the $100 fee is counted towards the cap). This means any parker who parked at least 166 out of 250 workdays\(^2\) would reach the cap, and no longer be billed for parking that year. With the parking year starting on September 15, this point was often reached at the end of the spring term in May or June.

During the 2016-17 parking year, 543 employees with daily parking permits parked at least 166 workdays. Of the 3,800 daily parking permit holders, this suggests that only 14% would hit the cap.

In 2017-18, the daily rate was kept constant at $10 per day while the annual cap was raised from $1,760 to $1,900. This meant that a driver would now have to park 180 days to reach the cap. Extrapolating on last year’s trends, this would reduce the proportion of parkers who reach the cap from 14% to only 9%, resulting in the daily pricing scheme working as a behavioral incentive to reduce parking for approximately two hundred more parkers, or 91% of all daily permit holders.

4.2.4 Transit Usage
Similar to parking trends, individual transit pass usage displays an approximately bimodal distribution. As shown in Figure 4-10, 22% of active passes accrue an average monthly bill of under $10, while another 22% bill between $60 and $90 per month, reflecting the two clusters of intermittent users and regular transit commuters. The median monthly bill was $43 while the mean was $50, skewed upwards by a few users who billed over $200 per month.

A map of Greater Boston in Figure 4-11 shows the average pass usage across home census tracts in 2016-17. It starkly indicates a concentration of transit users to the south and northwest of campus, largely tracking the MBTA Red Line. We also see higher frequencies of commuter rail riders (lines shown in purple) from the south than the north. This may be due to commuters coming from South Station tapping their MBTA card to ride the Red Line to campus, while commuters coming from North Station commuter rail use the EZ-Ride shuttle (a bus service operated by the Charles River Transportation Management Association, funded in large part by MIT) for free with no electronic record of ridership. Further, highway access to campus from the south (i.e. via downtown Boston) is more heavily congested at peak periods compared to a relatively easier drive from the north and west, potentially further incentivizing transit use from south of the city.

In the year prior to the rollout of AccessMIT (2015-16), approximately 3,600 staff purchased 50%-subsidized monthly local transit passes (‘LinkPass’). Once AccessMIT was launched and all LinkPass purchasers were provided no-cost transit, the average monthly bill of the 3,600 top-billing users was only $74 per month. This means that the average

\(^2\)This is calculated as: the $1,760 cap minus the $100 annual fee yields $1,660 in parking fees, which at $10 per day results in 166 billed days.
Figure 4-10: Frequency distribution of average monthly transit billing on employee ID-embedded passes, 2016-17. Dotted lines indicated what it used to cost MIT employees to purchase a subsidized LinkPass through payroll deduction (left line), and what it would cost an employee to purchase a full-price LinkPass.

MIT transit user was not using the MBTA enough to make it cost-effective for MIT to purchase $84.50 per month LinkPasses, further justifying the decision for MIT to pay for transit on a per-trip basis. This result was anticipated as MIT had previously been subsidizing the LinkPass by 50%, so an employee would only have to use transit half as often to benefit from the savings of a monthly pass.

Overall, four in five transit users billed less than $84.50 on any given month, meaning that the pay-per-use agreement helped MIT save a significant amount of money compared to providing all users with a full-cost LinkPass. If the Institute were to have purchased LinkPasses for all active users, the cost would have been 72% higher than the current average monthly bill of $290,000, and would likely have been deemed cost prohibitive by the MIT administration; the pay-per-use model allows MIT to provide transit access to all. Aggregate pass uptake is further discussed in Section 4.3.3.

Commuter rail passes, which are sold by the month, were not purchased in higher numbers in the first year of AccessMIT, even though the subsidy increased from 50% to 60%. As shown in Figure 4-12, the only significant change was a drop in the number of Zone 1A passes purchased (these allowed local commuters to board commuter rail trains within the most central zone in addition to using local MBTA bus and subway service, and cost the same as a LinkPass; most of these users opted for the free MIT pass instead). Commuter rail pass sales grew 4% in the second year of the program.

### 4.2.5 Attitudes Towards Program

The 2016 MIT Transportation survey included a set of additional questions asking about the extent to which AccessMIT benefits influenced commuting decisions. As shown in Ta-
Figure 4-11: Average number of workdays using free MBTA subway/bus pass in 2016-17 academic year by employee home location, aggregated by census tract.
ble 4.7, 57% of staff reported that the benefits influenced their commuting decisions (35% at least moderately). Of those who identified as drivers, either in 2016 or the year prior, 50% reported that the benefits influenced their commuting decisions (only 22% at least moderately).

Table 4.7: Responses to question: “To what extent have the new AccessMIT commuter benefits influenced your commuting decisions?”

<table>
<thead>
<tr>
<th></th>
<th>All staff</th>
<th>Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large influence</td>
<td>19%</td>
<td>9%</td>
</tr>
<tr>
<td>Moderate influence</td>
<td>16%</td>
<td>13%</td>
</tr>
<tr>
<td>Small influence</td>
<td>22%</td>
<td>28%</td>
</tr>
<tr>
<td>No influence</td>
<td>41%</td>
<td>48%</td>
</tr>
<tr>
<td>Unaware</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>N</td>
<td>5,183</td>
<td>1,422</td>
</tr>
</tbody>
</table>

To further delve into the aspects of the program that had an appreciable effect on behavior, respondents were asked to rank the five new elements of the program on a slider from 0 to 10 according to how much each influenced their travel patterns. Figure 4-13 indicates that the free transit pass was by far the most important new benefit, especially among staff who recently switched modes or are currently considering switching modes. The subsidy for parking at MBTA stations, as well as the increase in subsidy for commuter rail, were ranked as the next two most important elements, while daily parking pricing was seen as less influential. The online dashboard and incentives were consistently ranked least important.

Employees were asked how satisfied they are with MIT’s transportation services overall. Comparing responses in 2012, 2014 and 2016 (Figure 4-14), the proportion of staff reporting being “very satisfied” rose from 38% to 39% to 51%, respectively, indicating a stark increase after the introduction of AccessMIT. Only 1% of staff reported being very dissat-
Figure 4-13: Responses to question: “For each of the following new AccessMIT benefits, how important is the benefit towards influencing your commuting methods, even on an occasional basis? Scale from 0 to 10.

Figure 4-14: Responses to question: “In general, how satisfied are you with MIT’s transportation services?”

4.2.6 Employee Segmentation: Who Changed Behavior?

Significant heterogeneity exists among commuting patterns of MIT employees. Home location and accessibility to transit play a role, as well as demographic and socioeconomic indicators. Hartnett (2016) investigated these trends using ten years of MIT survey data, and found that behavioral responses to new employee benefits outweighed the impact of employee churn and demographic shifts. In this section, a panel analysis is undertaken—building off Hartnett’s study—that considers employees traceable before and after the commuting benefits reforms.
Analysis of disaggregate employee behavior is imperative in understanding the influence of the program. For example, while overall parking demand has dropped at MIT, the parking frequency among continuing drivers has not; this means that a substantial segment of the employee population was either not receptive to the AccessMIT program, or face external constraints that preclude behavior shifts.

One relevant dimension to consider is the attributes of the home neighborhood of each employee. While staff income was not available for this analysis, the median household income in an employee’s neighborhood is a relevant proxy. Figure 4-15 plots median household income by census tract against four aspects of MIT commuter travel behavior. Figure 4-15(a) shows a positive relationship between area income and SOV mode share ($R^2=0.21$), while (b) shows no significant relationship between area income and the proportion of MIT commuters who changed their travel mode in the 2016 survey. Figures 4-15(c) and (d) indicate a positive association between area income and MIT parking frequency ($R^2=0.21$) and a negative association with transit frequency ($R^2=0.24$). The outlier in (d), with a moderate median household income but very high transit usage is in South Boston, where residents have access to Broadway and Andrew stations on the Red Line with rapid access to MIT campus.

![Figure 4-15](image-url)

Figure 4-15: Relationships between median household income by census tract and attributes of MIT commuters living in these census tracts. Only census tracts with at least 15 MIT employees are included. (Source: 2016 American Community Survey)

**Employee Panel Analysis**

Employees with parking and/or transit usage data in both the 2015-16 and 2016-17 academic years were tracked in a longitudinal panel. This captured approximately two-thirds of all current employees (as those who walked or cycled in both years are not included). A
4.3 Institute Impacts

While Section 4.2 provided an overview of changes to employee travel behavior, this section considers the impact on MIT infrastructure and finances at an aggregate level. First, shifts in aggregate parking demand are presented by looking at peak lot occupancy and utilization levels; then, overall transit ridership and pass uptake is reviewed; finally, the financial impact of the program on MIT’s Parking & Transportation budget is analyzed.

4.3.1 Aggregate Parking Demand

As of October 2017, MIT employees had access to approximately 4,000 parking spaces; of these, 3,000 are owned by MIT and are gated on entry and exit; this allows for daily pricing and real-time lot occupancy data. The remaining thousand spaces are a combination of non-gated and leased spaces from third party landowners; in both cases, day-to-day lot occupancy counts are not available, and parking is priced on a monthly or annual basis.

Figure 4-17 shows the average weekday peak occupancy across gated lots from September through August of each parking year from 2015 through December 2017. Peak occupancy was usually reached between 11 a.m. and 1 p.m. The seasonality of parking is clearly evident in the 20-25% drop in demand each year through the summer months. Comparing the year before and after AccessMIT was launched, we note a general decrease in peak occupancy among most months, with a continued decreasing trend into the 2017-18 parking year. Average daily peak occupancy fell 2% in the first year, and an additional 8% in the first eight months of the second year. Table 4.9 indicates the five highest days of parking demand in the year before and after AccessMIT was launched. Among the busiest days, which tend to be midweek, and the peak-of-the-peak dropped by two percent.

Utilization in non-gated lots was estimated using intermittent manual counts across campus, taken at 11 a.m. each day for a week. The ‘before’ count was obtained in March 2015 while the ‘after’ count was done in October 2017. Total occupancy statistics for gated and non-gated lots are shown in Table 4.10, and indicate an overall decrease in average weekday peak occupancy from 71% to 66%, reflecting a 7% drop in peak demand.
Table 4.8: Attributes of two-year employee panel.

<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parker</strong></td>
<td><strong>Non-parker</strong></td>
</tr>
<tr>
<td>N: 4,904</td>
<td>N: 291</td>
</tr>
<tr>
<td><strong>Mean parking frequency:</strong></td>
<td><strong>Mean parking frequency:</strong></td>
</tr>
<tr>
<td>Stayed constant at 2.3 days/week</td>
<td>Increased from 39 to 59 workdays</td>
</tr>
<tr>
<td><strong>Mean transit usage:</strong></td>
<td><strong>Mean transit usage:</strong></td>
</tr>
<tr>
<td>Increased from 11 to 16 workdays</td>
<td>Mean age: 44 years</td>
</tr>
<tr>
<td><strong>Mean age:</strong> 52 years</td>
<td><strong>Mean age:</strong> 52 years</td>
</tr>
<tr>
<td><strong>Female:</strong> 45%</td>
<td><strong>Female:</strong> 47%</td>
</tr>
<tr>
<td><strong>Mean length of employment:</strong></td>
<td><strong>Mean length of employment:</strong></td>
</tr>
<tr>
<td>13 years</td>
<td>7 years</td>
</tr>
<tr>
<td><strong>Staff type:</strong></td>
<td><strong>Staff type:</strong></td>
</tr>
<tr>
<td>32% administrative</td>
<td>29% administrative</td>
</tr>
<tr>
<td>16% faculty</td>
<td>6% faculty</td>
</tr>
<tr>
<td>15% other academic</td>
<td>24% other academic</td>
</tr>
<tr>
<td>13% sponsored research</td>
<td>13% sponsored research</td>
</tr>
<tr>
<td>11% service</td>
<td>11% service</td>
</tr>
<tr>
<td>10% support</td>
<td>14% support</td>
</tr>
<tr>
<td>3% other</td>
<td>3% other</td>
</tr>
<tr>
<td><strong>Median commute length:</strong></td>
<td><strong>Median commute length:</strong></td>
</tr>
<tr>
<td>41 minutes driving</td>
<td>30 minutes driving</td>
</tr>
<tr>
<td>58 minutes by transit</td>
<td>45 minutes by transit</td>
</tr>
</tbody>
</table>

| **Non-parker**              | **Non-parker**            |
| N: 80                       | N: 2,855                  |
| **Mean parking frequency:** | **Mean parking frequency:** | 0 days/week |
| Increased from 0 to 1.7 days/week | Increased from 85 to 96 workdays |
| **Mean transit usage:**    | **Mean transit usage:**   | Mean age: 38 years |
| Decreased from 73 to 61 workdays | Female: 50% |
| **Mean age:** 41 years     | **Mean age:** 41 years    |
| **Female:** 49%            | **Female:** 49%           |
| **Mean length of employment:** | **Mean length of employment:** | 6 years |
| 6 years                    | 6 years                   |
| **Staff type:**            | **Staff type:**           |
| 22% administrative          | 23% administrative         |
| 14% faculty                | 5% faculty                |
| 27% other academic         | 30% other academic        |
| 15% sponsored research     | 18% sponsored research    |
| 11% service                | 4% service                |
| 12% support                | 20% support               |
| **Median commute length:** | **Median commute length:** |
| 28 minutes driving         | 20 minutes driving        |
| 43 minutes by transit      | 31 minutes by transit     |
Figure 4-16: Proportion of 2016 Transportation Survey respondents who reported switching travel modes since 2015, mapped by employee home location at the census tract level.
4.3.2 West Garage Closure

MIT’s West Garage was an above-ground parking structure located at 125 Vassar Street, near to the center of campus. With a capacity of 372 vehicles, it was the second largest above-ground parking structure at MIT and provided parking for employees during weekdays and for visitors to the adjacent athletic complex during evenings and weekends.

A recent engineering assessment deemed the concrete structure to be approaching the end of its life. Rather than reconstructing the lot, MIT designated the property as the future site of an undergraduate dormitory. The garage was to be closed for parking as of September 2017, and all 585 employee parkers assigned to the garage would have to be re-accommodated elsewhere.

Strategy
Managing lot closures was a primary impetus for AccessMIT. While the general trend of the TDM program is a reduction in parking demand, the West Garage closure represented a sudden drop in on-campus parking capacity of close to 10%, requiring short-term measures to manage existing parkers.

The Parking & Transportation Office notified all West Garage parkers about the closure beginning with an e-mail in February 2017. In the summer, renewing parkers were assigned parking areas across campus, with the majority offered nearby lots on the west side of campus or underground parking in Stata Garage.

Due to anticipated over-capacity operations at Stata Garage, an ‘Attendant Assist’ program was to be launched in September 2017. Once Stata filled up each morning, additional parkers would be required to leave their car keys with a lot attendant, who would double-park in the aisles of the underground garage. This would provide additional capacity of 136 spaces. The Attendant Assist program was carefully designed in consultation with a communications team to minimize staff complaints and ensure a perception of convenient and safe parking. An on-site supervisor was designated to oversee the garage

<table>
<thead>
<tr>
<th>Day</th>
<th>Peak Occupancy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday, February 23, 2016</td>
<td>2192</td>
</tr>
<tr>
<td>Wednesday, March 30, 2016</td>
<td>2209</td>
</tr>
<tr>
<td>Tuesday, April 5, 2016</td>
<td>2191</td>
</tr>
<tr>
<td>Tuesday, April 12, 2016</td>
<td>2202</td>
</tr>
<tr>
<td>Wednesday, May 4, 2016</td>
<td>2225</td>
</tr>
<tr>
<td><strong>Average:</strong></td>
<td><strong>2204</strong></td>
</tr>
<tr>
<td>Tuesday, November 15, 2016</td>
<td>2131</td>
</tr>
<tr>
<td>Tuesday, November 29, 2016</td>
<td>2184</td>
</tr>
<tr>
<td>Wednesday, November 30, 2016</td>
<td>2146</td>
</tr>
<tr>
<td>Monday, January 30, 2017</td>
<td>2115</td>
</tr>
<tr>
<td>Wednesday, February 8, 2017</td>
<td>2207</td>
</tr>
<tr>
<td><strong>Average:</strong></td>
<td><strong>2157</strong></td>
</tr>
<tr>
<td><strong>% Percent change:</strong></td>
<td><strong>-2.1%</strong></td>
</tr>
</tbody>
</table>
operations.

**Results**

On September 15, 2017, the lot was closed to employee parkers. Of the 566 staff who held daily parking permits and are still at MIT in 2017-18, an impressive 17% did not renew their permit after being reassigned a new parking location. The overall parking frequency among staff who used to park at West Garage dropped by approximately 16%, and even those that were frequent parkers (100+ days per year) exhibited a 4% decrease in average parking frequency. Figure 4-18 shows a breakdown of occupancy in five main parking areas, and indicates a net decline in parking demand after September 2017.

Parking demand in Stata Garage never reached capacity, meaning that the Attendant Assist program did not ever need to be used. An attendant waiting in the garage each morning was eventually re-assigned to other campus duties.

**Takeaways**

What can be learned from the West Garage closure? In retrospect, it perhaps reflects the transience of parking demand, and the ability of a perceived ‘shock’ to the system to spark a shift in travel behavior. It also reflects the risk aversion of parking managers, concerned about over-capacity parking operations. Two hypotheses are considered on the transience of demand. The first is that the fear factor of not knowing whether there will be parking available may have suppressed demand after the closure. This behavioral lever may be weakened as commuters realize capacity still exists in various lots across campus. The second hypothesis is that being re-assigned a new parking area caused commuters to consider their travel habits more carefully, and explore the new benefits made available through AccessMIT. For commuters who had never been on MIT’s Parking & Transportation Website before, this may have been their first foray into the online promotional materials about transit benefits. Given the literature on the role of habit in transportation and the potential for disruptions in habit to effect long-term changes in travel behavior (see Section 6.1.1), it may be that simply thinking about one’s commute caused some staff to re-evaluate their choices.

The closure was not entirely smooth, however. Parking & Transportation staff received some complaints about increases in walking time after the lot reassignments, and some commuters felt it was unfair to be increasing parking rates while their parking was made more inconvenient. The upcoming 2018 MIT Transportation Survey may shed light into how the former West Garage parkers have adapted their travel habits after a year.

<table>
<thead>
<tr>
<th></th>
<th>Fall 2015</th>
<th>Fall 2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gated</td>
<td>69%</td>
<td>65%</td>
</tr>
<tr>
<td>Non-gated</td>
<td>78%</td>
<td>70%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>71%</strong></td>
<td><strong>66%</strong></td>
</tr>
</tbody>
</table>
Figure 4-17: Average weekday peak occupancy among gated lots, 2015-18 (interim).

Figure 4-18: Comparison of occupancy in five main parking areas during 2016-17 and early 2017-18, showing the impacts of the West Garage closure in September 2017.

4.3.3 Transit Ridership

Prior to the introduction of AccessMIT, approximately 3,300 staff purchased a monthly MBTA LinkPass (providing unlimited local bus and subway service)\(^3\). Once AccessMIT was launched, staff were asked to swap their ID card for a CharlieCard-integrated card,

\(^3\)An additional 300 staff held a ‘Mobility Pass’ chip in their MIT ID card, which provided the functionality of a LinkPass (discussed in Section 3.4).
Figure 4-19: Billing to MIT for MBTA transit passes plotted alongside the number of active passes each month (September 2016 through February 2018).

which had the unlimited use pass enabled. As the ID swap process took several months beginning in summer 2016, the number of active passes gradually increased over the year as shown in Figure 4-19.

Figure 4-19 also indicates that the average monthly billing associated with the roughly six thousand active passes tended to grow only slightly from September 2016 onward, averaging around $300,000 per month (compared to LinkPass charges that averaged around $120,000 per month in the year prior to AccessMIT). The heaviest transit users generally received their new pass over the summer in 2016, and the slight increase in active passes throughout the academic year came mostly from intermittent users who did not accrue significant charges. Total costs to MIT are discussed in the following section.

Comparing trip diaries from the 2014 and 2016 MIT Transportation Surveys, an estimate of transit ridership growth can be made. Overall, MIT staff increased their usage of transit from an average of 1.9 to 2.1 days per week, reflecting a 10% increase in ridership.

4.3.4 Program Finances

Parking Revenue and Expenses

After the introduction of AccessMIT, employee parking revenues remained stable as increases in permit prices offset a reduction in parking campus-wide. Table 4.11 presents an overview of the revenue and expenses associated with employee parking at MIT. By far the largest expense incurred to the Parking & Transportation Office is the interest and depreciation on campus parking facilities, at around $5 million per year. This expense arises
mainly due to the cost of recent underground garage construction\textsuperscript{4}. Operating expenses including maintenance, gate equipment and IT systems, as well as personnel salaries, account for another $2 million annually. The other main parking-related expense is the leasing of off-campus spaces at approximately $1 million per year. While this represents a significant expense considering how few spaces are leased by MIT, their flexibility on a year-to-year basis allows MIT to adapt parking supply to demand.

The total expense of parking spaces at MIT is shown in Figure 4-20, broken down into the permit fee and the employer subsidy based on the Parking & Transportation Office budget. While subsidies in the last three years appear lower than historically, an accounting change was made to exclude the ‘space charge’ which is an estimate of the value of the land if it were converted to its highest-value use (Block-Schachter, 2009). The current subsidy, not accounting for this charge, is $987 per $1,900 permit or 34%. Also shown is the additional subsidy required to pay for leased parking spaces, for the last three years in which data was provided. The current subsidy for leased parking is approximately twice as much as for owned parking, and exhibited a sharp increase from 2016-17 to 2017-18 as spaces in new locations were leased at a higher rate.

If we take the cost of leased parking as a proxy for the area market rate, and compare this to the average of $50 per month spent by MIT subsidizing employee local transit use (or $600 per year, as discussed in Section 4.2.4), the $1,900/year leased parking subsidy means that MIT contributes over three times as much for each parker as it does for each transit user.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{parking_fees_subsidies.png}
\caption{MIT employee parking fees and subsidies, 2005-2018. (a) Subsidy calculations after 2014-15 do not include a ‘space charge’ (which accounts for opportunity cost associated with the value of the land). (b) Missing subsidy data, shown hatched, is interpolated linearly. (c) The additional subsidy associated with leased spaces is shown where data exists after 2014-15.}
\end{figure}

\textsuperscript{4}The Stata Center garage, for example, was estimated to add approximately $70 million to the cost of construction in 2004.
Table 4.11: MIT parking-related expenses and revenue, 2015-18

<table>
<thead>
<tr>
<th>Expenses</th>
<th>2015-16</th>
<th>2016-17</th>
<th>2017-18 (budgeted)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depreciation on Parking Facilities</td>
<td>$2,401,000</td>
<td>$2,520,000</td>
<td>$2,700,000</td>
</tr>
<tr>
<td>Interest on Parking Facilities</td>
<td>$1,725,000</td>
<td>$2,804,000</td>
<td>$2,800,000</td>
</tr>
<tr>
<td>Gate Equipment &amp; IT Systems</td>
<td>$1,053,000</td>
<td>$1,150,000</td>
<td>$1,080,000</td>
</tr>
<tr>
<td>Leased Parking</td>
<td>$744,000</td>
<td>$1,056,000</td>
<td>$1,119,000</td>
</tr>
<tr>
<td>Maintenance</td>
<td>$729,000</td>
<td>$839,000</td>
<td>$800,000</td>
</tr>
<tr>
<td>Other (salaries, office expenses, etc.)</td>
<td>$152,000</td>
<td>$163,000</td>
<td>$170,000</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td>$6,803,000</td>
<td>$8,534,000</td>
<td>$8,669,000</td>
</tr>
<tr>
<td><strong>Total Employee Parking Expenses</strong></td>
<td>$5,782,000</td>
<td>$7,254,000</td>
<td>$7,369,000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Revenue</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Employee Payroll Parking Deductions</td>
<td>$4,307,000</td>
<td>$4,602,000</td>
<td>$4,850,000</td>
</tr>
<tr>
<td>Credit Card Parking Payments</td>
<td>$580,000</td>
<td>$144,000</td>
<td>$850,000</td>
</tr>
<tr>
<td>Visitor Parking and Internal Billing</td>
<td>$535,000</td>
<td>$578,000</td>
<td>$400,000</td>
</tr>
<tr>
<td>Event Revenue</td>
<td>$415,000</td>
<td>$276,000</td>
<td>$450,000</td>
</tr>
<tr>
<td><strong>Total Revenue</strong></td>
<td>$5,837,000</td>
<td>$5,600,000</td>
<td>$6,550,000</td>
</tr>
<tr>
<td><strong>Total Employee Revenue</strong></td>
<td>$4,887,000</td>
<td>$4,746,000</td>
<td>$5,700,000</td>
</tr>
</tbody>
</table>

| Subsidy                          | 16%      | 38%      | 34%               |
| Subsidy per permit                | $548     | $1,014   | $987              |
| Subsidy per leased space          | $965     | $1,215   | $1,894            |

Notes:
1. Lease expenses grew as costlier spaces were acquired in 2016-17 and 2017-18.
2. Calculated based on the proportion of spaces allocated to employees.
3. Sum of employee payroll deductions and employee credit card payments.

Transit Expenses
On the transit side, Table 4.12 illustrates that the total additional expense associated with enhanced transit benefits was approximately $2.1 million in the first year of AccessMIT, or $190 per employee. This is comprised of $2.8 million in pay-per-use pass expenses and $300,000 in additional commuter rail subsidies, less a $1 million reduction in monthly LinkPass and bus pass subsidies. The AccessMIT local transit passes now make up 63% of MIT’s transit expenditures, with the remainder being commuter rail subsidies and a small number of LinkPass subsidies for employees at Lincoln Laboratories in Lexington, MA (who are not eligible for the AccessMIT pass).

Employee transit expenses declined by an estimated 54% after AccessMIT was introduced, reducing the average commuter transit expense by $107 annually. While the precise expenditures on private fares (e.g. loaded onto personal CharlieCards) is not known, responses from the week-long trip diary in the MIT Transportation Survey among non-pass-holders were used to estimate trip frequency.

The MBTA now forgoes this private fare revenue as all eligible staff have an employer-paid pass, but the net impact on MBTA revenue was a growth of approximately 5% in the
first year of AccessMIT. Annual fare revenue from MIT (both employees and employer contributions) grew from $6.5 million to $6.9 million in the first year, and is anticipated to hold steady in the second year. Despite early concerns that a pay-per-use employer agreement might lead to a reduction in transit agency fare revenue, this case study demonstrates that increased ridership more than offset the losses from under-utilized passes.

Growth in MBTA ridership among MIT employees, while more difficult to calculate precisely, is estimated at around 10% since the launch of AccessMIT. This is based on a comparison of the 2014 and 2016 MIT Transportation Survey trip diaries.

4.4 Discussion

The introduction of enhanced commuting benefits for MIT’s employees may be considered a success in its ability to effect a mode shift away from single-occupancy vehicles and to reduce parking demand by close to 10% in its first two years. There were a variety of shortcomings identified in the program design and implementation, as discussed below, but overall this initiative should serve as a promising case study for other employers to emulate.

4.4.1 Lessons

On metrics

The primary goal of AccessMIT, established prior to launch and publicized alongside its rollout, was to achieve a 10% reduction in parking demand over the first two years (2016-17 and 2017-18 academic years).

ICF & CUTR (2005) proposed a mnemonic to guide the evaluation of TDM programs. Objectives should have ‘SMART’ characteristics, meaning they are (1) specific, (2) measurable, (3) achievable, (4) realistic, and (5) time sensitive. Applying this framework to MIT’s program, we see that these objectives were partially satisfied.

On (1) specificity, the AccessMIT program was targeted towards staff parkers, but the metric on parking reduction could also apply to students, visitors, volunteers, contractors, etc. Parking reduction targets for each population could help guide what approaches are taken.

On (2) measurement, parking demand can be measured in myriad ways (e.g. permit sales, average parking frequency, average parking duration, total person parking days, average and peak lot occupancy, time to find a space, permit-to-space ratio, turnover rates, stated mode choice, etc. (Maleck, 2013)). The MIT administration had not specified a priori which metric the 10% benchmark was to be applied to, and as such, different narratives can be told with different metrics.

Fares were increased on July 1, 2016. Adult rapid transit fares increased from $2.10 to $2.25, and commuter rail pass prices grew as well. This helped contribute to an increase in MBTA revenue in 2016-17.
Table 4.12: Transit-related expenses to MIT and revenues to MBTA, 2015-18

<table>
<thead>
<tr>
<th></th>
<th>2015-16</th>
<th>2016-17</th>
<th>2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MIT Transit Expenses</strong>¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AccessMIT Pass²</td>
<td>$0</td>
<td>$3,051,000</td>
<td>$3,297,000</td>
</tr>
<tr>
<td>Commuter Rail Subsidy³</td>
<td>$1,116,000</td>
<td>$1,392,000</td>
<td>$1,483,000</td>
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<tr>
<td>Monthly Bus and LinkPass⁴</td>
<td>$1,379,000</td>
<td>$367,000</td>
<td>$116,000</td>
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<tr>
<td>Mobility Pass⁵</td>
<td>$246,000</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total Expenses</strong></td>
<td>$2,741,000</td>
<td>$4,810,000</td>
<td>$4,895,000</td>
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</tbody>
</table>

<table>
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<th>2016-17</th>
<th>2017-18</th>
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<tbody>
<tr>
<td><strong>Employee Transit Expenses</strong>⁶</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AccessMIT Pass</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Commuter Rail Passes</td>
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<td>Monthly Bus and LinkPass</td>
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<tr>
<td>Mobility Pass</td>
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<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Estimated private fares⁷</td>
<td>$880,000</td>
<td>$297,000</td>
<td>$303,000</td>
</tr>
<tr>
<td><strong>Total Employee Contributions</strong></td>
<td>$2,771,000</td>
<td>$1,279,000</td>
<td>$1,140,000</td>
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<table>
<thead>
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<th></th>
<th>2015-16</th>
<th>2016-17</th>
<th>2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Revenue to MBTA</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AccessMIT Pass</td>
<td>$0</td>
<td>$3,304,000</td>
<td>$3,570,000</td>
</tr>
<tr>
<td>Commuter Rail</td>
<td>$2,416,000</td>
<td>$2,513,000</td>
<td>$2,676,000</td>
</tr>
<tr>
<td>Monthly Bus and LinkPass</td>
<td>$2,987,000</td>
<td>$795,000</td>
<td>$251,000</td>
</tr>
<tr>
<td>Mobility Pass</td>
<td>$266,000</td>
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<td>$0</td>
</tr>
<tr>
<td>Estimated private fares</td>
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<td>$297,000</td>
<td>$303,000</td>
</tr>
<tr>
<td><strong>Total Revenue to MBTA</strong></td>
<td>$6,549,000</td>
<td>$6,908,000</td>
<td>$6,799,000</td>
</tr>
</tbody>
</table>

**Notes:**
1. Employer-paid transit expenses are reduced by payroll tax savings of 7.65%.
2. Billed on a pay-per-use basis, at 100% subsidy by the employer.
3. Subsidized at 50% in 2015-16; raised to 60% in 2016-17.
4. Subsidized at 50%; now only offered to Lincoln Laboratories staff (off-campus).
5. Legacy pay-per-use pass pilot program, rolled into AccessMIT in 2016-17.
6. Employee-paid transit expenses are reduced by income tax savings of 30%, except for personal fares not paid via the employer.
7. Private fares are estimated at 1.4 trips per week among non-pass-holders, based on 2014 (pre-AccessMIT) survey trip diary responses. Afterwards, private fare revenue is only from staff at Lincoln Laboratory, which does not provide a universal transit pass, and non-benefits-eligible staff at MIT’s main campus.

To the Office of Campus Planning, perhaps the most important metric is peak lot occupancy, relating directly to projections of future parking infrastructure needs. For the Office of Sustainability, statistics correlating to carbon emissions, such as total commuter vehicle miles traveled, and average parking frequency as a proxy, are more germane. The Parking & Transportation Office, which manages parking revenues, may be concerned with the total number of paid parking transactions. To researchers, each plays an independent and important role in piecing together the TDM implications of the program.
This thesis used four main metrics of revealed parking demand to complement self-reported survey data. These included: (a) parking permit sales, (b) total person parking days, (c) parking frequency per capita, and (d) overall lot occupancy (see Sections 4.2.2 and 4.2.3). The metric of parking frequency per capita (3) suggests the largest impacts with an 11% decrease after the first year of the program. This decrease is aided by the metric being normalized to employee population, which has recently grown approximately 2% each year (mostly with younger non-drivers). On the other hand, peak lot occupancy indicates a more modest decrease, with the 7% drop in maximum daily lot utilization after the first year being skewed by the fact that this is a maximum, not an average. It is understandable that statistics of extrema will shift less than means or medians.

On the characteristics of being (3) achievable, (4) realistic and (5) time sensitive, the AccessMIT objective does reasonably well. It was clearly and reasonably achievable in the time frame specified.

**On process vs. outcomes**
Alexander & Faludi (1989) explore different perspectives on the evaluation of plans. On one extreme, they describe the success of a plan as being dependent on the extent to which it is implemented. The other end of the spectrum is that the success of a plan relates only to whether the intended outcomes are achieved, regardless of whether the plan was followed. The authors apply the policy-plan/programme-implementation process (PPIP) model to evaluate plans, confronting the dichotomy between planning as a process and as a set of outcomes.

In the case of AccessMIT, this dichotomy presents itself in the ways the program departed from its intended behavioral pathways, yet still managed to achieve desirable results. The most striking of these observations is perhaps that the switch from annual parking pricing to daily charging did not result in a decrease in average parking frequency among parking permit holders as expected. Researchers hypothesized that drivers would generally continue to purchase permits (whose price was $100 per year), and simply park less (given a $10/day fee). However, on average, the decreases in parking came mostly from those who ceased to purchase a permit, with a small further decrease from permit holders who did not previously park every day.

Two lessons can be drawn from this. First, it emphasizes that positive shifts in travel behavior (outcomes) may arise due to a different uptake of incentives than expected (process). Second, more specifically, this finding points to possible shortcomings in the daily pricing scheme, discussed in more depth below.

**On cost salience**
As discussed in Section 2.2, cost salience refers to the gap between an actual cost and its perceived amount. The more salient a cost, the more it is felt. A common example in transportation is a highway toll, which if charged via a cash-only toll booth has high salience, whereas if charged through discreet wireless transponders has low salience (Finkelstein, 2009).

In the case of daily parking pricing, its behavioral impact depends significantly on how much the cost is felt. This is determined by both (a) the manner in which the cost is presented, and (b) the temporal lag between the parking event and the perceived transaction.
On point (a), most employees have their parking charges deducted directly from their paycheck. There is a line item for parking charges, which includes the $100 annual fee prorated throughout the year alongside the $10 per day parking fee (if the parker has not yet reached the annual cap). However, because employees were paid on a monthly or bi-monthly basis (or for some hourly employees, weekly), the annual portion of the parking charges are prorated to match the pay cycle, and a delay exists between when the daily charges are incurred and the fee shows up on the paycheck. As a result, a typical parking charge is not a round number and does not easily line up with an employee’s memory of how much they parked in the prior weeks.

To point (b), this also reflects a temporal lag between the time an employee parks and the time they see the charge reflected on their paycheck (although the $10 fee sometimes appears on gate interface as the driver taps out to exit). Given the literature on cost salience emphasizing the importance of a quick behavioral feedback loop (Tiefenbeck et al., 2016), shortening the time gap between parking transactions and paycheck deductions may improve the cost salience.

Various ideas have been presented to the Parking & Transportation Committee to remedy this lack of cost salience. A new mobile parking management app could offer immediate push notifications to drivers upon entering or exiting the lot, indicating the charges incurred (and the savings available next time they do not park). Additionally, a line item breakdown on the paycheck could identify exactly how the parking charge was calculated, and how much MIT subsidizes the charge. Further, the AccessMyCommute dashboard could have a ledger built in to show how parking charges are accrued, and emphasize the opportunity for savings through the daily parking scheme.

Finally, we may note that the parking daily rate increase from $8.50 to $10 per day might have increased the salience of the cost by virtue of $10 being a round, double-digit number. While this level of nuance would require further behavioral study, anecdotal evidence suggests parkers interpret the new charge as significantly more than the prior amount.

**On cultivating a shared vision**

MIT, as any large institution, has a large and complex bureaucracy. On parking and transportation, many areas within the administration are involved in policy, planning and operations. Each has its own perspective and vested interests, and sometimes these conflict. For example, the Human Resources group in charge of recruitment and retention may wish to promote the benefits of working at MIT, and would steer clear of negative language surrounding parking benefits. Conversely, travel demand management staff in Campus Planning and the P&T Office may wish to strike a more measured tone regarding parking provision. An important lesson from the launch of AccessMIT is that a shared, collective vision for the program should be articulated and adopted by a wide breadth of institutional stakeholders. This should range from senior administration to the most junior staff.

For junior staff, an example is in how customer service representatives in the P&T Office sell parking permits to the MIT community. While such representatives are well-trained in the technical aspects of the system, it was not clear that such employees were briefed on broader rationale of the policy reforms, such as to whom they should sell daily parking permits over annual permits. Survey responses indicated that some employees thought the
daily permits would ultimately cost more than the annual passes, and it was observed that some parkers tried to negotiate for (or demand) an annual permit, despite the fact that a daily permit can only save the parker money (due to the annual cap). In addition to further staff training, misinformation could be reduced through a deliberate re-branding of program elements to be more user-centric (such renaming the ‘occasional’ parking permit to ‘daily’ or ‘pay-as-you-park’).

For senior administration, part of cultivating a shared vision means ensuring that future policy adjustments work to further the objectives of the original program reforms, and not contradict them. A case in point is the recent decision to overhaul the online parking permit purchase system. After receiving complaints about the difficult-to-navigate parking web portal, the administration decided to build a new website and better integrate back-end systems. At the request of parkers, it was decided to develop an automatic renewal system for parking permits so that drivers would not have to sign up again each year. Based on the findings of this research, however, it is clear that the act of signing up for a parking permit presents a key decision point for a commuter, and that by reversing the default decision (see Section 2.2 on the importance of default choices), we may expect that parking demand will increase.

On equity
From the president to a custodial worker, MIT employs a diverse staff at a wide range of income levels. Key to measuring the success of any policy on employee benefits is understanding its impacts on equity across socioeconomic strata. For example, decades ago when MIT provided free parking, this was implicitly a subsidy for wealthy motorists, while employees without access to a vehicle were forced to pay for transit. Recent increases in the cost of parking, along with taxable income deductions for transit expenses, have reduced this inequity. With the introduction of a zero-cost transit pass, a great stride has been taken towards having an equitable transportation policy for all MIT staff commuters. Concerns have been raised, however, surrounding the daily parking pricing scheme and the extent to which it disproportionately penalizes lower-income workers. The issue is that high-paid employees, such as professors, have a high degree of flexibility in their schedules, and can choose not to commute to MIT during certain days or hours when parking fees are charged. Conversely, a typical support staff that works a rigid 9 am - 5 pm schedule does not have the same time flexibility, and is more likely to feel constrained to their existing commuting pattern. The result is that these lower-income workers may be more likely to reach the annual cap on parking fees. In the second year of AccessMIT, the annual cap was raised 8% while the daily fee remained constant. Although the desired narrative from the administration was that parking fees were frozen for the first time in many years, drivers who were going to reach the cap perceived yet another increase in fees\(^6\).

Some employers, such as Partners HealthCare (see Chapter 6), tier their parking fees by employee income in an effort to advance equity. MIT does not do so with transportation or any other employee benefits, although this has been considered in the past and was re-

\(^6\)A group of support staff protested the parking fee increases through an open letter, arguing that the increase in daily rate in 2016 from $8.50 to $10 was a significantly higher proportion increase than their raise that year. In what aimed to be gesture of goodwill, the $10 rate was kept constant the following year, but the cap increase nonetheless resulted in continued complaints.
cently raised as a potential policy reform once again.

Many survey respondents who drive to MIT indicated a desire to switch to transit, but lamented the unaffordability of housing in areas proximate to MBTA service, and especially in areas near MIT. A takeaway is that in order to truly advance transportation equity, societal resources must be put into ensuring that competitive and affordable alternatives exist to driving, especially in areas with lower-income households that currently may be in transit deserts, and that housing affordability remains a central tenet of local and regional planning.

4.4.2 Tensions in Policy Design and Implementation

The above section discussed some of the broad lessons that can be learned from the launch and early evaluation of the AccessMIT program. From a policy design and implementation perspective, this study also raised a number of specific tensions that must be reconciled based on a set of institutional values. Some key trade-offs are discussed below.

**Efficiency vs. equity**
Balancing these two objectives is a perennial challenge in the design of TDM programs. In a recent study of an early bird discount on the Hong Kong Mass Transit Railway (MTR), Halvorsen et al. (2016) describe how a TDM policy designed to target a specific segment of travelers loses efficiency when equitably applied to a large group of travelers.

Analogously, the most efficient program design for MIT would be one that solely targets existing drivers in a bid to reduce parking demand. This is what the 2010 Mobility Pass pilot project sought to accomplish. However, in scaling up to a permanent benefits package, it would be considered inequitable to only provide the perk of a free transit pass to commuters who drive to work.

As the AccessMIT program was developed, a proposal was made to divide the employee population into three subsets, each with slightly different commuting benefits (with a fourth control group). Random assignment would ensure that certain subsets of employees (e.g. drivers) did not receive preferential treatment, and such an initiative would provide researchers with a randomized (albeit not entirely controlled) trial to help inform causality of behavior change in response to incentives. While the administration considered this proposal, it was ultimately decided that all benefits would be uniform among staff to ensure equitable compensation.

That said, the large portion of the MIT community not covered under the umbrella of AccessMIT benefits is the student body. MIT’s 11,000 students can purchase a 50% subsidized MBTA LinkPass, but were not offered the zero-cost pass when this was introduced to employees. The simple reason is that, unlike at many suburban universities, very few MIT students drive to campus. As such, providing enhanced transit benefits to students would be cost-inefficient from the perspective of reducing parking demand.

**Carrots vs. sticks**
Ample research has been conducted on the relative effectiveness of rewards and penalties in achieving and maintaining behavior change. In the context of TDM strategies, a combi-
nation of carrots and sticks is often provided, such as the pairing of transit subsidies and increased parking costs. No matter the perks provided, the largest reductions in driving tend to come from making driving more costly and parking more difficult (Shoup, 2005). Therefore, an employer seeking to reduce its parking requirements can often simply take the ‘stick’ approach to parking management.

However, a primary duty of employers is to retain their employees and keep them happy and productive, so a purely punitive set of measures is unlikely to be politically sustainable within an organization. Furthermore, research suggests using ‘sticks’ can be economically inefficient (McShane & Meyer, 1982; Peters & Gordon, 2009). The trade-off often reduces to effectiveness against political viability, or ease of implementation versus cost. It is ultimately a question of what the employer is trying to accomplish, and the degree to which employee satisfaction or wellbeing is to be traded off against a specific policy objective such as reducing the cost of parking provision. This research, which found an increase in employee satisfaction alongside a reduction in parking demand, suggests that this need not be a zero-sum game.

**Economics vs. the environment**

Efforts to simultaneously achieve economic and environmental goals can be a tug of war, as earth-friendly measures do not always present the cheapest option, at least in the short term. In the case of AccessMIT, the program’s joint objectives of providing affordable, flexible and low-carbon commuting options led to a general alignment of economic and environmental goals, with free transit helping staff save money and reduce their carbon footprint.

That said, a measure like the parking subsidy at MBTA stations can be critiqued for its implicit encouragement of driving (at least for part of the commute). The incentive serves predominantly to shift the parking demand on MIT’s campus towards lots at the terminal stations of the MBTA subway and along commuter rail lines, many of which face parking constraints themselves. Nonetheless, the last few miles of the commute to campus tend to be the most congested (and thus highest polluting), so it may be argued that eliminating this portion of the drive is most effective from an environmental standpoint.

**Policy Design vs. Ease of Implementation**

One important (albeit easily overlooked) aspect of the AccessMIT program was the introduction of a first-time parker surcharge. This $100 fee was charged on top of the annual $100 permit fee to staff who never previously purchased a parking permit, was designed with the intent to pose one last hurdle before an employee decides to become a ‘parker’. Given the relative ease of nudging a new commuter to take transit compared to the difficulty in convincing a habitual parker to give up his or her parking spot, this policy was closely aligned with the goals of AccessMIT and is attuned to the literature on habit formation in travel choices (Gärling & Axhausen, 2003).

While the fee was well-intentioned and simple in principle, implementation proved more difficult. Staff in the Parking & Transportation Office noted that the software managing permit sales was not capable of reliably determining whether an employee previously held a permit, especially if there was a lapse in historical parking activity. Some parkers, who had worked at MIT for decades and had a permit many years ago, rightfully objected to being charged this extra fee. In an effort to reduce complaints and manual effort associ-
ated with looking up permit history, the P&T Office changed the way the extra ‘hurdle’ fee was assessed.

A new fee structure was introduced that charged employees only the $100 annual permit fee if they signed up on time, and charged an additional $100 if the employee signed up after the official enrollment period. Permits are active starting September 15 each year; permit sales begin in June and the regular rate ended in July. While the new pricing model greatly simplified the back-end processes, the impact on commuter travel behavior ended up being contrary to that originally intended. The new model encouraged would-be parkers to commit to a parking permit early, and penalized those who waited until later in the summer. Therefore, a new employee considering his or her commuting options would be unduly pressured to buy a parking permit rather than hold off and try transit for a few months.

This example highlights the tension between abstract policy design and concrete implementation details. Staff in the P&T Office were not seeking to encourage parking, but were understandably seeking to reduce the backlog of last-minute permit purchases that occurred every year as the deadline approached. For the 2018-19 year, the extra $100 “late fee” will be discontinued and all parkers (new and old) will be charged a single $100 fee to sign up.

**Current trends vs. future uncertainty**

The Office of Campus Planning, in its counsel to the MIT administration on future infrastructure needs, develops models of future travel demand in order to forecast parking capacity requirements for the next several decades. Extrapolation of current trends, primarily using data like the Transportation Survey, provides the backing for such models. Of course, as eminent statistician George E.P. Box once said, “all models are wrong, but some are useful”. The question is, how wrong are these models, and given their folly, how useful might they be?

The first aspect to note is that the philosophy around parking provision at MIT, like most employers, is to ‘predict and provide’. That is, the future demand for parking spaces is predicted, and the infrastructure is ultimately provided to accommodate such demand. Aggressive pricing and the recent introduction of enhanced commuter benefits have lowered the predicted demand, but anyone who wants to park at MIT can always find a spot; e.g. there is no waiting list for a parking permit. In the future, as land values continue to increase and parking inventories further dwindle, there may be scenarios where it makes sense for MIT to no longer provide as much parking as is requested by the community, and travel patterns will change by necessity. This would reflect a paradigm shift toward more proactive management and shaping of travel behavior.

Further, as alluded to in the introduction to this thesis, perhaps the biggest wildcard in this discussion is the autonomous vehicle (AV). The parking industry is awakening to the massive uncertainties around AV adoption and its potential impact on the nature of demand for parking. It may be that substantial urban parking facilities need no longer exist, in which case the focus should be on how to provide parking facilities that can be con-
verted to other uses when no longer required for parking\(^7\). Researchers at MIT are exploring potential scenarios for AV adoption and the interface with parking, and such scenario planning should be a part of parking demand forecasts, placing a large caveat on any current trend extrapolations.

**Classical economics vs. behavioral economics**

The field of behavioral economics, relying on the application of human psychology to explain economic decision-making, has been discussed as a central tenet in the design of the AccessMIT program. Aspects like the salience of daily parking charges, the ‘power of free’ with a 100%-subsidized transit pass versus a half-price pass, and the gamification introduced with the *AccessMyCommute* dashboard all attempted to leverage insights from this burgeoning field. However, the question remains as to whether the changes in behavior observed are a product of the behavioral science phenomena elucidated in this thesis, or a more basic response to classical economic stimuli, namely costlier parking and cheaper alternatives.

The randomized controlled experiment in the subsequent chapter sought to disentangle these concepts through the targeted application of monetary and non-monetary interventions. As for the overall AccessMIT program, however, we are somewhat left to conjecture on what economic theory is most applicable. The stated result that commuters cared most about the free pass and least about the *AccessMyCommute* dashboard (see Figure 4.7) gives credence to the finding that basic pricing mechanisms outweigh the impact of any ‘nudges’, but the relative impact of pricing and how such prices are communicated and internalized remains uncertain.

### 4.5 Conclusion

This chapter presented an evaluation of the new commuting benefits program for MIT staff known as AccessMIT. While a number of growing pains accompanied the rollout, the overall story is that of a successful reduction in parking demand in the first two years of implementation. With parking permit sales, overall parking transactions and per capita driving rates on the decline, this project demonstrated the efficacy of a holistic reform of employer commuting benefits in achieving a reduction in parking demand with associated decreases in carbon footprint. This is especially striking considering the program started with a very low drive-alone mode share of 30%, meaning that the ‘low-hanging fruit’, or easily-converted commuters, had long since switched from driving.

Beyond the promising statistics on paper, the program had tangible impacts on the ground. As discussed in Section 4.3, MIT’s 400-space West Garage was demolished in early 2018 and will be replaced with an undergraduate dormitory. While the demolition was planned before the results of AccessMIT were known, the results of the program are that a replacement garage will not be required elsewhere on campus. The modest increase in cost of transit pass provision and decrease in parking revenues will be dwarfed by the avoided capital expenditure of a new underground parking garage.

\(^7\)Building level-floor structures with higher ceiling clearance is an example of how parking garages are being constructed with future conversions in mind.
Next steps for the program include enhancing the equity of benefits among employees for whom public transit is not a viable commuting option. New carpool incentive programs are being explored to help drivers share their rides and receive discounted parking for doing so. It is also expected that the annual cap on daily parking rates will gradually be raised and ultimately eliminated such that all drivers will have a marginal cost savings associated with each day they do not park on campus.

Future research will continue to evaluate the impact of the commuter benefits program, with an emphasis on determining whether changes in travel patterns were instigated by the one-time stimulus of the new program, or whether shifts in behavior are here to stay.

This case study seeks to provide a proof-of-concept for other workplaces considering ways to reduce their parking demand and SOV mode share, as well as for transit agencies looking at potential strategies to enhance their corporate pass programs without jeopardizing farebox revenue. This chapter has shown how MIT’s program, introduced in collaboration with the MBTA, can hopefully be an exemplar for both.
Chapter 5

Randomized Controlled Trial

5.1 Introduction

This chapter discusses an experiment conducted as an extension of the AccessMIT program. The research seized on the opportunity to examine the changes in travel behavior among 11,000 employees at MIT, almost half of whom have parking permits, and deploy a series of multi-faceted, customized interventions in an attempt to reduce parking demand. A randomized controlled trial (RCT) experiment was conducted on employee parkers, exploring the extent to which targeted information and small monetary rewards can complement existing transportation benefits to shift commuter travel patterns. With a sample size of two thousand drivers and a comprehensive dataset of daily parking and transit records alongside survey-elicited preferences, this experiment is the largest known workplace-based RCT conducted in the TDM literature (Petrunoff et al., 2016; Graham-Rowe et al., 2011; Yang et al., 2010; Ogilvie et al., 2007). The research uses a combination of passive data collection and a survey to understand the behavioral and attitudinal responses to the interventions.

5.2 Background

Given the strategic position of employers, there are a number of ways in which workplaces can encourage a reduction in car use. Most fundamentally is through the location and multimodal accessibility of the workplace. Regardless of convenient alternatives to driving, however, Shoup (1997) describes the crucial role that parking provision plays in an individual’s decision to drive. He demonstrates the effectiveness of adequately pricing parking to manage demand.
5.2.1 Experiment Motivation

Attributes such as workplace location and transportation pricing are examples of ‘hard’ TDM, or direct measures that affect the utility of a commuting option. Many other approaches, involving a modification of the perceptions of choice or nudging, fall under the category of ‘soft’ TDM. Informed by behavioral science, these measures do not change the economic costs and benefits of a travel option, but rather acknowledge human irrationality and the sociological nuance of travel behavior. For example, research in behavioral economics has shown a distinction between social norms and market norms (Ariely, 2010), reflecting that a desire to be liked, to conform, or to impress others (i.e. peer pressure) can easily supersede a desire to spend less money. Workplace culture has a key role in determining the success of TDM programs. Wen et al. (2010) show that simply the perception of a workplace as being encouraging of non-single-occupancy vehicle (SOV) commuting is associated with a lower SOV mode share.

Changing the way costs are interpreted by commuters can dramatically alter travel behavior. Shoup, in his advocacy for the parking “cash-out”, shows that employers who seek to offer parking as a benefit can still do so, but by offering cash in lieu of parking for non-drivers, the playing field can be leveled for all commuters wherein non-parkers can cash-out their benefit (Shoup, 1997). Related to this is the idea of daily pricing for parking as an alternative to monthly or annual permits. In this paradigm, the sunk cost of a permit purchase is removed so that even if the maximum monthly cost is the same, there remains a daily incentive to not drive.

5.2.2 Evaluating TDM Programs

Despite the proliferation of employer and government-based TDM programs, there is often relatively little analysis of the effects of such programs, particularly regarding the extent to which changes in travel behavior can be causally attributed to the TDM initiative; the MIT and Partners case studies presented in this thesis attempt such analysis. Nonetheless, programs that encourage non-SOV commuting are often paired with more expensive and restricted parking, and it can be difficult to discern whether ensuing reductions in parking are simply the result of pricing or a more nuanced behavioral process. It can be argued that even in the presence of a forced shift in travel patterns (e.g. with the closing of a parking facility), a TDM program’s value can be in ‘softening the blow’ and making travelers feel the change in their travel routine was because of their own conscious decision (such as an appeal to environmentalism) rather than frustrated deference to a new policy. For this purpose, simple survey research can be effective at deducing the effectiveness of a program.

However, to move beyond conscious attitudes and measure the long-term behavioral effects of a TDM program, a randomized controlled trial (RCT) is a methodologically stronger approach. A technique perhaps best known for clinical trials in medical research, RCT experimental design allows researchers to control for selection bias, temporal effects and other confounding factors by randomizing a population sample and providing an intervention to one subset while passively monitoring another (the “control”). The theory of
RCT design advanced through agricultural trials in the 1920s by Ronald Fisher (1937), and grew in the social sciences towards the latter half of the twentieth century with experiments on income tax (Hausman & Wise, 1985) and development economics (Duflo et al., 2007). Today, the RCT is generally considered the “gold standard” of experimental design. That said, some challenge the implied methodological hierarchy that places the RCT on top, given that this experimental design may exaggerate quantitative precision and make overreaching claims on generalizability (Melia, 2015).

Further discussion on RCTs in transportation can be found in Section 2.3.1.

5.2.3 TDM Experimentation at MIT

Since the AccessMIT program was rolled out in the summer of 2016, MIT has experienced a drop in parking demand of approximately eleven percent (as measured by average parking frequency normalized across all staff). However, as a research institution, we wish to know why people changed behavior, and what aspects of the program were most successful. Thus, to further understand causality between transportation benefits and commuting behavior shifts, it was initially proposed to conduct an Institute-wide RCT wherein a different series of commuting benefits would be issued to several subsets of the staff population; despite early administration support, however, the proposal did not ultimately move forward due to concerns of equity. Instead, a smaller-scale experiment was conducted after enhanced benefits were provided to all staff.

The 2016 biennial Transportation Survey, in which all MIT staff and students were surveyed about their commuting habits and benefits usage, illuminated how staff used and perceived the AccessMIT program. In recognizing that a subset of staff either did not know about certain aspects of the program or did not understand the benefits, the authors used this as an opportunity to explore how a targeted information campaign might increase user uptake of the various benefits while serving as a useful case study on the behavioral effects of such interventions.

5.3 Methods

This chapter discusses an experiment entitled “Sustainable Commuting @ MIT.” Framed as a campaign encouraging low-carbon travel, the experiment was designed as an RCT whose target population was MIT’s most frequent on-campus employee parkers.

5.3.1 Developing the Research Sample Pool

Figure 5-1 illustrates how the sample pool was established. Of the Institute’s 10,500 full-time employees, approximately half of them (5,400) hold a parking permit. Noting that MIT’s parking facilities are a combination of gated facilities (in which drivers must tap their ID card to enter and exit the lot) and non-gated open lots, only parkers assigned to gated lots (4,100) were considered for participation due to traceability. Of this subset,
some parkers held occasional permits and only parked on campus sporadically throughout the year, and as such were not considered a target audience of a campaign to reduce parking. Only permit holders that parked an average of at least one day per week during the academic year were considered, resulting in a final sample size of 2,023 employees.

Figure 5-1: Composition of experimental population and treatment groups.

An opt-out framework was approved such that all eligible parkers were automatically enrolled in the research. Using a MailChimp account, the researchers disseminated messages using staff email addresses. On April 4, 2017, an introductory message was sent to all prospective participants informing them of an upcoming initiative to promote MIT’s commuting benefits while disclosing the upcoming research project at a high level, and provided an explicit opportunity for employees to opt out of monitoring and communication. After a week, 56 individuals opted out of the research (3%), resulting in a finalized starting sample of 1,967 staff.

5.3.2 Treatment Groups

With the experimental population established, the population was randomly divided into four arms: one control arm and three experimental treatment arms (‘E1 Information’, ‘E2 Rewards’ and ‘E3 Both’). Randomization was carried out using the last two digits of the employee ID number and resulted in arms of approximately five hundred each. Descriptive statistics of the 1,967 participants are presented in Table 5.1, and show that restricting the sampling frame to frequent drivers results in a higher proportion of professors and older employees compared to the general composition of staff at MIT.
For each of the six weeks from April 10 through May 19, 2017, emails were sent out to all participants of the three treatment groups. The complete experimental timeline is shown in Figure 5-2.

Table 5.1: Descriptive statistics of population sample

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>E1 Information</th>
<th>E1 Rewards</th>
<th>E2 Both</th>
<th>E3 Both</th>
<th>All MIT Employees</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>494</td>
<td>481</td>
<td>489</td>
<td>503</td>
<td>10,471</td>
<td></td>
</tr>
<tr>
<td>Mean age (st. dev.)</td>
<td>50 (12)</td>
<td>50 (12)</td>
<td>51 (12)</td>
<td>52 (12)</td>
<td>45 (14)</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>41%</td>
<td>49%</td>
<td>46%</td>
<td>47%</td>
<td>44%</td>
<td></td>
</tr>
<tr>
<td>Non-white</td>
<td>35%</td>
<td>30%</td>
<td>31%</td>
<td>30%</td>
<td>38%</td>
<td></td>
</tr>
<tr>
<td>Staff type: Faculty</td>
<td>20%</td>
<td>19%</td>
<td>19%</td>
<td>22%</td>
<td>10%</td>
<td></td>
</tr>
<tr>
<td>Staff type: Support &amp; Service</td>
<td>20%</td>
<td>22%</td>
<td>23%</td>
<td>22%</td>
<td>22%</td>
<td></td>
</tr>
<tr>
<td>Mean years working at MIT</td>
<td>13</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Median driving distance to campus (mi)</td>
<td>11</td>
<td>10</td>
<td>11</td>
<td>10</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5-2: Experiment timeline

**Informational Campaign (E1 & E3)**

The one thousand participants in treatments E1 and E3 received six weeks of emails with information about AccessMIT benefits available to them. The six digests are summarized in Table 5.2, with example screenshots shown in Figure 5-3. The digests were designed to concisely summarize all of the commuting benefits relevant to frequent drivers, and address common misconceptions through conversations with the Parking & Transportation Office staff and a review of the 2016 Transportation Survey responses. The tone of each
message aimed to suggest that even an intermittent switch to non-driving modes is beneficial, and appealed to both collective action, on environmental sustainability and local congestion, as well as individual cost savings. The content was ordered to begin and end the campaign with general trends about commuting at MIT, with specific information provided in the middle of the initiative.

Table 5.2: Summary of Commuter Digest Email Campaign

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject Line</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MIT Commuting Myths &amp; Facts</td>
<td>Info-graphics of three misperceptions of MIT commuters and the benefits available to them</td>
</tr>
<tr>
<td>2</td>
<td>Your Parking Benefits</td>
<td>FAQ on how the switch from annual to daily parking pricing can benefit all commuters</td>
</tr>
<tr>
<td>3</td>
<td>A New Way to Carpool at MIT</td>
<td>A three-step guide to using MIT’s AccessMyCommute carpool trip planner</td>
</tr>
<tr>
<td>4</td>
<td>Riding the Rails to MIT</td>
<td>Q&amp;A about Commuter Rail benefits</td>
</tr>
<tr>
<td>5</td>
<td>Something for Everyone’s Commute</td>
<td>Information on bicycling, private transit, Emergency Ride Home program and walking</td>
</tr>
<tr>
<td>6</td>
<td>How MIT’s Doing So Far</td>
<td>Statistics on interim program results</td>
</tr>
</tbody>
</table>

Monetary rewards (E2 & E3)

Treatments E2 and E3 involved offering incentives in the form of TechCASH, an MIT currency loaded onto employee ID cards and redeemable at on-campus dining locations, bookstores and various campus services. Participants were informed of their average weekly parking frequency during the academic year so far (September, 2016 through March, 2017 excluding holiday weeks), and were offered weekly TechCASH reward deposits proportional to how much they reduced their parking frequency compared to their baseline. A rewards structure benchmarked to prior personal behavior was used to avoid simply rewarding infrequent parkers, and is analogous to a study by Jakobsson et al. (2002) which rewarded households based on a reduction in driving distance. Rewards were disbursed weekly as follows: if a driver reduced their parking by one day (e.g., they used to park four days a week but only parked three days last week), they received $5. For each additional day of reduction, they would receive an additional $2.50.

Using this reward structure, participants who reduced their parking by one day or more each week could receive between $5 and $15 weekly, for a total of up to $90 over six weeks. For example, a former five-day-a-week parker who parked only two days each week of the campaign would receive $10 weekly. The subject line for E2 messages was “Your Commuting Rewards (Date)”, while E3 messages combined the subject lines from Table 5.2 with a
Figure 5-3: Samples of digest content (a-b) and rewards notification (c).
reminder of weekly rewards (e.g. “Your Commuting Rewards (May 1-5) + MIT Commuting Myths & Facts”).

5.3.3 Implementation

Given the experimental framework, a number of design decisions were made that influenced user interaction and response. On communications, the medium of email was chosen (over text messages, websites, mobile apps, in-person communication, etc.) due to its universality among MIT employees and the ability for researchers to monitor via MailChimp whether each respondent opened and/or clicked on the email. The from-address was set as “MIT Transit Lab <sustainable_commuting@mit.edu>”, and messages were personalized with a first-name greeting and message content that was only applicable to that person (e.g. rewards recipients were only shown their past and potential future earnings).

Messages were scheduled such that E1 participants received their Commuter Digest each Monday morning at 10:30 am, while messages for the other two treatment groups were sent the preceding Sunday afternoon at 5:00 pm. This was done to ensure that participants eligible for monetary rewards were given sufficient time the day before to consider an alternate commuting method for Monday morning. While the different schedules added another potentially confounding variable, open rates across each group were not found to significantly vary.

On incentive design, the TechCASH currency was chosen for its logistical ease and recognizability among MIT employees, and a deterministic payout was favored over lottery rewards due to the increased salience of having so many participants receive monetary rewards. The monetary value of rewards was designed as a linear ramp with a positive intercept such that a reduction in parking of even just one day per week would be enough to receive $5 a week bonus, encouraging participants to overcome this hurdle.

The initial design of the experiment framed the rewards as a monetary loss rather than gain (i.e. every participant would be given $90, then clawed back if parking was not reduced), in an attempt to leverage the behavioral economics finding that avoiding losses is a more powerful motivator than seeking gains (Kahneman & Tversky, 1992). However, this proved difficult to implement both logistically and politically, leading to a hybrid model where participants were reminded weekly of their maximum potential earnings, but the money was won, not lost.

5.3.4 Evaluation Metrics and Criteria

Evaluation of experimental results took place using a combination of passive data collection and stated attitudes through a post-campaign survey.

Parking frequency was measured passively using MIT parking lot gate entries and exits. This allowed non-intrusive and continuous monitoring of employee parking activity. Similarly, transit use was also passively recorded by tracking the number of CharlieCard taps by employees. For the purposes of experimental validity, it was important that these
tracking tools were discreet and continuous, to avoid the pitfalls of prior experiments where intrusive behavior measurement (e.g., trip diaries) led to participants consciously or subconsciously altering their travel behavior.

Primary behavioral variables included the number of days parked each week before, during, and after the initiative, as well as the use of the local transit pass integrated in employee ID cards. Additionally, subsidy claims for parking at MBTA transit stations and private transit services were analyzed. Engagement variables including email open rates and unsubscriptions were monitored, facilitating segmentation by user participation levels. An exit survey asked participants about their awareness and perceptions of the various benefits and interventions offered, and questions on recalled behavior change helped corroborate any changes revealed through the data. Independent variables included employee attributes such as date of hire and staff type, along with geographic data on employee place of residence and transit accessibility aggregated at the census block group level. Summary statistics and a set of difference-in-differences regression models are presented to explore trends among each treatment arm, as well as the ‘top performers’ in each group as defined by the highest reduction in parking and/or increase in transit use.

5.4 Results

5.4.1 Campaign Engagement

During the six-week campaign, a majority of message recipients were engaged in the communications as gauged by email open rates, click rates and unsubscriptions. Approximately two-thirds of recipients opened multiple email messages and remained subscribed, with open rates typically between 40-60%. This meant that approximately half of our target population may have received the information sent each week. E2 tended to have the most active participation on any given week, with users opening the message to see whether they won TechCASH rewards that week. However, E2 also reported a slightly higher frequency of mid-campaign unsubscriptions, suggesting that the treatment was the most polarizing: either users appreciated the rewards and opened their emails, or were bothered by notifications of zero winnings each week and chose to opt out.

5.4.2 Change in Travel Behavior

Changes in travel patterns during and after the experiment largely tracked seasonal trends, with both parking and transit usage decreasing as the weather warmed and the MIT spring academic term ended. As shown in Table 5.3, all four arms had a similar mean and standard deviation of parking frequency throughout the academic year prior to the campaign. A slight majority of participants in each arm were found to have reduced their parking during the campaign, with the information treatment exhibiting the largest proportion (57.0%). Following the experiment, over five weeks from May 22 through June 23, 2017, all three treatments showed a higher proportion of parkers who reduced their frequency than the control. On transit, weekly use of employee MBTA passes (measured in days
Table 5.3: Change in Parking and Transit Usage

<table>
<thead>
<tr>
<th>Control</th>
<th>E1 Information</th>
<th>E2 Rewards</th>
<th>E3 Both</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Parking Days Per Week</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before campaign</td>
<td>3.1</td>
<td>3.2</td>
<td>3.2</td>
</tr>
<tr>
<td>During campaign</td>
<td>3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>After campaign</td>
<td>2.5</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Before campaign</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>During campaign</td>
<td>1.4</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>After campaign</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Transit Days Per Week</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before campaign</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>During campaign</td>
<td>0.9</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>After campaign</td>
<td>0.7</td>
<td>0.9</td>
<td>0.9</td>
</tr>
<tr>
<td>Before campaign</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>During campaign</td>
<td>0.8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>After campaign</td>
<td>0.7</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>

*aPercent of drivers who reduced their parking or increased their transit use, respectively, compared to before the campaign.*

**Difference-in-differences**

| Parking (before-to-during) | +0.02 | -0.04 | +0.01 |
| Parking (before-to-after)  | -0.09 | -0.07 | +0.05 |
| Transit (before-to-during) | +0.04 | +0.01 | +0.01 |
| Transit (before-to-after)  | +0.05 | +0.03 | +0.06 |

*bMean change benchmarked against control. E.g. negative differences-in-differences denote reductions beyond those of the control.*

where at least one transit trip was made) tended to be significantly lower, consistent with the auto-oriented tendency of the selected population. Treatments E2 and E3 exhibited slightly increased transit usage relative to the control, as shown by the differences-in-differences.

Figure 5-4 illustrates the changes in parking frequency across arms. The left plot shows all participants, while the right plot shows only ‘active’ participants, defined as those who opened at least two emails during the campaign and did not unsubscribe (this distinction is used to focus on participants who were most likely impacted by the nudges). Treatment E3 exhibited the largest decrease during the experiment (-0.11 and -0.15 days per week for all and active participants, respectively), while E2 had the largest sustained decrease after the experiment concluded (-0.09 for both groups). Comparing difference-in-differences using an unpaired two-sample t-test (null hypothesis: zero difference-in-differences) yielded no significant differences at p < 0.05, while E3 showed significant differences at p < 0.10.

Linear regression of differences-in-differences was conducted as per Equation 5.1 using the average weekly parking frequency of person $i$ in period $t$ as the dependent variable regressed against the treatment type, time period and a vector of covariates $X_i$, with scalar coefficients $\beta_{0-3}$, and vector $\gamma$, respectively. Covariates included dummy variables for whether the person was a faculty member, a support staff, a recent hire (under 10 years), as well as whether their commute by transit is at least 20 minutes longer than by driving (using Google Maps Directions API). A continuous variable of prior parking frequency was also included in select models.
Figure 5-4: Plot of changes in mean parking frequency for all (left) and active (right) respondents. The downward trend among all groups can be attributed to seasonal variation.

\[
park_{it} = \beta_0 + \beta_1 \text{Treatment}_i + \beta_2 \text{Period}_t + \beta_3 (\text{Treatment} \ast \text{Period})_{it} + \mathbf{X}_i' \gamma + \varepsilon_{it} \quad (5.1)
\]

Table 5.4 indicates no significant treatment effect population-wide nor just among active participants. Interaction terms of demographic and spatial covariates with treatment groups were insignificant as well. Figure 5-5 shows the distribution of changes in parking across each arm. We observe a larger left tail for E3 than the control, with 17% of combination participants reducing at least one day a week (versus only 14% in the control), 8% reducing at least two days (versus 5%) and 4% reducing at least three days (versus 2%). On the right tail, the control group exhibited the largest increases in parking during the campaign, confirming that changes were not symmetric across both tails. Put differently, 39% of the top changers were among the E3 group, meaning that while E3 did not exhibit an across-the-board shift, it contained the highest proportion of ‘top performers’.

Further investigation of the left tail indicates some common characteristics of the 87 ‘top performing’ participants in E3, as defined by a parking reduction of at least one day a week. While the group had a composition of employment types (e.g. faculty, support staff, other academics, etc.) similar to Institute proportions, it tended to be comprised of more recent hires, with 26% being hired in the last five years (versus only 19% across the group as a whole); age and gender, however, did not significantly vary. Using geospatial data aggregated at the census block group level, it was observed that the top performers tended to live in areas where transit travel times are more similar to driving times, with an 18% smaller time penalty compared to the general population.

Additionally, the top parking reducers also had a slightly lower baseline parking frequency (3.0 vs 3.2), suggesting that the treatment was more effective on occasional parkers than five-day-a-week drivers.
### Table 5.4: Regression Analyses (Differences in Differences)

<table>
<thead>
<tr>
<th></th>
<th>Parking(^a)</th>
<th>Parking with covariates(^a)</th>
<th>Parking with covariates, active participants only(^a)</th>
<th>Transit use(^b)</th>
<th>Transit use with covariates(^b)</th>
<th>Transit use with covariates, active participants only(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Intercept)</td>
<td>3.135</td>
<td>3.001</td>
<td>2.996</td>
<td>0.836</td>
<td>1.714</td>
<td>1.772</td>
</tr>
<tr>
<td>During treatment</td>
<td>-0.179</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
</tr>
<tr>
<td></td>
<td>(0.038)*</td>
<td>(0.049)*</td>
<td>(0.047)*</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
</tr>
<tr>
<td>After treatment</td>
<td>-0.597</td>
<td>-0.636</td>
<td>-0.636</td>
<td>-0.531</td>
<td>-0.584</td>
<td>-0.584</td>
</tr>
<tr>
<td></td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
</tr>
<tr>
<td>E1 Information</td>
<td>0.064</td>
<td>0.041</td>
<td>0.083</td>
<td>0.023</td>
<td>-0.014</td>
<td>0.059</td>
</tr>
<tr>
<td></td>
<td>(0.464)</td>
<td>(0.668)</td>
<td>(0.437)</td>
<td>(0.678)</td>
<td>(0.813)</td>
<td>(0.382)</td>
</tr>
<tr>
<td>E2 Rewards</td>
<td>0.070</td>
<td>0.061</td>
<td>0.01 (0.924)**</td>
<td>0.069</td>
<td>0.045</td>
<td>0.126</td>
</tr>
<tr>
<td></td>
<td>(0.419)</td>
<td>(0.514)</td>
<td>(0.210)</td>
<td>(0.446)</td>
<td>(0.054)</td>
<td>.</td>
</tr>
<tr>
<td>E3 Both</td>
<td>-0.033</td>
<td>-0.070</td>
<td>-0.079</td>
<td>0.089</td>
<td>0.043</td>
<td>0.087</td>
</tr>
<tr>
<td></td>
<td>(0.704)</td>
<td>(0.457)</td>
<td>(0.446)</td>
<td>(0.104)</td>
<td>(0.473)</td>
<td>(0.184)</td>
</tr>
<tr>
<td>During * E1</td>
<td>-0.403</td>
<td>-0.041</td>
<td>-0.27</td>
<td>0.007</td>
<td>0.046</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>(0.727)</td>
<td>(0.761)</td>
<td>(0.858)</td>
<td>(0.926)</td>
<td>(0.585)</td>
<td>(0.773)</td>
</tr>
<tr>
<td>During * E2</td>
<td>0.019</td>
<td>0.012</td>
<td>0.008</td>
<td>0.053</td>
<td>0.078</td>
<td>0.037</td>
</tr>
<tr>
<td></td>
<td>(0.878)</td>
<td>(0.930)</td>
<td>(0.955)</td>
<td>(0.499)</td>
<td>(0.354)</td>
<td>(0.684)</td>
</tr>
<tr>
<td>During * E3</td>
<td>-0.107</td>
<td>-0.109</td>
<td>-0.142</td>
<td>0.027</td>
<td>0.090</td>
<td>0.102</td>
</tr>
<tr>
<td></td>
<td>(0.380)</td>
<td>(0.414)</td>
<td>(0.331)</td>
<td>(0.728)</td>
<td>(0.283)</td>
<td>(0.273)</td>
</tr>
<tr>
<td>After * E1</td>
<td>-0.071</td>
<td>-0.035</td>
<td>-0.072</td>
<td>0.011</td>
<td>0.058</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>(0.563)</td>
<td>(0.793)</td>
<td>(0.632)</td>
<td>(0.886)</td>
<td>(0.489)</td>
<td>(0.713)</td>
</tr>
<tr>
<td>After * E2</td>
<td>-0.091</td>
<td>-0.067</td>
<td>-0.076</td>
<td>0.042</td>
<td>0.107</td>
<td>0.038</td>
</tr>
<tr>
<td></td>
<td>(0.459)</td>
<td>(0.616)</td>
<td>(0.603)</td>
<td>(0.587)</td>
<td>(0.203)</td>
<td>(0.680)</td>
</tr>
<tr>
<td>After * E3</td>
<td>-0.073</td>
<td>-0.043</td>
<td>-0.028</td>
<td>0.064</td>
<td>0.060</td>
<td>0.086</td>
</tr>
<tr>
<td></td>
<td>(0.550)</td>
<td>(0.750)</td>
<td>(0.851)</td>
<td>(0.411)</td>
<td>(0.477)</td>
<td>(0.352)</td>
</tr>
<tr>
<td>Is faculty</td>
<td>-0.159</td>
<td>-0.15</td>
<td>-0.097</td>
<td>-0.138</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>(0.001)**</td>
<td>(0.008)**</td>
<td>(0.002)**</td>
<td>(&lt;0.001)**</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>Is support staff</td>
<td>0.141</td>
<td>0.141</td>
<td>0.130</td>
<td>0.092</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>(0.025)*</td>
<td>(0.049)*</td>
<td>(0.001)**</td>
<td>(0.043)*</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>Recent hire</td>
<td>-0.331</td>
<td>-0.333</td>
<td>0.078</td>
<td>0.101</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>(&lt;10 years)</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(0.003)**</td>
<td>(0.001)**</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>Transit &gt; 20</td>
<td>0.417</td>
<td>0.425</td>
<td>-0.255</td>
<td>-0.269</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>min longer than driving</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td>(-0.001)**</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>Age over 60</td>
<td>-0.126</td>
<td>-0.103</td>
<td>-0.102</td>
<td>-0.083</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>(0.007)**</td>
<td>(0.061).</td>
<td>(&lt;0.001)**</td>
<td>(&lt;0.001)**</td>
<td></td>
<td>.</td>
</tr>
<tr>
<td>Past year average weekly parking frequency</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.</td>
</tr>
</tbody>
</table>

\(R^2\) | 0.04 | 0.08 | 0.08 | 0.07 | 0.16 | 0.18 |
\(\text{Adj}\ R^2\) | 0.04 | 0.07 | 0.07 | 0.07 | 0.15 | 0.18 |

Note: \***\*: p < 0.001; \**\*: p < 0.01; \*: p < 0.05; \.: p < 0.10

For the time period dummy, “Before” is the reference case; for treatment groups, “Control” is the reference case; for staff type, all non-faculty and non-support staff (incl. research, administrative, and service staff) are the reference case.

\(^a\)Dependent variable: change in weekly parking frequency (negative change indicates reduction in parking)

\(^b\)Dependent variable: change in days per week using transit (positive change indicates increase in transit use)
5.4.3 Exit Survey Results

An exit survey was conducted following the conclusion of the six week campaign. Personalized links to a web-based Qualtrics survey were distributed via email such that responses could be traced back to user behavior. After being open for two weeks, 37% of experiment participants completed the survey. The complete questionnaire can be found in Appendix C.

Table 5.5 summarizes key survey results. Treatments E2 and E3 tended to have more frequent user engagement, with participants most often reporting to have “always read” the messages. While the survey response rate is biased towards those who were previously engaged in the email campaign (i.e. 86% of survey respondents were active participants compared to only 66% across the general sample), the relative differences between treatments are nonetheless appreciable. On employee benefits, respondents were asked about their awareness and use of (a) their free MBTA local transit pass, (b) the 60% commuter rail subsidy, (c) the 50% subsidy on parking at MBTA stations, (d) the 50% private transit subsidy, and (e) the AccessMyCommute dashboard and trip planner. Save for the private transit subsidy, the three treatment arms indicated higher use of all the benefits than the control. The free MBTA pass was the most commonly used benefit, with 25% and 23% of E2 and E3 respondents, respectively, reporting ‘frequent’ use compared to only 16% in the control.

The vast majority of participants already knew about the free MBTA pass, so the afore-
mentioned increase in usage cannot be attributed simply to awareness. Participants were less aware of other program elements, notably the online trip planner and private transit subsidy, with a third of informational digest recipients reporting that they learned about the online dashboard during the campaign.

In general, survey results tended to markedly overstate behavior changes compared to passively collected travel data. Participants were asked what travel modes they use when not driving, and while 47% of the control group responded that they always drive alone to campus, only a third of E2 and E3 participants responded similarly. The largest reported mode shift during the experiment was toward public transit, by twelve percentage points, followed by working from home by six points. This suggests that if experimental results were measured solely using stated behavior, the finding would be a resounding success in shifting single-mode drivers toward occasional transit use. The revealed behavior, however, dampens these results.

In order to gauge the effectiveness of each campaign element, participants who reduced their parking were asked to rate how strongly each element influenced their decision. For rewards recipients, TechCASH was unsurprisingly the largest motivator, while one’s desire to reduce their carbon footprint was the largest motivator for the information group. Peer influence was consistently rated as least influential, although this tends to be more of an implicit motivator than consciously recognized (Feygin & Pozdnoukhov, 2017).

Informational digest recipients were asked to indicate which message(s) they found interesting or helpful. Overwhelmingly, the message with subject line “Your Parking Benefits” was rated as most helpful, and was the only digest to be indicated as so by the majority of participants. It outlined the rationale behind the switch from annual to daily parking pricing, and explained why it benefits all commuters (in that occasional parkers can save money while frequent parkers are protected by an annual cap on billing). The helpfulness of this message potentially indicates a prior lack of understanding about daily pricing and presents an opportunity for the Institute to ensure it is properly communicated.

Finally, participants were asked if they anticipated parking enough times during the 2016-2017 academic year to reach the annual cap of $1760 in daily parking fees. Substantially fewer treatment recipients anticipated parking enough times to do so (37-41% compared to 49% in the control group). To test whether this was simply due to response bias resulting from low-frequency parkers, we estimated the true likelihood of each parker reaching this annual cap by extrapolating parking trends to date. Interestingly, all three treatment groups tended to underestimate their parking frequency and associated likelihood of reaching the cap. For example, 49% of control group participants anticipated reaching the cap while 52% were estimated to actually do so (an underestimation by three percentage points); in contrast, only 37% of E2 participants anticipated reaching the cap while 49% of them were estimated to actually do so (an underestimation of twelve percentage points). This may again suggest campaign participants painted a rosier picture of their behavior change than was actually exhibited, or may be in part due to social desirability status, in which treatment group survey respondents select answers that they believe the surveyors wish to observe, or self-serving bias, in which respondents select answers that help enhance their own self-image. In this case, either bias would lead participants to overstate their reduction in parking.
<table>
<thead>
<tr>
<th>Category</th>
<th>Variable</th>
<th>Metric</th>
<th>Control</th>
<th>E1 Info</th>
<th>E2 Rewards</th>
<th>E3 Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campaign Engagement</td>
<td>Interaction with messages</td>
<td>Mean Likert score</td>
<td>-</td>
<td>3.23</td>
<td>4.05</td>
<td>3.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0=never saw; 5=always read)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of Benefit</td>
<td>Free MBTA subway &amp; local bus pass</td>
<td>Mean Likert score</td>
<td>0.86</td>
<td>0.93</td>
<td>1.02</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0=never use; 1=occasionally use; 2=always use)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subsidized commuter rail</td>
<td>% knew already / % learned during campaign</td>
<td>-</td>
<td>67/22/10</td>
<td>65/15/21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% don’t know</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Subsidized MBTA station parking</td>
<td>% knew already / % learned during campaign</td>
<td>-</td>
<td>50/35/15</td>
<td>38/34/28</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% don’t know</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private transit subsidy</td>
<td>% knew already / % learned during campaign</td>
<td>-</td>
<td>29/32/39</td>
<td>25/26/49</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% don’t know</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Online Dashboard &amp; Trip Planner</td>
<td>% knew already / % learned during campaign</td>
<td>-</td>
<td>34/34/32</td>
<td>33/34/34</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>% don’t know</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alternate modes used</td>
<td>I always drive alone to campus</td>
<td>% selected (multiple allowed)</td>
<td>47%</td>
<td>43%</td>
<td>34%</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Public Transit</td>
<td>% selected</td>
<td>21%</td>
<td>24%</td>
<td>34%</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Carpool / passenger / shared ride</td>
<td>% selected</td>
<td>11%</td>
<td>10%</td>
<td>6%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>Bicycle</td>
<td>% selected</td>
<td>8%</td>
<td>5%</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Walk</td>
<td>% selected</td>
<td>2%</td>
<td>1%</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td>Work from home</td>
<td>% selected</td>
<td>7%</td>
<td>12%</td>
<td>14%</td>
<td>12%</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>% selected</td>
<td>4%</td>
<td>5%</td>
<td>4%</td>
<td>6%</td>
</tr>
<tr>
<td>Influence of campaign elements</td>
<td>TechCASH Rewards Increased awareness of benefits</td>
<td>Mean Likert Score</td>
<td>-</td>
<td>-</td>
<td>3.01</td>
<td>3.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0=least influence; 5=most influence)</td>
<td>2.42</td>
<td>2.60</td>
<td>2.13</td>
<td>2.24</td>
</tr>
<tr>
<td></td>
<td>Desire to reduce carbon footprint</td>
<td>% selected</td>
<td>2.57</td>
<td>2.82</td>
<td>2.69</td>
<td>2.76</td>
</tr>
<tr>
<td></td>
<td>Peer influence</td>
<td>% selected</td>
<td>1.30</td>
<td>1.36</td>
<td>1.11</td>
<td>1.04</td>
</tr>
<tr>
<td>Helpfulness of commuter digests</td>
<td>Week 1</td>
<td>% who selected helpful</td>
<td>-</td>
<td>37%</td>
<td>-</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>Week 2</td>
<td>% selected</td>
<td>-</td>
<td>62%</td>
<td>-</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td>Week 3</td>
<td>% selected</td>
<td>-</td>
<td>10%</td>
<td>-</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td>Week 4</td>
<td>% selected</td>
<td>-</td>
<td>20%</td>
<td>-</td>
<td>13%</td>
</tr>
<tr>
<td></td>
<td>Week 5</td>
<td>% selected</td>
<td>-</td>
<td>24%</td>
<td>-</td>
<td>22%</td>
</tr>
<tr>
<td></td>
<td>Week 6</td>
<td>% selected</td>
<td>-</td>
<td>21%</td>
<td>-</td>
<td>27%</td>
</tr>
<tr>
<td>Larger influence: Rewards versus information</td>
<td>TechCASH Rewards</td>
<td>% selected &quot;larger influence*&quot;</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>45%</td>
</tr>
<tr>
<td></td>
<td>Information Campaign</td>
<td>% selected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9%</td>
</tr>
<tr>
<td></td>
<td>Combination of rewards and information</td>
<td>% selected</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>46%</td>
</tr>
<tr>
<td>Rewards</td>
<td>Awareness of how to spend TechCASH</td>
<td>% selected &quot;yes*&quot;</td>
<td>-</td>
<td>79%</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Contagion</td>
<td>Awareness that others received rewards</td>
<td>% selected &quot;yes*&quot;</td>
<td>35%</td>
<td>26%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Peer Influence</td>
<td>Whether participant discussed commuting benefits with colleagues</td>
<td>% selected &quot;yes*&quot;</td>
<td>51%</td>
<td>64%</td>
<td>52%</td>
<td>55%</td>
</tr>
<tr>
<td>Pricing Cap</td>
<td>Anticipate reaching annual cap</td>
<td>% selected</td>
<td>49%</td>
<td>41%</td>
<td>38%</td>
<td>37%</td>
</tr>
<tr>
<td></td>
<td>Do not anticipate reaching annual cap</td>
<td>% selected</td>
<td>22%</td>
<td>29%</td>
<td>29%</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td>Unsure</td>
<td>% selected</td>
<td>22%</td>
<td>23%</td>
<td>26%</td>
<td>27%</td>
</tr>
<tr>
<td></td>
<td>Unaware of cap</td>
<td>% selected</td>
<td>7%</td>
<td>7%</td>
<td>7%</td>
<td>6%</td>
</tr>
</tbody>
</table>
5.5 Discussion

This experiment influenced participant awareness and perceptions of MIT’s transportation benefits program, but cannot conclusively indicate universality of behavior change induced by the treatments. Using controlled randomization, an opt-out framework and three treatment arms allowed the distinction of the relative effects of information provision and small monetary incentives, with a finding that the E3 Combination approach is most effective. Feedback suggested the rewards-only emails were somewhat irritating amongst those who were unable or unwilling to reduce their parking (and were thus reminded of all their foregone rewards money), while the information-only messages were well-received but often glossed over among the deluge of staff emails. Initial post-experiment analysis indicates continued reduction of parking among the top reducers, though it remains to be seen whether any effects will continue into future months.

We observed a stronger behavioral effect on occasional parkers than on full-time drivers, the latter of whom frequently cited a lack of viable alternatives to driving, as well as unaffordable housing near MIT or any areas well-serviced by transit. Many participants noted a desire to reduce their carbon footprint, albeit with a minority complaining of environmental guilt-tripping suggested by the campaign’s appeal to sustainability.

Ajzen’s Theory of Planned Behavior, which describes the underpinning of behavior on intentions formed by attitudes, social norms and perceived control, has long been used to map the various stages of behavior change (Ajzen, 1991). Our results indicate that the combination treatment was generally effective at influencing awareness, attitudes and hypothetical intentions, but did not always translate into action (most evident in the fact that E3 participants reported a fifteen percentage point increase in the stated use of alternate modes, yet only had a small decrease in parking through passively collected data). Some of this may be attributed to psychological reactance, where the cognitive dissonance between one’s decision to drive and their desire not to is resolved in favor of continued driving because of a dislike of the information campaign or a perceived threat to one’s individualism. Nonetheless, general perception of the campaign was positive, with complimentary comments outnumbering negative feedback by a ratio of three to one. This is unsurprising, given the focus on ‘carrots’ over ‘sticks’ in the experimental design.

Unlike many past experiments that rely on volunteer participants (e.g. Garvill et al. (2003); Bamberg (2006); Hunter et al. (2016), etc.), this study was bolstered by a truly randomized sample whose 3% opt-out rate meant that self-selection effects were minimized to an extent rarely seen in comparable studies. Although the ensuing behavior changes were less compelling than hypothesized, they serve as a reminder of the challenge of designing effective TDM strategies.

Various limitations in the experimental design are to be acknowledged. First, the structure of providing rewards for reductions in parking, while more efficient than simply rewarding all non-drivers, suffers from the bluntness of not specifically targeting those who reduce for certain reasons. For example, because the campaign occurred as the spring academic term was ending, it coincided with a seasonal reduction in parking and resulted in higher rewards payouts than if the campaign were launched in the middle of the Boston winter. Some participants openly admitted to parking on a nearby street with free park-
ing to avoid being tracked. In total, approximately $16,600 in rewards were disbursed, or $16.60 per eligible recipient. Future campaigns with more restricted budgets could instead offer lottery prizes, which take advantage of how people tend to overestimate small probabilities (Kahneman & Tversky, 1979).

Another limitation was that by limiting the sampling frame to frequent parkers, the experiment failed to test how the interventions might affect occasional or intermittent drivers who park less often to begin with. While frequent parkers may be seen as the segment most worth targeting, reducing the number of occasional drivers is an important step towards reducing peak demand (which may occur during inclement weather or special events).

The most fundamental limitation, however, comes down to the availability and attractiveness of alternatives to drive-alone commuting. This campaign was designed as a series of nudges to help commuters explore new modes of travel, but in some cases exploration led simply to confirmation that driving was the preferable mode.

In generalizing the results, there is clearly a value proposition to be made for the marketing of affordable, flexible and low-carbon commuting alternatives as modeled by this experiment. If a suite of subsidies such as free local transit and reduced-cost regional transit are able to achieve a ten percent decrease in parking demand, and a campaign of advertising and marketing, at a small fraction of the price of subsidies, can further reduce demand by two percent (extrapolating from E3 difference-in-differences), a takeaway is that nudging drivers to reduce car use through targeted information and token rewards can meaningfully increase the reach of subsidy programs. Further monitoring of the MIT case study will indicate how behaviors evolve as the novelty of its benefits subsides.

The opt-out nature of this experiment was instrumental in ensuring exposure among those with strong preferences for driving, who would likely not opt in to a campaign branded to promote non-car travel. As found in the behavioral science literature, the hurdle of opting out is enough to ensure that most individuals who may be borderline-receptive to our campaign would remain engaged, even if it meant that the results were not as convincing as if we had only nudged those who actively signed up.

Finally, while this experiment took place on an urban population with relatively good access to public transit, the takeaways from this campaign can be applicable to non-transit oriented environments as well. With increasing suburban congestion and limited roadway capacity, tools to promote high-occupancy vehicles through carpooling and vanpooling can ensure non-SOV alternatives are available in lower-density environments. Related research focuses on measures to support populations underserved by transit, such as through preference-based carpool matching (Zhang & Zhao, 2017) and workplace carpool incentives. Future studies will investigate how lottery rewards and carpool-specific promotions can extend the reach of employer-based TDM efforts.
Chapter 6

Case Study: Partners HealthCare

This chapter presents a case study of commuter behavior at the administrative offices of Partners HealthCare System (PHS), a non-profit hospital and physicians network based in Boston, Massachusetts. PHS employs 73,000 staff, making it the largest healthcare provider and among the largest private employers in Massachusetts (The Boston Globe, 2008). The case study is focused on approximately four thousand employees at PHS administrative offices, which underwent an office consolidation in 2016 from worksites scattered across Greater Boston to a central location in Somerville, MA. The consolidation, which did not involve any front-line care providers, was meant to organize PHS administrative functions in a centralized, state-of-the-art facility and reduce administrative redundancies across offices.

From a transportation perspective, this case study provides insight into the impact of workplace relocation and travel demand management strategies on commuting patterns. Three research questions are addressed: First, how do commuters adapt their travel patterns upon a relocation of their place of work? Second, to what extent can changes in travel be attributed to factors of transportation infrastructure, accessibility and employer commuting benefits? And third, what can these patterns tell us about the role of employers in influencing travel behavior?

A broad literature exists on the role of habit in travel behavior, indicating that prior commuting habits play a role in future travel choices even when the decision context has changed (Schlich & Axhausen, 2003; Bamberg et al., 2003; Ralph & Brown, 2017). This hypothesis is tested in the case study. Further, PHS enhanced their commuting benefits in conjunction with the move, so the study also considers how workplace incentives can influence the formation of new commuting habits in the face of relocation.

The research uses data from a post-move survey conducted in late 2017 on PHS administrative employees, combined with parking, transit and personnel records of staff in a similar methodology to Chapter 4. The chapter begins with background on relevant literature and an overview of PHS, its employee composition and the office consolidation. This is followed by an analysis of commuting patterns before and after the move, including mode choice, parking activity and transit pass usage. A subsequent discussion considers the lessons learned from this case study, with commentary on broader applicability of
findings and study limitations.

6.1 Overview and Background

6.1.1 Literature

Commuting is seen to be a habitual behavior, a daily ritual deserving of little thought once a regular mode, route and departure time have been chosen. While many past studies of travel behavior use frameworks like the theory of planned behavior (Ajzen, 1991), theory of interpersonal behavior (Triandis, 1977) and the Norm-Activation model (Schwartz, 1977), such research has been criticized for not accounting for the role of habit in mediating the relationship between intention and action (Schwanen et al., 2012). We take cognitive shortcuts to ease the burden of decision-making, and do not perform a utility-maximizing optimization each morning upon leaving the house.

Past behavior, intention, and situational aspects are three key determinants of future behavior according to social psychology (Eagly & Chaiken, 1993; Gärling et al., 1998). Habit and intention are traded off each other; the stronger one is, the weaker the other. If we apply this to travel behavior, we see that a regular pattern of travel can be indicative of a habit—and predictive of future behavior—but sometimes repeated behavior is not simply habitual and rather reflects a conscious and repeated intention. Drivers, for example, may regularly monitor traffic reports and alter their daily commute based on roadway and public transit operating conditions.

In travel demand management (TDM) research, acknowledging the influence of habit is important in devising strategies to alter or nudge commuters’ travel decisions, and to sustain such behavior change. Schwanen et al. (2012) argue that in order to change behavior, we need to work with habit, not against it. Recognizing that patterns can be broken in the midst of external stimuli, some studies have attempted to use a stimulus to spark long-term behavior change. Fujii et al. (2001) found that a structural change like a temporary road closure can lead to a willingness to shift travel behavior, sustained even after the road is re-opened. Bamberg (2006) explored the potential for residential relocation to be a period of increased willingness to adopt new travel habits; he used a randomized controlled trial to demonstrate a significant increase in transit use among relocated individuals who received a free transit ticket and personalized information upon moving homes. The period right after residential relocation was found to be a ‘sensitive phase’ wherein people are more susceptible to change their travel behavior before any habits are formed.

Other studies have also shown residential relocation to be a prime opportunity for TDM interventions (Scheiner, 2003). Similarly, changing jobs is associated with shifts in commuting patterns (Van der Waerden et al., 2003). Lesser known, however, is the potential for relocation of an existing job to trigger long-lasting changes in travel patterns. Is the stimulus of a new worksite enough to counteract the continuity of an unchanged workplace commuting culture and commuting benefits? What if the employee benefits change in tandem with the relocation, as is the case of PHS?
While it is impossible to know with complete certainty how employees will alter their travel, past research suggests a number of heuristics that help us predict likely shifts in behavior. For example, Naess (2002) finds that travelers tend to value choice over proximity to a single destination, and that transit usage will likely be higher if the workplace is located alongside other amenities, as opposed to a workplace located in isolation. De Vos et al. (2012) argue that many individuals reside in areas incongruous to their desired travel preferences (e.g. would-be cyclists or transit users living in suburbs due to urban housing unaffordability). They suggest that given the opportunity to resolve this ‘residential dissonance’, latent shifts in mode choice can be realized. This finding speaks to the nuanced causal mechanisms of travel behavior, and the two-way relationship between home/work location and mode choice.

In achieving TDM objectives, targeting stakeholders beyond just the travelers themselves is seen as a key to success, given that travelers form their habits in the context of a decision framework influenced by employers, government, friends, family, and society at large (Schwanen et al., 2012). In this thesis, we focus on the potential for workplaces, through their location, infrastructure and policies, to alter the choice architecture (Thaler & Sunstein, 2008) upon which commuters make their travel decisions.

Such reforms typically involve a combination of a ‘push’ from drive-alone commuting and a ‘pull’ towards transit, shared rides and/or active modes. Pricing parking is a key lever, with Shoup (1997) finding that switching from employer-paid to driver-paid parking can reduce parking demand by a third. For employers that already charge for parking, switching from annual or monthly permits to a daily, pay-as-you-park charge can remove the sunk cost of a permit, and can be most effective when parking charges are made salient and billed promptly after the transaction (Leong et al., 2018). On the transit side, increased subsidies can help make local and regional transit options more cost-effective for employees, and their costs can be offset by a long-term reduction in parking provision.

### 6.1.2 Assembly Row Development

The neighborhood of Assembly Square derives its name from the Ford Motor Company assembly plant built in 1926 along the McGrath Highway in Somerville. The plant, shuttered in 1958, left a brownfield site that remained largely undeveloped for decades. In the early 2000s, the City of Somerville planned a redevelopment of the area, and by 2005, Federal Realty Investment Trust (FRIT) acquired properties in Assembly Square.

Branded as ‘Assembly Row’, FRIT led a $1.2 billion mixed-use development consisting of 45 acres along the Mystic River. This included 2 million square feet of office space, 500,000 square feet of retail, 2,100 residential units, a hotel, and various other amenities built in one of the largest brownfield sites in Massachusetts (Development Management Associates, 2016; Cambridge Systematics, 2014).

Development of Assembly Row was coordinated with the construction of Assembly Station on the MBTA Orange Line. Funded in part by FRIT, this was an infill station intended to provide rapid transit access to residents, retail patrons and employees at Assembly Row in an otherwise auto-oriented area.
PHS announced in 2013 that it would consolidate parts of 14 of its existing offices into the planned mixed-use development, and in 2016 it moved most of its administrative functions into a new office development at 399 Revolution Drive, directly adjacent to the new Assembly MBTA station.

In its 2014 development application to the City of Somerville’s Planned Unit Development (PUD) at Assembly Row, PHS outlined its plan for conformity with SomerVision, the 20-year Comprehensive Plan. The plan requires a minimum of 50% of new trips to the city to be made by walking, cycling or public transit. PHS was also required to conform to Somerville’s minimum and maximum parking requirements based on building square footage (Somerville Mayor’s Office of Strategic Planning and Community Development, 2014).

While the maximum number of spaces permitted by the Somerville Zoning Ordinance was 1,778, the approved PUD allowed PHS to exceed this amount in a compromise to attract developers and tenants. The developer proposed 1,997 spaces, 1,617 of which were to be allocated for PHS employees (and the remainder serving retail uses). With 4,500 desks, this would provide parking spaces for only 36% of staff, requiring the other 64% to use alternate means of transportation.

With a series of TDM initiatives including teleworking and flexible schedules, PHS estimated that only 75% of employees would be on-site during peak business hours, meaning that approximately 50% of on-site employees would be provided with parking at Assembly Row (and would thus satisfy the SomerVision mode share requirement).

Given the uncertainty of employee commuting patterns and the desire to provide sufficient parking in case the Assembly Row garage reached capacity, PHS also leased 150 spaces of off-site parking (with the option of increasing to 200 spaces) at 80 Station Landing, Medford, located one stop north at Wellington Station. A free shuttle transports employees to and from the off-site lot.

### 6.1.3 Offices and Consolidation

Prior to consolidation, PHS administrative offices were located at 14 sites across Greater Boston. Figure 6-1 shows these sites clustered into 10 areas as well as the new office at Assembly Row. Most of the prior sites were located in the City of Boston, clustered around the Prudential Center, Downtown and Charlestown areas. Other offices reached as far as Wellesley and Needham. (A complete summary of locations, along with their approximate size and parking fees, is provided in Table 6.1.)

### 6.1.4 Parking & Commuting Benefits

#### Parking
Given the diversity of office locations—urban vs. suburban, senior administration vs. middle management, etc.—different parking benefits existed from site to site. Four of the sites offered free employee parking (Table 6.1), while all others charged between $200 and $480...
Figure 6-1: Locations of prior PHS administrative offices (orange) and the new Assembly Row consolidated office (blue).

<table>
<thead>
<tr>
<th>Location</th>
<th>City /Neighborhood</th>
<th>Staff Count</th>
<th>Monthly Parking Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schrafft’s Building, 529 Main St</td>
<td>Charlestown</td>
<td>1,025</td>
<td>Free</td>
</tr>
<tr>
<td>One Constitution Center</td>
<td>Charlestown</td>
<td>539</td>
<td>$306</td>
</tr>
<tr>
<td>101 Merrimac St</td>
<td>Boston</td>
<td>175</td>
<td>$465</td>
</tr>
<tr>
<td>253 Summer St/27 Melcher St</td>
<td>Boston</td>
<td>642</td>
<td>$430</td>
</tr>
<tr>
<td>2 Ave de Lafayette</td>
<td>Boston</td>
<td>482</td>
<td>$379</td>
</tr>
<tr>
<td>1 Cabot Road</td>
<td>Medford</td>
<td>214</td>
<td>Free</td>
</tr>
<tr>
<td>93 Worcester St</td>
<td>Wellesley</td>
<td>403</td>
<td>Free</td>
</tr>
<tr>
<td>115 4th Ave</td>
<td>Needham</td>
<td>200</td>
<td>Free</td>
</tr>
<tr>
<td><strong>Prudential Group:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Prudential Center</td>
<td>Boston</td>
<td>20</td>
<td>$275</td>
</tr>
<tr>
<td>101 Huntington Ave</td>
<td>Boston</td>
<td>218</td>
<td>$480</td>
</tr>
<tr>
<td>116 Huntington Ave</td>
<td>Boston</td>
<td>75</td>
<td>$297</td>
</tr>
<tr>
<td><strong>Bowdoin Group:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>100 Cambridge St</td>
<td>Boston</td>
<td>9</td>
<td>$342</td>
</tr>
<tr>
<td>25 New Chardon St</td>
<td>Boston</td>
<td>20</td>
<td>$200</td>
</tr>
<tr>
<td>50 Staniford St</td>
<td>Boston</td>
<td>72</td>
<td>$237</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>4,094</td>
</tr>
</tbody>
</table>
per month.

Upon the move to Assembly Row, free parking was eliminated, and parking rates were harmonized and switched from monthly to daily to incentivize drivers to reduce their frequency of parking (a TDM strategy discussed earlier in the context of MIT in Section 3.3). Daily rates were pegged to employee income in an effort to advance equity and minimize the likelihood of employee dissatisfaction, especially given that almost half of employees did not previously have to pay for parking (see new rates in Table 6.2). Everyday parkers would pay approximately $80 to $200 per month. Staff could also opt to park in the discount lot at 80 Station Landing, and pay a fixed monthly fee of $43 (equivalent to approximately $2/day) to park\(^1\). For comparison, the market rate for 8 hours of retail parking is $7 at Station Landing and $8 at Assembly Row, which means some PHS employees parking at Assembly Row pay more than retail parkers. While this would incentivize these employees to park in the retail section of the garage, the agreement between PHS, Federal Realty and the City of Somerville precludes any employees working at Assembly Row from parking in the retail section.

<table>
<thead>
<tr>
<th>Employee Income Level</th>
<th>Daily Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;$50,000</td>
<td>$4.00</td>
</tr>
<tr>
<td>$50,000 - $90,000</td>
<td>$6.00</td>
</tr>
<tr>
<td>$90,000 - $125,000</td>
<td>$8.00</td>
</tr>
<tr>
<td>&gt;$125,000</td>
<td>$10.00</td>
</tr>
</tbody>
</table>

**Transit**

Transit benefits were uniform across prior worksites, with a 30% subsidy offered for monthly purchases of an MBTA LinkPass, bus pass, commuter rail or boat pass. Employees were only eligible for the subsidy if they did not also purchase a parking permit. The subsidy was increased to 50% at Assembly Row, and was made available to all employees including parking permit holders. The new office is accessible via the MBTA Orange Line at Assembly Station directly adjacent. Several MBTA bus routes also serve the area, including from downtown Boston (Route 92) and Davis Square (Route 90). Transit benefits at other major Boston area Partners locations, including Massachusetts General Hospital and Brigham and Women’s Hospital, have remained at a 30% subsidy.

**Other benefits**

PHS provides free bike parking for 39 bicycles in a sheltered and secured facility, and for 112 bicycles in a sheltered but unsecured area in the parking garage. Showers are also provided. Flexible hours are also offered through a program called *ConnectedWork*, which allows employees to work remotely depending on the requirements and flexibility of their department. Approximately 600 employees, or 15% of the Assembly Row staff population, are enrolled in the program.

A weekday shuttle service is also provided free-of-charge to PHS employees, connecting Assembly Row with Brigham and Women’s Hospital (once every hour), Massachusetts

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\(^1\)Parking fees are deducted from an employee’s weekly paycheck. For those charged daily, a five-day-a-week parker billed $10 per day would see a line item for $50 the following Thursday. Station Landing parkers would see the $43 monthly fee apportioned to a weekly deduction.
General Hospital (once every half-hour), Boston's South Station (two shuttles during AM peak only) and the Station Landing parking facility (once every ten minutes during peak periods; every 20 minutes outside peak).

### 6.1.5 Employee Profile

A staff composition profile was developed using a combination of Human Resources data and the results of an employee commuting survey conducted in fall of 2017. The survey, co-led by PHS and the MIT Transit Lab, elicited a valid response from 1,089 individuals or 27% of all staff.

A summary of survey respondents, contrasted with the employee population, is shown in Table 6.3. It indicates a roughly representative sample across dimensions of age, sex, tenure, commute distance and commuting benefits. Employee home locations are spread across Greater Boston, with the most common cities being Boston, Somerville and Malden (as shown in Figure 6-2). A map of employee home locations (Figure 6-3) indicates clusters of transit commuters along corridors north and south of the city while many drivers are dispersed across Greater Boston, with concentrations to the northwest and periphery of the city.

<table>
<thead>
<tr>
<th>Table 6.3: Survey representativeness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Survey</strong></td>
</tr>
<tr>
<td>N</td>
</tr>
<tr>
<td>% Female</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>&lt; 35</td>
</tr>
<tr>
<td>35-55</td>
</tr>
<tr>
<td>&gt;= 55</td>
</tr>
<tr>
<td>Tenure</td>
</tr>
<tr>
<td>&lt; 5 years</td>
</tr>
<tr>
<td>5-15 years</td>
</tr>
<tr>
<td>&gt;= 15 years</td>
</tr>
<tr>
<td>Home Distance to Assembly Row</td>
</tr>
<tr>
<td>&lt; 5 miles</td>
</tr>
<tr>
<td>5-10 miles</td>
</tr>
<tr>
<td>10-20 miles</td>
</tr>
<tr>
<td>&gt;= 20 miles</td>
</tr>
<tr>
<td>Parking Permit Possession</td>
</tr>
<tr>
<td>Average monthly parking frequency among permit holders</td>
</tr>
<tr>
<td>Never parked</td>
</tr>
<tr>
<td>0 to 5 days</td>
</tr>
<tr>
<td>5 to 10 days</td>
</tr>
<tr>
<td>Over 10 days</td>
</tr>
<tr>
<td>MBTA Monthly Pass Possession</td>
</tr>
</tbody>
</table>

*Benefits-eligible PHS employees only; approximately 200 on-site temporary and affiliated workers are not included.
Figure 6-2: Top twenty cities and neighborhoods of home residence (Other: 2,402 staff, not shown)
Figure 6-3: Home location of PHS employee survey respondents, indicating primary mode choice. The upper map shows Greater Boston, while the lower map shows a zoomed-in perspective around Assembly Row. Location coordinates are approximated and scattered for privacy.

6.2 Impact of Relocation on Employee Travel Behavior

This section analyzes PHS commuting patterns before and after the relocation to Assembly Row. It begins by presenting commuter profiles of the ten prior workplace groups. This is followed by an in-depth analysis of mode shift using logistic regression, as well as changes in parking and transit usage.
6.2.1 Changes in Commuting by Prior Office Location

The following pages present site profiles for the ten former worksite areas of PHS Assembly Row employees shown earlier in Figure 6-1. Each profile outlines the changes in travel behavior among the group of employees before and after the move. The prior site’s parking fees and transit adjacency are described, and the Walk Score, Transit Score and Bike Score are shown, which provide a rating from 0-100 describing the relative accessibility of the workplace by each mode as estimated by Walk Score®; a higher score indicates greater accessibility. The change in SOV mode share is presented, followed by a breakdown of estimated driving and transit travel times at both locations, calculated using the Google Maps API for peak period travel conditions. Commentary follows at the bottom of each page.
Site Profile:

Schrafft’s Building
529 Main St, Boston, MA 02129

- Employees: 1,025
- Monthly parking cost: Free
- Adjacent to Sullivan Square Station (MBTA Orange Line)

Mode Share

Before (Schrafft’s)
- SOV 64%
- non-SOV 36%

After (Assembly Row)
- SOV 60%
- non-SOV 40%

Travel Time

Median driving time
- To Schrafft’s: 46 min
- To Assembly Row: 45 min

Median transit time
- To Schrafft’s: 61 min
- To Assembly Row: 57 min

- Schrafft’s was the only Boston PHS site to offer free parking
- Despite a move further from downtown, SOV mode share dropped slightly, as did travel times for both driving and transit
Site Profile:

**One Constitution Center (OCC)**

*1 Constitution Rd, Charlestown, MA 02129*

- Employees: **539**
- Monthly parking cost: **$306**
- 15 minute walk from North Station

---

**Mode Share**

<table>
<thead>
<tr>
<th></th>
<th>Before (OCC)</th>
<th>After (Assembly Row)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOV</td>
<td>57%</td>
<td>52%</td>
</tr>
<tr>
<td>non-SOV</td>
<td>43%</td>
<td>48%</td>
</tr>
</tbody>
</table>

**Median driving time**

- To OCC: **64 min**
- To Assembly Row: **61 min**

**Median transit time**

- To OCC: **75 min**
- To Assembly Row: **71 min**

- OCC saw a five point reduction in SOV mode share
- Drive and transit travel times are slightly reduced since move to Assembly Row
Site Profile:

**Prudential Center Area**

101 Huntington Ave, Boston, MA 02199  
116 Huntington Ave, Boston, MA 02116  
99 Exeter St, Boston, MA 02116

- Employees: 313  
- Monthly parking cost: $351  
- Accessible by MBTA Green and Orange lines (Back Bay)

**Mode Share**

Before (Prudential)

- SOV: 24%  
- non-SOV: 76%

After (Assembly Row)

- SOV: 39%  
- non-SOV: 61%

**Median driving time**

To Prudential: 44 min  
To Assembly Row: 39 min

**Median transit time**

To Prudential: 50 min  
To Assembly Row: 55 min

- While Prudential area employees came from a highly transit-accessible neighborhood, their SOV mode share did not rise as much as most other offices  
- Drive time to Assembly Row has decreased while transit time has risen
Site Profile:

**Merrimac Street**

*101 Merrimac St, Boston, MA 02114*

- Employees: 175
- Monthly parking cost: $465
- Located at Government Center in downtown Boston

**Mode Share**

<table>
<thead>
<tr>
<th></th>
<th>Merrimac</th>
<th>Assembly Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOV</td>
<td>14%</td>
<td>45%</td>
</tr>
<tr>
<td>non-SOV</td>
<td>86%</td>
<td>55%</td>
</tr>
</tbody>
</table>

**Travel Time**

- **Median driving time**
  - To Merrimac: 51 min
  - To Assembly Row: 50 min

- **Median transit time**
  - To Merrimac: 51 min
  - To Assembly Row: 58 min

- Commuters had the lowest SOV mode share of any prior location, which now has risen almost to the Assembly Row mean of 49%
- This shift has occurred despite transit travel times remaining competitive
Site Profile:
**Seaport Area**
253 Summer St, Boston, MA 02210
27 Melcher St, Boston, MA 02210

- Employees: 642
- Monthly parking cost: $430
- 10 minute walk from Downtown Crossing; 5 minutes from South Station

Mode Share

<table>
<thead>
<tr>
<th></th>
<th>Before (Seaport)</th>
<th>After (Assembly Row)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOV</td>
<td>19%</td>
<td>38%</td>
</tr>
<tr>
<td>non-SOV</td>
<td>81%</td>
<td>62%</td>
</tr>
</tbody>
</table>

Travel Time

**Median driving time**

- To Seaport: 53 min
- To Assembly Row: 53 min

**Median transit time**

- To Seaport: 56 min
- To Assembly Row: 59 min

- SOV mode share has risen substantially as transit travel times have become polarized (either shorter or much longer)
Site Profile:

**Lafayette City Center**

2 Ave de Lafayette, Boston, MA 02111

- Employees: 482
- Monthly parking cost: $379
- Located at Downtown Crossing

**Mode Share**

- Median driving time
  - To Lafayette: 55 min
  - To Assembly Row: 49 min

- Median transit time
  - To Lafayette: 46 min
  - To Assembly Row: 58 min

- Only modest rise in low SOV share despite transit trips lengthening and driving trips shortening
Site Profile:

**Bowdoin Area**

25 New Chardon St, Boston, MA 02114
50 Staniford St, Boston, MA 02114
100 Cambridge St, Boston MA 02108

- Employees: 101
- Monthly parking cost: $260
- Located near downtown by Bowdoin Station

**Mode Share**

Before (Bowdoin)

- SOV: 24%
- non-SOV: 76%

After (Assembly Row)

- SOV: 43%
- non-SOV: 57%

**Median driving time**

- To Bowdoin: 45 min
- To Assembly Row: 33 min

**Median transit time**

- To Bowdoin: 51 min
- To Assembly Row: 63 min

- 19 point increase in SOV mode share
- Drive time has dropped while transit time has increased to almost double that of driving
Site Profile:

**Medford**

1 Cabot Rd, Medford, MA 02155

- Employees: **241**
- Monthly parking cost: **Free**
- Located an 8 minute walk from Wellington Station on Orange Line

**Mode Share**

**Before (Medford)**

- SOV: 72%
- non-SOV: 28%

**After (Assembly Row)**

- SOV: 68%
- non-SOV: 32%

**Median driving time**

- To Medford: **25 min**
- To Assembly Row: **30 min**

**Median transit time**

- To Medford: **45 min**
- To Assembly Row: **40 min**

- SOV-dominated workplace only reduced drive-alone share by four points, despite increased drive time and reduced transit time
- Drivers tended to have the shortest drive of any worksite
Site Profile:
**Wellesley Gateway**
93 Worcester St, Wellesley, MA 02481
- Employees: 403
- Monthly parking cost: Free
- Limited transit accessibility
- Adjacent to Interstate 95

Mode Share

<table>
<thead>
<tr>
<th></th>
<th>Before (Wellesley)</th>
<th>After (Assembly Row)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOV</td>
<td>86%</td>
<td>62%</td>
</tr>
<tr>
<td>non-SOV</td>
<td>14%</td>
<td>38%</td>
</tr>
</tbody>
</table>

Median driving time

- To Wellesley: 43 min
- To Assembly Row: 67 min

Median transit time

- To Wellesley: N/A
- To Assembly Row: 74 min

- 24 point drop in SOV mode share as transit becomes a viable option and drive time increases over 50%
**Site Profile:**

**Needham**

*115 4th Ave, Needham Heights, MA 02494*

- Employees: **200**
- Monthly parking cost: **Free**
- No transit accessibility
- Adjacent to Interstate 95

### Mode Share

**Before** (Needham)

- SOV: 97%
- non-SOV: 3%

**After** (Assembly Row)

- SOV: 61%
- non-SOV: 39%

### Median driving time

- To Needham: **42 min**
- To Assembly Row: **49 min**

### Median transit time

- To Needham: **N/A**
- To Assembly Row: **64 min**

- Zero transit mode share at Needham worksite
- Remarkable 36 point drop in SOV share after move
6.2.2 Enhanced Commuter Benefits

As discussed in Section 6.1.4, PHS introduced a series of enhancements to its commuter benefits program as part of the move to Assembly Row. As this aimed to help encourage alternatives to drive-alone commuting, it acts as a confounding factor in the analysis of why employees did or did not alter their travel patterns after moving to Assembly Row.

In an effort to better understand the influence of both the move and the enhanced benefits, survey respondents were asked to rank the importance of several aspects on a scale from 1 to 5. Results are shown in Figure 6-4, broken down by all commuters, transit riders and drive-alone commuters. We see that transit riders perceive the 50% MBTA subsidy and the proximity to the Orange Line as extremely important, while the daily parking charges and employee shuttles are moderately important. For drivers, the daily parking scheme is by far the most important, with all other aspects less so. Bicycling amenities are consistently ranked as unimportant, understandable given the lack of a mature bicycling network in the area.

![Figure 6-4: Self-reported influence of enhanced commuting benefits and workplace location, on a scale from 1 (least influence) to 5 (most influence).](image)

6.2.3 Mode Choice

In the consolidation to Assembly Row, the overall PHS mode split remained approximately constant, with an SOV share of approximately 50% and a public transit share of 43%. A slight increase in the use of shared rides has been offset by a small drop in active commuting (walking and cycling), both of which comprise under 4% each of overall mode share.

As shown in Figure 6-5, an analysis of mode choice by age and sex indicates that female staff under 55 years of age tend to be more often SOV commuters compared to male em-
ployees, with the most pronounced gap among staff under 35 (53% SOV among <35 women vs. only 41% SOV among <35 men). This trend inverts for staff 55 and over, with older male staff comprising the highest share of SOV commuters.

Logistic regression was used to better understand the determinants of mode choice among PHS staff. Table 6.4 presents three binary logit models predicting the likelihood that an Assembly Row commuter will choose to drive alone to work over taking transit (other modes are omitted due to their marginal proportions). Model 1 is a traditional mode choice model, taking into account basic trip and employee attributes. It suggests that employees living further away from Assembly Row are more likely to take transit to work, and that early-arriving staff tend to drive more often. Contrary to typical trends, younger staff tend to be more likely SOV commuters than older staff, though this is after controlling for tenure of employment at PHS (which is positively associated with SOV propensity). Commuters without a driver’s license or living in a household with fewer cars than licensed drivers (labeled ‘captive transit riders’) are much less likely to drive to work, as one would intuitively surmise. Finally, the Transit Score at an employee’s home location (calculated using Walk Score®), which measures the degree to which the location is accessible to public transportation, is inversely correlated with drive-alone rates. Several variables hypothesized to be predictors of mode choice were found insignificant, including gender, flexible work schedules, working hours and specific age/gender groups.

Model 2 introduces site-specific coefficients for each of the ten prior worksites. Only the Medford coefficient is significant, and indicates a higher propensity of driving among commuters formerly at this office.

Model 3 introduces a coefficient for the employee’s mode choice at their former workplace, given the hypothesis that prior habit would play a significant role in determining future behavior. However, it is statistically insignificant when explicitly controlling for prior workplace location. We note several notable findings from parameter magnitudes:

\[ \text{This parameter was estimated using methods outlined in Cantillo et al. (2007).} \]
• Employees arriving before 7:30 am have twice the odds of driving

• Employees under 35 have twice the odds of driving, while those over 55 have less than half the odds

• Classification as a ‘captive’ transit rider\(^3\) decreases the odds of driving by a factor of 6

• Every point increase in home \textit{Transit Score} (0 to 100) is associated with a 3\% decrease in odds of driving

• All else equal, those who worked at Schrafft’s are now 1.6 times as likely to drive to work today

• For those who formerly worked at Wellesley and Medford, the odds of continuing to drive increase by a factor 2.0 and 3.3, respectively

The latter findings indicate that prior office locations themselves played a role in setting today’s commuter mode choice. Given the long-term nature of decisions such as car ownership and residential relocation, it is understandable that there may be a lag effect in reduced vehicle dependence among commuters that used to drive to work every day\(^4\).

Of the PHS employees who reported changing modes, the vast majority were drivers and transit riders switching between the two, as shown in Figure 6-6. The diagram indicates that 33\% of the changes were drivers becoming transit riders, while 29\% were transit riders who became drivers. Over twice as many commuters switched towards active modes than switched away, though the proportions are small. Shared modes (carpooling, vanpooling and PHS shuttle) declined by two-thirds.

6.2.4 Parking

PHS employees driving to Assembly Row have the option of parking in the on-site garage (‘A.R. Garage’) with 1,664 spaces attached to the office building or the off-site garage (‘Station Landing’) with 150 PHS-allocated spaces located at Wellington Station, one stop north of Assembly on the Orange Line. Of the 4,015 employees at Assembly Row, 2,800 (70\%) hold a parking permit (2,680 at the A.R. Garage and 120 at Station Landing). The following analysis will solely focus on the A.R. Garage, given its use by 96\% of parkers.

Garage Occupancy

With 2,800 registered parkers and only 1,664 on-site spaces, less than six in ten permit holders would expect to find a space in the A.R. Garage on a given day if all were to drive to Assembly. However, garage occupancy data indicates that average and peak occupancy

\(^3\)Defined as not holding a driver’s license or living in a household with fewer cars than licensed drivers.

\(^4\)This was observed in many survey responses, with employees noting a period of several months in which they adjusted to a new commute and reconsidered their car ownership (or lack thereof) and home location. Sample response: “When our office migrated from Needham to Assembly Row my commute became 1 hour 20 minutes long. I moved closer to the building after about 6 months of the longer commute.”
Figure 6-6: Stated mode shifts from before (left) to after (right) the move, among the 22% of survey respondents who reported changing their primary commuting mode.

has never come close to reaching capacity. In fact, Figure 6-7 shows that between September 2017 and February 2018, the weekday average garage occupancy was 61% of its capacity, while the average maximum occupancy observed each month was 71% during this period. This occurred even as the building occupancy rose 8% with more employees moving in during the study period.

**Employee Parking Trends**

Exploring individual parking records more closely, we see that the average PHS employee parks 6.4 days per month at the A.R. Garage. Among those identifying as primary-mode drive-alone commuters with A.R. Garage permits, this figure rises to 11 days, while for primary-mode transit riders, it is only 1.5.

Survey results indicate that many commuters tend to be multimodal. Of the respondents who listed transit as their primary mode, half of them also hold a parking permit (available free of charge to staff). Furthermore, among these permit-holding transit riders, 41% of them have parked at least once per month in the period between September 2017 and February 2018, and 15% report parking at least once a week. Had these commuters been forced to purchase a monthly pass instead of being priced daily, we may expect that the sunk cost would have contributed to a higher frequency of parking.

While employee income was not made available to researchers, the four income-based tiers of parking rates are a useful proxy. Analysis indicates that those registered in to lowest tier (corresponding to income under $50,000) tend to park most often, as shown in Figure 6-8. While it was hypothesized that such a trend would be correlated with home dis-
Table 6.4: Binary mode choice model (dependent variable: SOV (1) vs. non-SOV (0) primary mode choice). Percentages alongside dummy variables indicate the proportion at which the variable takes on a value of 1.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>2.29***</td>
<td>2.04***</td>
<td>3.85**</td>
</tr>
<tr>
<td>Drive time (hours, AM peak)</td>
<td>-1.31***</td>
<td>-1.31***</td>
<td>-1.70***</td>
</tr>
<tr>
<td>Has flexible work hours (76%)</td>
<td>-0.175</td>
<td>-0.108</td>
<td>-0.174</td>
</tr>
<tr>
<td>Work week longer than 40 hours (39%)</td>
<td>-0.0340</td>
<td>-0.0220</td>
<td>-0.0392</td>
</tr>
<tr>
<td>Arrival time is before 7:30 am (32%)</td>
<td>0.565***</td>
<td>0.489**</td>
<td>0.741**</td>
</tr>
<tr>
<td>Age under 35 (22%)</td>
<td>0.470</td>
<td>0.460</td>
<td>0.633*</td>
</tr>
<tr>
<td>Age 55 or over (29%)</td>
<td>-0.512*</td>
<td>-0.508*</td>
<td>-0.728**</td>
</tr>
<tr>
<td>Male (34%)</td>
<td>-0.183</td>
<td>-0.222</td>
<td>-0.304</td>
</tr>
<tr>
<td>Tenure under 5 years (38%)</td>
<td>-0.530**</td>
<td>-0.419*</td>
<td>-0.645**</td>
</tr>
<tr>
<td>Captive transit rider (32%)</td>
<td>-1.23***</td>
<td>-1.24***</td>
<td>-1.78***</td>
</tr>
<tr>
<td>Home Transit Score</td>
<td>-0.0220***</td>
<td>-0.0220***</td>
<td>-0.0309***</td>
</tr>
<tr>
<td>Age 55 or over and male (9%)</td>
<td>0.549</td>
<td>0.577</td>
<td>0.311</td>
</tr>
<tr>
<td>Age under 35 and male (7%)</td>
<td>-0.614</td>
<td>-0.600</td>
<td>-0.391</td>
</tr>
<tr>
<td>Prior office: Schrafft’s (24%)</td>
<td>0.427</td>
<td>0.474</td>
<td></td>
</tr>
<tr>
<td>Prior office: OCC (12%)</td>
<td>0.275</td>
<td>0.266</td>
<td></td>
</tr>
<tr>
<td>Prior office: Prudential Area (10%)</td>
<td>-0.173</td>
<td>-0.153</td>
<td></td>
</tr>
<tr>
<td>Prior office: Merrimac (8%)</td>
<td>0.140</td>
<td>0.166</td>
<td></td>
</tr>
<tr>
<td>Prior office: Seaport (8%)</td>
<td>-0.235</td>
<td>-0.216</td>
<td></td>
</tr>
<tr>
<td>Prior office: LCC (4%)</td>
<td>-0.315</td>
<td>-0.316</td>
<td></td>
</tr>
<tr>
<td>Prior office: Bowdoin Area (4%)</td>
<td>-0.276</td>
<td>-0.262</td>
<td></td>
</tr>
<tr>
<td>Prior office: Medford (2%)</td>
<td>1.08*</td>
<td>1.20*</td>
<td></td>
</tr>
<tr>
<td>Prior office: Wellesley (8%)</td>
<td>0.494</td>
<td>0.679</td>
<td></td>
</tr>
<tr>
<td>Prior office: Needham (6%)</td>
<td>0.463</td>
<td>0.548</td>
<td></td>
</tr>
<tr>
<td>Formerly SOV commuter (47%)</td>
<td>-2.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

McFadden $R^2$ 0.19 0.21 0.21

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

*Defined as a commuter without a driver’s license and/or whose household has fewer cars than licensed drivers.

In terms of parking cost, none existed ($R^2$ of 0.04). Additionally, there was no significant correlation between parking frequency and home Transit Score, a proxy for transit accessibility ($R^2$ of 0.01). This is an important finding, reinforcing that parking cost alone appears to strongly influence parking frequency among staff with income under $125,000. Above this income, the increased frequency of parking can likely be attributed to lesser sensitivity to parking fees.

Parking trends vary widely across employees’ prior worksites. As shown in Figure 6-9, employees that were formerly at either the Schrafft’s Center or the Medford site now exhibit the highest frequency of parking at Assembly Row today. These were the two nearest sites to the Assembly Row office, meaning that commuters did not need to make significant changes to their commute after the move. Further, these were two of the four prior sites that offered free parking, and unsurprisingly had some of the highest SOV mode shares.
This suggests that many commuters who habitually drove before are continuing to drive today. In contrast to the Schrafft’s and Medford sites, employees moving from the Wellesley and Needham sites exhibited the largest reductions in parking (see Figure 6-10). These were previously the two sites with the highest SOV mode shares (86% and 97%, respectively), yet the average post-consolidation parking frequency at Assembly Row was in line with the average across all sites.

Parking frequency was also analyzed as a function of neighborhood attributes of employees’ place of residence. As proxies for local accessibility, the Walk Score, Transit Score and Bike Score were extracted using the Walk Score® API and are plotted against current parking frequency in Figure 6-11 (a higher score closer to 100 indicates greater accessibility). While little correlation is shown to walk score, transit access and bike access are observed to generally have an inverse relationship with employee parking frequency. This finding, contrasted with the lack of correlation between home-to-work distance and parking frequency, is consistent with prior research that emphasizes the importance of transit accessibility to a broad set of attractions (as proxied by Transit Score), rather than simply access to a single worksite, in predicting transit mode share (Naess, 2002).

Finally, stated changes in parking frequency were analyzed to reveal patterns from the
Figure 6-8: Parking frequency by income level.

Figure 6-9: Average calculated monthly parking frequency at A.R. Garage (September 2017 through February 2018) among employees formerly located at each worksite, derived from garage tap-in/tap-out data. Shaded bars indicate that these workers previously received free parking.

self-reporting of prior parking frequency among PHS staff. As shown in Figure 6-12, most staff did not shift their frequency of parking. The average change, however, was a -0.3 day/week reduction in parking across all respondents. Among those who changed their
Figure 6-10: Average stated weekly parking frequency among employees formerly at each worksite, before and after the move. Locations 1, 8, 9 and 10, which had free parking, have the largest decreases.

Figure 6-11: Average parking frequency at A.R. Garage (September 2017 through February 2018) by Walk Score, Transit Score, and Bike Score at employees’ place of residence.

frequency of parking, 28% more employees reduced their parking than increased it, and decreases tended to come more often from female employees (who tended to park more in the first place). Among the survey respondents who were not working at PHS prior to the relocation, their parking frequency dropped an average of 0.8 days per week compared to their prior place of work (N=109).
6.2.5 Transit

Of the 43% of PHS commuters who report transit as their primary mode, most of these riders (37% of all staff) purchase a subsidized monthly MBTA pass (including LinkPass, commuter rail, express bus and boat). The breakdown is shown in Figure 6-13. A quarter of transit commuters have a one-seat ride, while 53% make one transfer and 23% require two or more transfers to reach Assembly Row.

Among the 929 staff who purchase LinkPasses, CharlieCard usage data were available for 700 commuters. Figure 6-14 illustrates the distribution of average monthly MBTA usage among these LinkPass holders, and is overlaid with three dotted lines indicating break-
even points at which purchasing the LinkPass becomes more economical than using cash fares\textsuperscript{5}. The right-most line indicates that an unsubsidized $84.50 LinkPass, paid with pre-tax dollars, is economical for commuters using their pass at least 14 days a month (at two trips per day); about 50% of commuters currently use their pass enough to reach this point. For PHS commuters, the prior subsidy of 30% meant that 10 days were required to break even, and about 68% of commuters reach this point today. With the newly increased subsidy to 50%, only 7 days of round-trip usage are required to break even, and over three-quarters (78%) of pass holders surpass this amount of usage, making it economically rational for them to continue purchasing the pass.

Figure 6-14: Average monthly LinkPass usage among 700 PHS employees with available data.

This data shows that, absent a LinkPass subsidy, half of pass holders would not use the MBTA enough to justify the monthly purchase. While the proportion decreases once the 50% subsidy is included, more than one in five staff does not use their LinkPass enough to cover their out-of-pocket cost of purchase.

**Scenarios of Enhanced Transit Benefits**

With half of employees still driving to work, PHS may consider steps to further encourage mode shift among its commuters. The current subsidy on monthly MBTA passes is an effective incentive for some staff, but is not helpful for those using transit on an occasional

\textsuperscript{5}Break-even points for cash vs. LinkPass are based on the equivalent subway fare of $2.25 and an average of two trips per day. An average income tax rate of 30% is used to account for pre-tax purchase savings on the monthly pass, as permitted by IRS commuter tax benefit.
basis, or those who might consider it. As discussed in the MIT case study, switching to a zero marginal cost transit benefit can lead to a significant increase in ridership and an associated decrease in parking demand. Here we outline three scenarios with revenue and cost impacts on the MBTA, PHS and individual commuters.

The first scenario is (1) business as usual. As shown in Table 6.5, this present-day scenario reflects the 50% subsidy on local and commuter MBTA passes to 1,487 employees plus the unsubsidized, privately-paid trips made by an estimated 630 other staff as based on the 2017 employee survey. Dividing staff into four groups of (a) current LinkPass holders, (b) Commuter Rail/Bus/Boat pass holders, (c) pay-per-use riders and (d) non-riders, we estimate that the average monthly revenue to the MBTA is $257,500, of which $99,600 is paid by PHS (after accounting for transit-related payroll tax deductions). The average employee pays $24 per month for transit today, and two-thirds of staff receive no transit benefits from PHS.

Scenario 2 presents the option for PHS to offer a (2) fully subsidized universal pass to all employees, similar to what MIT offers, in which employees are provided with an unlimited pass but PHS only pays for trips actually taken. This is advantageous for PHS because many of the two thousand drive-alone commuters receiving a pass would not all be likely to begin frequent MBTA usage. However, when paired with their daily parking fee, the marginal cost each day for employees becomes zero for transit, and non-zero for parking. As explored in the behavioral science literature on the so-called power of ‘free’, offering a full subsidy on transit can have a markedly stronger behavioral effect than a large partial discount (Ariely, 2010). Offering this pass product to all employees would undoubtedly increase transit usage while decreasing parking demand, and improve employee satisfaction with transportation benefits.

In this scenario, three factors would likely lead to changes in revenues for the MBTA and costs to PHS. First, existing LinkPass holders would provide less revenue to the agency because their average monthly usage is only $55, less than the $84.50 purchase price. Second, the former pay-per-use riders would likely start using transit more often, leading to an increase in agency revenues. And finally, some of the non-riders would begin using transit, growing the overall ridership base. Using findings from the MIT case study, we estimate that existing riders will increase their frequency of use by 10% while another 10% of non-transit riding staff would begin using the MBTA (with half of them becoming regular users at $55/month and the other half becoming occasional users at $18/month, again based on MIT trends). The result is that total MBTA revenue would decrease by about 3%, while the cost to PHS would rise by two-thirds to $167,000 per month. The average employee would only pay $7/month, based on a minority of commuters still purchasing commuter rail passes at an unchanged 50% subsidy. This subsidy also could be increased in an effort to promote commuter rail usage.

While PHS would experience an increase in monthly transit costs, the long-term impacts would likely be positive in four ways. First, it would reduce parking demand, helping to ensure that off-site parking—like the current lease at Station Landing costing $16,000 per month—is not required in the future. Second, it would improve employee satisfaction, possibly increasing rates of employee retention and successful recruitment. Third, it would

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6Bus pass holders are grouped alongside LinkPasses due to their negligible numbers.
serve to soften the ‘blow’ of future parking rate increases, which will be inevitable given region-wide development and the costs of maintaining significant structural assets. Finally, it would close the loop on the behavioral ‘nudge’, pairing pay-per-day parking fees with a universal, zero marginal cost transit benefit to encourage new ridership.

That said, PHS may decide not to fully subsidize employee transit passes. The final scenario is a (3) hybrid option in which employees are still provided with a universal transit pass, but all four thousand staff are automatically billed a monthly ‘mobility fee’ that partially covers the cost of a transit pass, plus multi-modal perks such as a few days of free parking each month (after which a daily charge is incurred). In Table 6.5, we present the financial impacts of a $30/month employee fee providing all commuters with an unlimited-use local subway and bus pass and three days of free parking each month. Assuming the same mode shift as in Scenario 2, the revenue impacts to the MBTA would be the same, but the cost to PHS would rise by only 5% rather than 67% over the business-as-usual case\(^7\). The average employee would pay $33 per month, with 546 staff still purchasing more costly commuter rail/express bus/boat passes. For these riders, the aforementioned proposals would be of lesser benefit, as the current fare collection system does not easily accommodate a pay-per-use employer billing scheme analogous to the LinkPass. However, with upcoming improvements to commuter rail fare collection, including a tap-on/tap-off system, PHS may be able to implement a fully or partially-subsidized pay-per-use commuter rail pass product that allows occasional drivers to incorporate discounted commuter rail into their commute. If paired with an employer-paid pay-per-use local transit pass, this would harmonize transit benefits to eliminate the sunk cost barrier associated with monthly pass purchases.

In all, PHS has a variety of options at its disposal to further encourage transit ridership among employees. The employer-paid payroll tax savings on transit subsidies, alongside the employee-paid income tax savings on employer-provided transit benefits, are an important motivator. Given that PHS currently subsidizes parking at a rate of up to 84%\(^8\), enhancing transit benefits would advance equity and strengthen the identify of PHS as a progressive employer.

### 6.3 Discussion

#### 6.3.1 Research Questions

This analysis sought to answer three research questions regarding (1) how commuters adapt their travel patterns upon workplace relocation; (2) the extent to which factors of transportation infrastructure, neighborhood accessibility and workplace benefits play a role in this adaptation; and (3) lessons learned on the role of employers in influencing travel behavior.

**Travel Behavior Changes Upon Relocation**

\(^7\)The modest cost increase would be due to the forgone daily parking revenue, but mostly made up by monthly employee contributions.

\(^8\)Based on a market rate of $25/day for parking ten or more hours at the Assembly Row Garage.
<table>
<thead>
<tr>
<th>Scenario</th>
<th># of Staff</th>
<th>Monthly Revenue to MBTA</th>
<th>Monthly Cost to PHS</th>
<th>Monthly Cost per Employee</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1) Business as Usual:</strong> 50% subsidy on monthly passes</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Link/Bus Pass holders</td>
<td>941</td>
<td>$79,200</td>
<td>$36,600</td>
<td>$30²</td>
</tr>
<tr>
<td>Commuter Rail/Bus/Boat Pass holders</td>
<td>546</td>
<td>$136,700</td>
<td>$63,100</td>
<td>$51²³</td>
</tr>
<tr>
<td>Pay-per-use riders</td>
<td>630⁴</td>
<td>$41,700</td>
<td>$0</td>
<td>$66⁶</td>
</tr>
<tr>
<td>Non-riders</td>
<td>1,898</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,015</strong></td>
<td><strong>$257,500</strong></td>
<td><strong>$99,600</strong></td>
<td><strong>$24 average</strong></td>
</tr>
<tr>
<td><strong>2) Fully Subsidized Universal Pass:</strong> Universal pass subsidized in full by PHS, paid on a per-trip basis to MBTA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former Link/Bus Pass holders</td>
<td>941</td>
<td>$51,800</td>
<td>$47,800</td>
<td>$0</td>
</tr>
<tr>
<td>Commuter Rail/Bus/Boat Pass holders</td>
<td>546</td>
<td>$136,700</td>
<td>$63,100</td>
<td>$51²</td>
</tr>
<tr>
<td>Former pay-per-use riders</td>
<td>630⁵</td>
<td>$45,900</td>
<td>$42,400</td>
<td>$0</td>
</tr>
<tr>
<td>Former non-riders now using transit</td>
<td>402¹⁰</td>
<td>$14,700</td>
<td>$13,500</td>
<td>$0</td>
</tr>
<tr>
<td>Remaining non-riders</td>
<td>1,497</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,015</strong></td>
<td><strong>$248,900</strong></td>
<td><strong>$166,800</strong></td>
<td><strong>$7 average</strong></td>
</tr>
<tr>
<td><strong>3) Hybrid:</strong> Universal mobility pass with mandatory $30 employee contribution and 3 free parking days per month</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Similar ridership to Scenario 2, with PHS costs partially shifted to employee</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,015</strong></td>
<td><strong>$248,900</strong></td>
<td><strong>$104,700¹¹</strong></td>
<td><strong>$33² average</strong></td>
</tr>
</tbody>
</table>

1 PHS saves 7.65% through payroll tax deductions.
2 Commuters purchasing a pass through PHS save approximately 30% through income tax deductions.
3 Weighted average of commuter rail, ferry and express bus monthly fares.
4 Number of staff who do not purchase a monthly MBTA pass but reported at least one day of transit use in a week-long commuting diary as part of the 2017 survey.
5 Pay-per-use ridership among these 630 employees was estimated at 6.8 trips per week based on the commuting diary in the 2017 survey.
6 Interestingly, the pay-per-use riders accrue a higher average bill than the typical Link Pass rider. This is partially due to the lack of tax benefit.
7 Based on an average use of $55/month among current Link Pass holders.
8 Current commuter rail, express bus and boat pass holders would be excluded from the universal pass as these passes include unlimited local bus and subway use.
9 A 10% increase in ridership among former pay-per-use riders is estimated.
10 Based on the MIT case study, we estimate a 10% of staff will become new transit riders, half of whom will use the service on a regular basis. Regular ridership is estimated at $55/month while occasional ridership is $18/month, based on MIT employee behavior.
11 The cost to PHS decreases due to a $104,000/month contribution from employee fees but is partially offset by a $42,000 reduction in monthly parking revenue.

Table 6.5: Scenarios of MBTA transit benefits offered to employees by PHS, including (1) existing benefits, (2) a universal pass, and (3) a hybrid structure.
The analysis showed significant changes to PHS employee commuting patterns when ten workplaces were consolidated to a single, transit-accessible campus. The heterogeneity of changes, however, suggests a breadth of contributing factors. Intuition tells us that commuters transitioning from a non-transit-accessible location to a transit-adjacent site will undoubtedly increase their use of public transit, but the magnitude of the increase surprised the researchers. The six hundred commuters formerly at the Wellesley and Needham sites had transit mode shares of 5% and 0%, respectively. After the move to Assembly Row, these increased to 27% and 32%. Given the immediacy of the changes, this dramatic increase cannot be attributed to employees moving their place of residence to more transit-accessible areas. Rather, it reflects a widespread latent demand for public transit that is only realized when such a commute becomes feasible. Of course, a longer drive also likely led some commuters to explore alternatives (a push rather than pull), though the increases in median driving time were generally not excessive.

Figure 6-15 highlights the differences in transit accessibility between Assembly Row and two prior sites, Wellesley and Prudential. Figure 6-15(a) indicates that most employees living in central Boston and inner suburbs are well served by transit to Assembly. In contrast, (b) shows that the Wellesley site is accessible to only a small area of Newton (with a hostile pedestrian environment to access the nearest MBTA Green Line station). Finally, (c) shows the even greater reach of the Prudential Location, which covers almost all of the Assembly Row and Wellesley commuter shed plus more areas to the south and west of the city.

Employees whose driving times increased upon relocation were usually more likely to use transit, and vice versa. However, at the two largest former worksites—Schrafft’s and One Constitution Center (OCC)—this pattern did not hold. Among former Schrafft’s and OCC commuters, SOV mode share dropped four to five points after the move despite a slight drop in median drive time. While transit travel time dropped in similar proportions, it should be noted that the length and pleasantness of the walk from the transit station to the office improved substantially. For example, at Schrafft’s, the walk from Sullivan Square Station to the office involved crossing a series of highway-like intersections, while at the new Assembly Row station, transit commuters are welcomed by a station headhouse directly adjacent to their office with clearly demarcated crosswalks and a human-scale design (see Figure 6-16). Similarly, the fifteen-minute walk from North Station to OCC had required crossing the Charles River and walking along major streets. Schrafft’s employees formerly had free parking, so the drop in SOV mode share is relatively predictable, but parking costs among OCC staff have decreased, making the drop in SOV mode share more remarkable.

The analysis also shows that PHS employees do not tend to be single-mode commuters. Approximately 44% of survey respondents reported a secondary mode prior to the move, and 49% now report one. Beyond the survey respondents, the actual parking and transit records indicate that many commuters make use of both their parking pass and a subsidized MBTA pass, with 53% of transit pass purchasers also holding a parking permit. Including the employees who use a personal CharlieCard, this proportion is likely even higher.
Figure 6-15: Isochrones indicating areas accessible within one hour by MBTA transit (walk access). (a) shows current accessibility at Assembly Row, while (b) indicates the limited accessibility of the prior Wellesley site and (c) indicates the broader accessibility of the Prudential Center sites, especially to the south and west of downtown. Source: Conveyal Commute.
Contributors to Behavior Change

In the discussion of employer benefits, TDM strategies and nudges, it is important to note that the most significant predictor of transit usage is, intuitively, proximity to high-quality transit. The decision by PHS to relocate at an MBTA rapid transit station, and contribute to the construction of a station entrance directly adjacent to its office, was a key
decision that helped achieve a reduction in average driving rates among employees at five of the ten prior worksites. (The employees who increased their rate of driving moved from even more transit-accessible locations, as downtown offices are more centrally accessible.) Access to transit matters, but so does perception of access to transit. As discussed above, having the transit station placed so prominently and in a pedestrian-oriented scale makes a clear urban design statement that PHS is a transit-oriented employer.

Alongside physical access, financial access to transit also plays an important role in increasing ridership. Survey results showed that the increased subsidy of 50% for all monthly MBTA passes was very important to transit riders (and moderately so for drivers), and the increase from a 30% subsidy means that a monthly pass is more economical than cash fares for an additional 400 employees. Those who use public transit for commute trips tend to be more likely to also use it for other discretionary travel, so these enhanced benefits are likely contributing to a more sustainable, lower-carbon and active lifestyle among many more PHS staff.

Drivers clearly saw the benefits of daily parking pricing. While the MIT case study (Chapter 4) found mixed results, the replacement of monthly passes with pay-as-you-park pricing at PHS was well-received among drivers, with SOV commuters rating this policy change as very influential. The parking rates tied to income effectively address equity, and the weekly paycheck deduction ensures that the costs remain relatively salient and the behavioral feedback loop is thus short (e.g. unlike a monthly statement).

Analysis of commuter attributes indicated some important results. On average, employees with longer driving commute times tend to be more likely to take transit, even if the transit travel times are also long. Prior research suggests this may relate to commuters’ desire to use their travel time productively and avoid the stress of driving (Mokhtarian & Salomon, 2001). Intuitively, older staff (55+) reduced their parking more than younger staff (under 35), and they had a lower SOV mode share to begin with.

Finally, the findings point to the importance of pricing in managing the demand for parking. While a number of factors contribute to one’s decision to drive to work, it should not be overlooked that those paying $8/day to park do so 40% less often than those paying $4/day. A key policy takeaway is an common sense one: economic incentives to shift behavior are powerful motivators.

**Lessons Learned for PHS and Other Employers**

There are a number of take-aways from this study into PHS commuting patterns for PHS management, other employers, and the TDM research community. First and foremost, this research is yet another confirmation that the myth of the single-mode commuter (Block-Schachter, 2009) is, indeed, a myth. Commuters to Assembly Row, spoiled by accessibility from an adjacent subway line and freeway, are decidedly multimodal. It therefore makes clear sense that an employer should offer transportation benefits that align with employees’ revealed preference for a choice of commuting options (including work-from-home and flexible schedules). PHS administration, aware that Somerville’s parking maximums would not permit enough parking for all employees who might request a space (especially if they were offered one for free), took prudent steps to manage travel demand through its adoption of daily parking pricing tied to income, 50% transit subsidies offered to all employees (instead of excluding parkers as per the former policy), flexible hours, encouragement of
off-site work, and a working relationship with the City of Somerville and the MBTA that facilitated a transit-oriented location.

Acknowledging the uncertainty of parking demand, PHS took two further steps to ensure success of its TDM efforts: first, it notified drivers that parking rates would increase if demand rose beyond supply, thereby hedging against possible future parking shortages. Second, it secured off-site parking for cost-sensitive drivers. The fact that the A.R. Garage has yet to approach capacity, and that the off-site garage is sparsely used, points to the success of TDM efforts by PHS and an exemplar for other employers.

It is important to discuss employee wellbeing and satisfaction in the context of TDM programs, as a heavy-handed policy risks achieving the above outcomes at the cost of employee recruitment, satisfaction and retention. The survey found that the majority of commuters are satisfied with the transportation services offered by PHS, with only 8% reporting dissatisfaction. Even among the staff who formerly had free parking, and are now charged $4 to $10 each day they drive to work, only 9% reported dissatisfaction. This indicates that parking pricing need not be the third rail of TDM has it is sometimes perceived to be, and that given a series of ‘carrot’ incentives like transit accessibility and multimodal benefits, a ‘stick’ comprising of paid parking will not be resented by employees.9

Building on its progress, PHS could take steps to improve its commuting benefits to bring down the SOV mode share below 50%. As discussed in Section 6.2.5, adopting a universal transit pass with a partial, or even full, subsidy would make financial sense given the willingness of the MBTA to offer a pass product billed on a pay-per-use basis, similar to the arrangement piloted with MIT. Even if the cost to PHS ends up slightly higher than the current subsidy of monthly passes, future savings will likely arise from a reduction in parking needed (e.g. the elimination of off-site parking) as well as more intangible aspects like long-term employee retention, important given the significant expense of recruitment and training. Beyond transit, enhancing carpool programs through the use of an web-based matching service (like the AccessMyCommute dashboard adopted by MIT) and incentive programs could help increase the marginal carpool mode share.

6.4 Conclusion

This study was a unique opportunity to evaluate how stimuli in the form of workplace relocation and employer benefit enhancements can influence commuter travel behavior at a large urban workplace. The research found that while prior habit plays a role in predicting future behavior, there exists a significant latent demand for alternatives to SOV commuting that is only realized when transit becomes perceived as accessible and cost-effective when compared to car travel. The study suggests that a switch from monthly to daily parking charges is an effective way to encourage multimodality, and that adoption of

9A cautionary tale: The Assembly Row garage is shared between PHS employees and public parking for nearby commercial outlets. The daily rate for commercial parking is currently cheaper than that for high-income PHS employees, and enforcement is required to ensure that employees park in the PHS section of the garage, as per the agreement between PHS and the parking garage owner. This offers a reminder of the limitations of employer-based or site-based TDM strategies compared to neighborhood or regional scale initiatives.
a universal transit benefit would further increase transit ridership.

Future research could delve into the specific causal mechanisms of behavior change. In this project, the workplace relocation occurring simultaneous to enhanced transportation benefits somewhat confounds the ability to differentiate among effects of accessibility and monetary factors. Nonetheless, this chapter highlighted the malleability of travel behavior, and serves to bolster the case that the geographical place of work and employer benefits are crucial factors in influencing commuter travel patterns.
Chapter 7

Conclusion

This research seeks to develop a deeper understanding of effective workplace-based strategies to reduce drive-alone commuting, framed around three main objectives.

The first objective is to evaluate the impacts of novel travel demand management (TDM) strategies at two major urban employers in the Boston area. The second is to develop and test a series of experimental interventions to inform the design of future TDM strategies that can further the reach of traditional measures such as parking pricing and transit benefits. Third, building off the first to objectives, the research seeks to put forth a series of recommendations for policy-makers, transit agencies and employers on how to reduce car commuting using demand-side strategies informed by behavioral science.

The research is motivated by a series of often-aligned and sometimes conflicting interests of several key stakeholders: the commuter, the employer, the transit agency and society at large.

- **The commuter** seeks an easier commute, involving less time and money spent traveling. Quality of life is an overarching interest.

- **The employer** seeks to maximize their objective of profit (private sector), academic output and prominence (university), et cetera. This requires them to attract and retain employees and minimize costs.

- **The transit agency** is ideally looking to grow ridership and provide better service to its community. These two objectives often form a positive feedback loop where ridership growth can justify service expansion and vice versa.

- **Society at large**, which can be framed as either the general population or the public sector that governs it, seeks accessibility to opportunity, and mitigation of the negative externalities of mobility such as congestion and pollution.

This research considers these interests in concert with each other, and attempts to reconcile them when they appear to conflict. For example, a typical employer does not have a vested interest in trying to influence the travel behavior of each commuter per se, and
may object to the transit agency or local government imposing commuting benefits or mode share requirements. However, as shown in this study, the ever-growing costs of providing parking and attracting employees can necessitate a shift towards transit, and a full cost-benefit analysis of transportation policies and infrastructure (incorporating the hidden costs of parking) can make a compelling case for improved transit benefits.

With these motivations in mind, this chapter summarizes the main contributions of the research. Section 7.1 presents the key findings of the evaluation of TDM efforts at MIT and Partners HealthCare System (PHS). Section 7.1.5 explores the interests and values of the stakeholders engaged in this research. Section 7.2 puts forth a series of recommendations based on the research. Finally, Section 7.3 discusses areas of future research.

7.1 Overview

7.1.1 Summary of Interventions

MIT: The administration launched a program of commuting benefits reforms, branded as AccessMIT, which aimed to promote flexible, affordable and low-carbon transportation options for its ten thousand employees. It involved five main interventions:

1. **A free universal bus and subway transit pass** provided to all benefits-eligible staff, integrated on their employee ID badge, paid for by MIT on a per-trip basis via a monthly bill from the MBTA.

2. **Daily parking pricing** instead of annual permits, to remove the sunk cost of parking and promote daily flexibility.

3. **An increased commuter rail monthly pass subsidy** from 50% to 60% to encourage ridership.

4. **A new 50% parking subsidy at transit stations** to encourage drivers to park at an MBTA transit station and ride transit for the last portion of their trip to campus.

5. **An online commuter dashboard** called *AccessMyCommute*, which provides a multi-modal trip planner, carpool partner matching, and incentives for sustainable commuting.

These interventions were introduced in September 2016 on top of existing commuter benefit programs which include car-sharing and bike-sharing subsidies, an emergency ride home program, bicycle facilities, local shuttles and others. MIT’s objective was to reduce parking demand on campus by ten percent over two years.

In the spring of 2017, the MIT Transit Lab conducted a randomized controlled trial on two thousand of the Institute’s most frequent employee parkers to investigate how behavioral ‘nudges’ like targeted information provision and financial incentives could further en-
encourage drivers to use alternative modes of transportation. The results of this experiment are evaluated alongside the MIT-wide benefits reforms.

**Partners HealthCare:** The administrative headquarters of PHS was consolidated from a group of offices scattered across Greater Boston to a single worksite at Assembly Row in Somerville, MA. This new location is the site of a newly opened MBTA Orange Line station, opened to serve this and nearby developments. In the midst of employee relocation, PHS introduced several enhancements to its commuter benefits. These included:

1. **New parking pricing** that offers on-site parking with daily rates tied to employee income as well as the option of an off-site discount lot at a monthly rate.

2. **Increased transit subsidies** from 30% to 50% for all MBTA monthly passes including local transit and commuter rail, with expanded eligibility to all staff instead of non-parkers only.

3. **A shuttle network** providing employee access to other Partners sites across the region.

4. **Flexible work hours and telecommuting** options to encourage employees to work remotely and commute at off-peak hours.

### 7.1.2 Evaluation Strategy

In assessing the impacts of the aforementioned TDM programs, this study considers their efficacy from five perspectives as outlined in ICF & CUTR (2005): (1) program awareness; (2) participation; (3) behavior change; (4) transit agency impacts; and (5) regional impacts. Behavior change is the focus of the work, and centers around mode shifts and reductions in parking demand.

In the MIT case study, stated shifts in attitudes and travel behavior are elicited from a biennial campus-wide transportation survey. This is supplemented with passive data collection through gated parking lots and employee ID-embedded transit passes. For the RCT experiment, an exit survey is used alongside these data sources to build an understanding of participant responses.

At PHS, a similar combination of survey responses (after relocation) alongside passive travel data (through parking and transit records) provides a snapshot of how commuters adapted to the office consolidation and benefits improvements.

In both case studies, quantitative shifts in travel patterns are explored alongside the qualitative aspects of stakeholder perceptions and institutional challenges.

### 7.1.3 Key Findings

The first main take-away of this thesis is that travel behavior is highly malleable; TDM initiatives were shown to have an appreciable impact on commuter travel choices.
MIT

Overall, the AccessMIT program was generally successful at achieving a reduction in employee parking demand on campus, and doing so without hurting employee satisfaction. Looking back at the last decade of survey data (in which drive-alone mode share held constant around 30% from 2008 through 2014), employees exhibited a remarkable drop in single-occupancy vehicle (SOV) mode share after the program was launched. The 2016 survey found that only a quarter of staff now drive alone to work, a 41% drop since 2004. The 2016 survey was the first to ask about secondary modes as well, and found that the majority of commuters used multiple means of commuting, in line with the intended design of AccessMIT. Among parking permit holders in particular, 73% of them used a different mode at least one day during the 2016 survey week.

Commuter attitudes towards the program indicated a widespread increase in satisfaction, as the proportion of employees satisfied with MIT’s transportation services increased from 76% to 84%. The majority of staff reported that the new benefits influenced their commute, with the zero-cost transit pass listed as most influential, followed by the parking subsidy at transit stations. Daily parking pricing was not ranked as important, though this may be attributable to weaker dissemination of this policy and a lack of understanding of its benefit.

From the perspective of MIT Campus Planning, the aggregate statistics paint a picture of widespread change in travel habits that may reduce the need for future parking infrastructure rehabilitation and replacement. The number of daily parking permits sold (which cost an upfront fee of $100 plus $10 per day) dropped 5% in the first year and another 8% through most of the second year, while staff parking transactions declined 8% in the first year.

Across MIT’s gated parking lots, which comprise three quarters of parking supply on campus, peak demand dropped 2% in the first year and an additional 8% in the first eight months of the second year, potentially indicating a lagged effect of the program on parking demand. Survey responses and anecdotal evidence from transportation benefits administrators affirmed that awareness of the program and its benefits grew in the second year, with more employees electing to switch from non-gated to gated lots to save money through the daily parking permit.

Transit usage increased significantly, with 24% more staff using the MBTA bus or subway service on a regular basis (at least 2 workdays per week). Active pass usage rose an additional 4% in the second year.

After AccessMIT was implemented, an experiment was conducted on two thousand of MIT’s most frequent staff parkers. In a randomized controlled trial, targeted nudges of information and cash rewards were tested to see whether they could further reduce parking demand among these employees. Broken into four groups of 500 staff each, one group received six weeks of ‘Commuter Digest’ email messages with tips on how to make the most of AccessMIT; a second group received weekly monetary rewards proportional to any reduction in parking recorded over the week prior; a third group received a combination of digest emails with monetary rewards; and a fourth group served as a control with no intervention. While no significant reduction in parking was observed across each treatment group as a whole, the combination treatment had the highest proportion of top-
performing participants. A post-experiment survey indicated a widespread increase in awareness of MIT’s commuter benefits, and indicated a larger stated mode shift than was supported by passively-collected parking data. Survey results suggested that while intent to reduce car use existed, complaints of insufficient transit service quality and the relative convenience of driving kept many commuters in their cars.

**Partners HealthCare**

Fourteen worksites were relocated to one centralized, transit-accessible location on the fringe of the urban core and northern end of the MBTA’s Orange Line. This move, combined with enhanced commuter benefits, led to shifts in travel behavior that emphasize the importance of both workplace accessibility and employee benefits. Because some of the prior locations were in downtown Boston while others were on the suburban periphery, the net change in proportion of SOV commuters after the move to Assembly Row was insignificant; former downtown commuters began using their cars more often while suburban workers elected to begin taking transit. However, average reported parking frequency dropped 12% from 2.32 to 2.06 days per week, as reported by a post-relocation employee survey.

One of the most remarkable findings was the sheer magnitude of the mode shifts that occurred. For example, workers relocating from the Wellesley and Needham sites (both distant from downtown and poorly accessible via transit) exhibited an increase in transit mode share from practically zero to almost 40% shortly after relocation.

Employees were asked about reasons why they did or did not modify their commuting methods upon moving to Assembly Row. For those who now take transit to work, the new office-adjacent Orange Line station and the subsidy of 50% for MBTA passes ranked as the most influential factors.

For the average commuter, and especially drivers, the switch to daily pay-as-you-park pricing was deemed the most important factor influencing commuting choices. Like at MIT, the rationale behind this policy was to unlock the sunk cost of monthly parking passes and allow commuters to make use of multiple commuting options on any given day without feeling ‘locked in’ to one mode.

This strategy makes sense when considering that the average PHS employee only parks six days per month, and even among those identify as SOV commuters, the average on-site parking frequency is eleven days per month, or slightly more than once every other workday.

Where PHS differs most significantly from MIT’s benefits reforms is its lack of a universal transit pass. PHS commuters must commit to a monthly pass to receive any employer transit subsidy (and tax incentive), even though 22% of pass-purchasing employees do not use their pass enough to make it financially advantageous over single fare payments. Passholders are benefiting from the daily parking pricing, especially given that 15% of them park at least once a week and might reasonably have purchased a monthly parking permit if it were the only option.

PHS also differs from MIT’s parking reforms in that it now offers daily parking rates pegged to employee incomes, in four tiers of $4, $6, $8 and $10 per day, in an effort to advance
equity. A comparison of parking frequency across these tiers shows that for those earning a salary of less than $125,000, parking rates exhibit a strong negative correlation with parking frequency. In other words, the price elasticity of parking demand is significant for low and moderate-income workers. While $4-a-day parkers were hypothesized to live further away and less accessible to transit, the relationship holds even after controlling for these variables.

Most importantly, eliminating free parking was found to be paramount in achieving a reduced SOV mode share. Employees relocating from the offices with free parking showed by far the largest drop in drive-alone rates, corroborating established research that reinforces the role of parking pricing.

7.1.4 Cross-Cutting Themes

Based on the results of interventions at MIT and Partners HealthCare, and further informed by a research experiment nudging commuters away from drive-alone commuting, three main take-aways are summarized below.

1. It’s About Classical Economics...
When employers strategically price commuting options, they can achieve dramatic shifts in employee travel behavior that correct for market failures of seemingly underpriced driving and overpriced alternatives, and can do so without a staff revolt nor excessive expenditures.

In both the MIT and PHS case studies, basic economic incentives proved powerful at managing parking demand and promoting transit ridership. MIT’s universal transit pass has become a popular and well-utilized benefit, and is paid for in the long-term by a reduction in massive capital expenditures that would have been required for new parking facilities (not to mention the more intangible savings associated with employee retention due to competitive benefits). At Partners, eliminating free parking and enhancing transit benefits upon worksite consolidation helped coax many drivers to use alternate modes, and the implementation of daily parking pricing tied to income helped to mitigate the punitive perception of charging for parking.

Despite a focus in this research on principles of behavioral economics (e.g. nudging commuters using social norms, gamification and various mental heuristics), it appears the rational *homo economicus* is not so bad at making short-term decisions based on cost minimization. It remains to be seen how long-term decisions, such as car ownership and residential relocation, are influenced by transportation benefit pricing, but we hypothesize that transit subsidies and parking pricing closer to its true cost will lead to reductions in car use and a trend towards home location choices that foster more diverse travel options.

2. ...But Behavioral Economics Plays an Important Role Too
Although transportation pricing clearly plays a primary role in individual travel behavior, this research found that theories of behavioral science can indeed help leverage the most out of a TDM program, helping to shape both traveler attitudes and behavior more than through monetary interventions alone.
Most significantly, the principle of cost salience cannot be overemphasized. Making the cost of driving noticeable, easy to understand, and frequently front-of-mind to commuters can help them appreciate how much driving costs to themselves and to society (in the form of congestion and pollution externalities). Further, showing employees what an employer spends to subsidize parking can help build support, or at least empathy, for parking charges and TDM initiatives.

Beyond the commuter, making transportation costs more salient is also important for the employer themselves. TDM strategies will never be implemented if the only champion for the policies is a parking operations director, HR staff or facilities manager; a constituency of support must be cultivated among senior leadership at an employer, and the best way to achieve this constituency is by showing how much the employer spends on aspects like parking provision, employee work time lost to traffic congestion, and recruitment expenses associated with losing staff due to difficult commutes. Parking subsidies are often deeply hidden within workplace budgets, and bringing them to the forefront of policy discussions can make the case that the cost of a 100% transit subsidy for employees is dwarfed by that of a single parking garage construction project.

3. There’s No One-Size-Fits-All TDM Program

Finally, while the demand management strategies employed at MIT and Partners were generally effective at these workplaces, it must be stressed that an effective employer-based TDM program is one that fits the geographic context, administrative structure and culture of the workplace.

First and foremost, geographic location plays an important role in determining what set of TDM measures make sense. A highly transit-accessible workplace can pursue the ‘stick’ of aggressive parking restrictions or pricing strategies alongside the ‘carrot’ of subsidized transit. Strategies can even transcend the traditional TDM toolkit, for example with some universities investing in housing for students and junior faculty with the purpose of shortening their commute. For workplaces outside the core service area of traditional public transit, strategies may focus instead on carpooling incentives to increase average vehicle occupancy, and may use technology platforms to provide carpool matching with priority parking spaces for these commuters. Programs like flexible scheduling and telecommuting provisions can be effective at workplaces regardless of geographic location.

Second, the administrative structure of the workplace is an important variable to consider. There need to be advocates for TDM policies within the management team, even if aspects of day-to-day program management are contracted out to third parties (such as in MIT’s partnership with RideAmigos for an online commuter dashboard). Workplace stakeholders who need to be involved in program operations may include a parking & transportation office, human resources, payroll and accounting, facilities management, planning, information technology, senior leadership, and potentially others. Each stakeholder has its own interests, and aligning these to achieve successful TDM can be a challenge. Further, the composition of parking assets—especially the distinction between owned and leased parking spaces—can influence how short and long-term reductions in parking demand can impact the employer’s bottom line.

Finally, the famous management consultant Peter Drucker once said “culture eats strategy for breakfast”. The success of TDM strategies is predicated on workplace culture, with
the wrong set of incentives (or those poorly communicated) liable to alienate employees. At MIT, the AccessMIT program was designed to appeal to a broad base of staff by being framed around the triad of flexibility, affordability and sustainability. Survey results showed that these elements clearly motivated different segments of the MIT community. For example, flexibility appealed to staff with young children and others who needed their car some days, but could take transit on others. Affordability appealed broadly to cost-sensitive commuters. And sustainability is central to much of the research being output at MIT, so it appeals to the eco-conscious segment of the community.

In all, workplaces can develop TDM strategies with the assurance that, as long as classical and behavioral economic strategies are accounted for, and as long as the program is sufficiently context-sensitive, program goals can be achieved. The following section outlines recommendations based on the above findings.

### 7.1.5 Motivating the Stakeholders

The prior chapter explored how commuter mode shift away from driving can be achieved in the midst of a change of job location and an enhancement of transportation benefits. The study focused on individual employees’ likelihood of mode shift. It is important to recognize, however, that the employee is only one of the stakeholders being motivated to change behavior. The broader challenge is to motivate employers to recognize the benefits of taking measures to reduce SOV mode share, and to motivate government entities like transit agencies to adopt policies that facilitate this. While private sector goals may center around reducing parking requirements, minimizing costs and maximizing employee satisfaction, overarching public sector objectives relate more towards reducing congestion and pollution and improving quality of life.

**The Traveler**

The individual traveler, the central actor in this thesis, is a semi-rational agent whose behavior depends on intrinsic preferences and external stimuli. In encouraging mode shift from driving towards transit, the low-hanging fruit are typically those who do not have the option of driving (so-called ‘captive’ transit riders), and those whose commutes are significantly shorter and cheaper using transit. These individuals have usually already made the decision to use transit, and thus the focus turns towards choice riders who may need additional incentives.

One of the fundamental challenges is the tragedy of the commons. Here, road space is the commons, and it is rendered congested due to overuse. Hypothetically, if every *other* commuter used transit, a lone driver’s commute would be in idyllic free-flow conditions. Unfortunately, because every driver shares the same mentality, the road network regresses to a congested user equilibrium wherein no single driver can shift routes to improve their commute time without delaying another driver.

A solution can be the use of economic incentives—such as tax benefits, employer perks, and congestion charging—that serve to internalize the otherwise unaccounted externality imposed by driving. Non-economic factors, using tenets of behavioral science like invoking social norms, re-framing choices, and emphasizing cost saliency, can help stretch (or re-
place) economic incentives. Additionally, regulatory measures such as road use restrictions (e.g. limiting when vehicles can be on the roads) can play an important role.

Many of the aforementioned approaches rely on taking an aggregate approach beyond individual travelers, and as such it may be more efficient to consider how we motivate employers and policy-makers to consider such measures.

The Employer
The employer needs to be convinced that it is in their best interest to encourage alternative commuting modes amongst employees. In Partners’ downtown offices, the case is easily made where the market rate for parking is so high that it makes intuitive fiscal sense to not offer free or subsidized parking, and instead promote and subsidize transit. On the other extreme, in office parks on the suburban fringe, there exists little to no incentive to reduce what may be close to a 100% SOV mode share.

Many employers are in some sort of middle ground, located in moderately dense and accessible locations, but with a present-day SOV mode share high enough to require significant investment in parking. At these employers, there may be a wide range of attitudes and approaches to managing commuter mode choice. The overarching trend is that to attract a younger, city-dwelling workforce, employers are putting increasing consideration on transit-oriented locations, a departure from past decades in which inexpensive office space pushed many companies to the outer fringes of the city (Logan, 2018).

The employer needs to be convinced that (a) pricing and/or restricting parking will not lead to a staff revolt, and that (b) the economics are in their favor.

On the former, there is a ubiquitous fear associated about having an undersupply of parking. If an employer has long offered free and abundant parking, a culture around driving can lead toward resistance to policy measures that seek to restrict car use. Nonetheless, travel behavior is remarkably pliable, especially when opportunities to break habits are presented (e.g. in the case of home or work relocation) (Bamberg, 2006). If a commuter benefits package is provided to employees that places choice at the core of its philosophy, then employees should be more likely to accept it. For example, increasing parking pricing alone will likely be ill-received. But if paired with a zero marginal-cost transit pass and other benefits that unlock single-mode commuters to benefit from being more multimodal, the MIT case study showed that such resentment can be mostly averted. In the best case scenario, employees would shift modes of their own volition, rather than feel compelled to switch due to pressure from an employer. Both the MIT and PHS case studies indicate, through reports of high employee satisfaction, that commuters are accepting and supportive of their commuting options.

On the latter—the economics of incentivizing alternatives to driving—the life cycle costs of building, maintaining and operating parking facilities may be evidence enough that it is in an employer’s best interest to reduce parking demand. These costs, however, are typically quite hidden and diffused over long time periods, making it difficult to benchmark

1Nonetheless, care must be taken to ensure that salient reductions in parking supply, like observed with the West Garage closure at MIT, are carefully managed from a public relations standpoint. Despite sufficient parking supply after the closure, a number of support staff circulated a complaint letter arguing that parking rates had risen unfairly and that the lot closure would adversely impact many commuters.
against the very salient and short-term costs of subsidizing transit on a month-to-month basis. Much as the relative salience of transit fares over driving costs perversely encourages individuals to drive, the same salience gap exists for employers. The other challenge is that parking investments are long-term and stepwise (either a garage is built or it isn’t), so a 30-year time horizon can be difficult to plan for. In a risk-averse effort to mitigate the chance of parking under-supply, marginally needed lots may be built more often than they should. One clear opportunity for cost savings at PHS is the elimination of parking at the off-site Station Landing location, given the $16,000 per month lease of 150 spaces which do not appear to all be used2.

Another key aspect for employers is about equity. Typically, parking subsidies are much higher than transit subsidies, and the most senior employees tend to have the best parking benefits (Block-Schachter, 2009). Non-drivers end up subsidizing the parking expense of drivers, when the equitable scenario would be the inverse (to account for the externalities described earlier). From this perspective, the argument for increased transit benefits is to level the playing field for all employees.

Finally, in an effort to attract and retain top talent, employers must offer attractive compensation and culture. Around commuting, it would be remiss to neglect the societal trend of younger people exhibiting lower rates of car ownership and an increased propensity for urban lifestyles (N. C. McDonald, 2015). Given these trends, many workplaces are prioritizing more central and/or transit-accessible locations. For sites located in more distant suburban locations without attractive non-car commuting options, the intangible opportunity costs of lost talent should be considered against the savings associated with cheap land and ‘free’ parking (Shoup, 2005; Logan, 2018).

The Public Agency

Beyond the commuter and the workplace, the third key stakeholder in need of motivation is the policy-maker, be it the transit agency, city government, metropolitan planning organization, IRS, etc. For the transit agency, the primary motivator is the prospect of increased ridership and revenue. Public transit agencies across the country are facing declines in ridership and revenue. Public transit agencies across the country are facing declines in ridership, and are looking at novel ways of encouraging higher patronage. A corporate pass program, like that currently offered by the MBTA, can encourage employers to enroll with the benefit of tax savings. Today, the corporate pass program brings in almost a third of all MBTA revenue, and is responsible for 55% of all monthly pass sales (Stuntz, 2018).

But as discussed earlier, restricting employer transit benefits to monthly passes limits the attractiveness of such fare products to part-time or occasional transit users. Transit agencies are risk-averse, and often prefer the regularity of pass income over the risk of undulations associated with pay-per-use fare agreements like that arranged with MIT. From a budgeting perspective, a fixed pass price is preferable. As such, the key to motivating transit agencies to adopt new employer fare products is to demonstrate a clear value proposition. Block-Schachter (2009) proposed that a universal pass program can be de-

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2 Additionally, it should be noted that the $16,000 per month lease does not incorporate any bulk discount. Any commuter can purchase a $105 monthly parking pass at Station Landing public parking, or choose to pay $3 to $10 to park each day. One option to reduce costs is for PHS to subsidize daily parking in the public section (e.g. reimbursing parking receipts), thereby harmonizing all parking options to pay-per-day.
signed whereby instead of selling a standard monthly pass to 30% of workers, a pass can be provided to 100% of workers and the employer would simply pay what it used to cost for 30% to buy passes. Then, as ridership increases, the transit agency would negotiate commensurate increases in employer payments. Since the advent of electronic fare media, however, the precise payment can be calculated to remove the guesswork on employee usage. Employers could pass on the cost to employees in any way they see fit (e.g. from direct fare payments to complete subsidies, or anywhere in between). The end result is that the transit agency has hedged its risk of revenue loss, and the employer has offered a fare product that is attractive to all employees, including those who previously never or rarely used transit but may begin with the right nudges.

Thinking beyond the transit agency, municipal governments also have tremendous potential to influence commuter mode choice, using regulatory means to protect the ‘commons’ of public roads from overuse. While the broader topic is largely beyond the scope of this thesis, it should be mentioned that the Parking and Transportation Demand Management (PTDM) Ordinance in Cambridge, MA, has played an important role in reducing workplace SOV mode share across the city. The PTDM Ordinance, which stipulates mode share and maximum parking allowances, is an example of a policy largely mandating outcomes over process, leaving employers free to choose from a suite of PTDM measures to achieve required mode splits. Most cities lack legislation as progressive as the Cambridge PTDM Ordinance, and would benefit from its model.

7.2 Recommendations

General
It is recommended that workplaces eliminate annual and monthly parking permits in favor of daily parking rates, regardless of the employer’s drive-alone mode share, as this policy change has been shown to have an appreciable effect on reducing parking demand. Even if the net costs work out to be the same, paying per day increases the salience of the parking fees and unlocks the sunk cost to encourage commuters to consider a more multi-modal lifestyle.

Further, adoption of a universal transit pass, paid for either entirely or in part by the employer, is an effective intervention to promote transit usage. The agreement between MIT and the MBTA, in which MIT provides a fully subsidized pass to all employees but only pays for trips taken, is a model demonstrating that a pay-per-use arrangement can be financially advantageous for the employer without detracting from transit agency revenues.

Additionally, incorporating softer elements like commuter incentives and gamification can extend the reach of aforementioned TDM programs, helping to ‘soften the blow’ of reduced parking availability and foster a voluntary shift in travel behavior.

Recommendations for MIT
MIT has seen early success in its effort to reduce parking demand on campus, but must be prudent to ensure that its program continues to work after the novelty wears off, and that drivers feel supported by the TDM initiatives, rather than alienated or punished.
One recommendation is to be more deliberate in developing and tracking specific metrics of program success. The stated goal of AccessMIT was to reduce parking demand by 10% over two years, but said nothing of how parking demand was defined, nor did it set targets for other criteria such as transit usage and employee satisfaction. Going forward, a set of multi-faceted objectives, with unambiguous metrics of success, should be adopted as the evaluation continues.

On program design, MIT should consider ways to assist commuters who feel unduly burdened by transportation costs. While a free transit pass greatly advanced the goal of commuter equity, low-income staff who drive to work have faced 11% annual price increases in parking for over a decade. Implementation of daily parking rates proportional to income, like Partners HealthCare has introduced, may help in this regard. However, simply reducing the cost of parking for some staff would likely lead to a reversal of the parking reductions observed to date. To avoid this, high-income staff would likely need to incur an increase in rates, and the political feasibility of such a rate increase is perhaps difficult. Future MIT transportation surveys could help elicit potential behavioral responses in such scenarios.

MIT should also enhance its offerings for current and prospective carpoolers. Today, ‘full-time’ carpoolers are eligible to receive a half-price annual permit (unlike most other parkers, who have been switched to daily parking), and would benefit from a more flexible program where any drivers sharing rides instead receive discounted daily parking. The AccessMyCommute dashboard has been well-received for its carpool partner matching service, but uptake of the website (not currently mobile-compatible) remains very small. Improved promotion of a revamped carpool incentive, including the use of a mobile app, may help reverse the decline in carpool rates observed over many years.

Other tweaks in the AccessMIT program could help increase its effectiveness. For example, right now the annual cap on daily parking fees means that frequent parkers who hit the cap at some point through the year have no more incentive to reduce their driving for the remainder of the year. Transitioning from an annual cap to a monthly cap would allow drivers who have to park frequently one month to remain incentivized to park less on all other months. Further, changing the way that parking costs are presented may help increase the salience of the parking fees. Right now, paycheck deductions for parking are relatively opaque as the bi-monthly pay cycle lags behind parking activity and no itemized breakdown of parking charges is provided. Clearly showing the number of days parked, with the opportunity for savings associated with daily fees, may help increase the effectiveness of this policy.

Finally, MIT should proactively plan for the future of the AccessMIT program after this research project concludes. A TDM program manager, working with the Parking & Transportation Office, the Office of Sustainability, Campus Planning and Facilities, should be hired to assure that someone at MIT is focused on the continued success of this program. Annual adjustments in parking fees should be tied to changes in employee travel behavior and Institute finances, rather than simply fixed percentage increases. Subtle shifts in culture should be encouraged through program communications, with changes such as renaming departmental ‘parking coordinators’ to ‘transportation coordinators’. And policy discussions at meetings of the MIT Parking & Transportation Committee (on which I
sat as a graduate student representative for two years) should remain grounded on data-driven analysis of campus transportation trends like that provided in this research.

**Recommendations for Partners HealthCare**

Parking pricing at PHS, which consists of income-scaled daily rates with no annual cap, is a best practice in TDM and should serve as a model for other employers. In other areas, however, PHS could consider improvements to its commuter benefits program to try and reduce its SOV mode share, which remains around 50% despite a transit-adjacent location.

Most importantly, PHS should consider adopting a universal transit pass program similar to that of MIT, in which it provides an unlimited-use local transit pass to all employees, but only pays the MBTA for actual trips taken. Right now, 37% of PHS employees purchase a monthly MBTA pass for local transit or commuter rail, and like MIT’s case study has shown, providing a pass to all employees can increase transit mode share and reduce parking demand, all the while incurring only modest expenditures by the employer under a pay-per-use agreement. If PHS is concerned with the additional cost of transit subsidies, a small mobility fee can be charged to all employees that partially supports the cost of a transit pass, while also providing a certain number of free parking days. This would appease both transit riders and drivers, building a widespread constituency of support.

With its 1,664 parking spaces operating at only 61% occupancy, PHS is clearly not facing a parking shortage at Assembly Row. It leased an additional 150 spaces off-site out of concern that parking demand would exceed A.R. Garage capacity, but this scenario never materialized. The off-site parking spaces at Station Landing are thus not needed, and ending this lease could help PHS reduce expenses, especially given that the employee shuttle to this garage (which runs every 10-20 minutes all day long) also could be discontinued.

Without a present-day parking shortage, the broader question may be raised: why even bother with transit benefits? There remain many reasons. Beyond the impact on commuter wellbeing, environmental sustainability and employer competitiveness, the financial argument remains that freeing up parking spaces can help PHS save money (as spaces can be converted for commercial use). In the long-run, the above-ground garage will not need to be rebuilt, and land currently used for parking can be put to more productive uses.

A broader lesson learned is that TDM program design should be context-sensitive to not only a workplace, but to the surrounding neighborhood. A case in point is that daily parking rate in the PHS garage is currently cheaper in the commercial section (for patrons of adjacent businesses) than it is for high-income staff in the employee section. The recommendation is not to reduce parking costs for staff, but rather to engage with other stakeholders at the Assembly Row development to try and harmonize parking prices such that employees do not pay more than those parking in public use commercial lots.

**Recommendations to Policy-Makers**

While this research focused on the workplace as the main point of TDM intervention, the research highlights the importance of local, regional, state and federal governments in creating transportation policy that furthers or hinders TDM objectives.

As exposed in Transit Center (2017), the federal government currently pays Americans
to drive to work through federal income tax exclusion for parking. It currently costs taxpayers $7.3 billion per year, and is estimated to put almost a million additional car commuters on our roads. The federal government should end the commuter parking benefit, and consider adopting models like that of Ireland, Australia, Sweden or Austria, which tax employer-provided parking.

On the transit side, eligibility rules for the tax exclusion on transit expenses should be expanded beyond those employed at workplaces offering transit benefits. Workers who are self-employed, working in the ‘gig economy’, or at employers who don’t provide transit benefits should still be able to access the $260/month benefit. This would help level the playing field, and promote transit usage among a growing segment of the American workforce.

State and local governments should follow the lead of model legislation like the Commute Trip Reduction Law in Washington State and the Parking and TDM Ordinance in Cambridge, Massachusetts. These laws require employers to implement TDM measures to reduce the number of drive-alone commuters, and most importantly for researchers, they put in place a framework for mandatory data collection on employee travel behavior. Such datasets are crucial to track the effectiveness of workplace-based and regional programs and ensure that TDM initiatives remain grounded in solid evidence.

### 7.3 Future Research

While this research offers contributions to the travel demand management literature, the case studies raise a series of additional research questions worthy of future study.

First, it would be advantageous to conduct longer-term studies with longitudinal data to track the evolution of travel behavior in the presence (or lack) of TDM reforms. In MIT’s case, the next biennial survey occurring this fall presents a perfect opportunity to explore how existing commuters have re-adjusted their habits two years into the program, while observing how new staff have made use of their benefits. Future work should explore long-term behavior changes related to transportation such as household car ownership and residential location.

Second, future research should incorporate more employers, with the objective of capturing a greater breadth of geographic, cultural and policy contexts. Intrigued by the results of AccessMIT, various TDM professionals have reached out to ask whether MIT’s program would work at workplaces that have, say, a 90% SOV mode share (in contrast to MIT’s 30% share). While aspects of the program can generalize (such as the use of an online commuter dashboard with gamification), more research must be conducted to better inform how the program can be applied in other contexts.

Finally, with the rapidly evolving mobility technology and policy landscape, future research may look at different areas of focus within TDM. MIT recently changed its ‘Emergency Ride Home’ program to partner with transportation network companies (e.g., Uber and Lyft), and it remains to be seen how such partnerships will play out. App-based matching tools for carpooling may lower the barriers to casual carpooling, and may finally re-
verse the decades-long decline of this mode. Perhaps most importantly, the rise of the automated vehicle will likely have a transformative impact on TDM: if parking constraints no longer exist to motivate reductions in car use, the most influential tool in the toolkit of TDM practitioners will suddenly disappear. The impacts remain wildly unclear.
Appendix A

AccessMyCommute Incentive Programs

This Appendix summarizes the Fall 2016 Sustainable Commuting Contest (Referenced in section 3.3), an incentive program that was piloted prior to the randomized controlled trial experiment discussed in Chapter 5.

Contest Objective:

- Promote MIT’s rollout of new employee transportation benefits and encourage travel modes other than driving alone.
- Encourage logging of commutes using AccessMyCommute online dashboard.
- Increase usage of carpool partner matching service on AccessMyCommute.

Contest Overview:
The fall contest ran six weeks from November 1 through December 6, 2016. During this time, all MIT employees could collect points by tracking their commute on the AccessMyCommute dashboard. Drivers could log trips automatically through the parking lot in/out gate transactions, while transit riders would have their trips automatically uploaded to the dashboard. Other commuters could self-report their trips or use an app called Moves to report automatically.

At the end of the contest, employees could redeem their points for TechCash (a campus currency) or for lottery draws. Furthermore, a leaderboard of average points by department was used to encourage department-wide participation and friendly competition.

Communication Strategy:
Contest outreach included promotional materials online on Atlas (employee web portal), Campus News, Facilities, and Information Systems & Technology (IS&T) websites. Emails were the primary method of communication, and were sent out to staff as follows: Email #1: Sent at launch to all employees. Informed participants on how to access the dash-
board and track their commutes. Email #2: Sent during week four (of the six week contest) to all employees. Reminded participants about the contest, and informed them to redeem their points at the end. Email #3: Sent after the end of the contest announcing winners of contest.

**Carpool Promotion:**
One of the goals of the contest was to promote the carpool partner matching tool, part of the AccessMyCommute dashboard. A banner was added to the top of the website for users who had not yet opted into sharing their trip details:

![Carpool Promotion Banner](image1)

For users who had already filled out their “favorite trip” to enable carpool matching, the following banner was displayed:

![Carpool Promotion Banner](image2)

**Points Structure:**
The following point structure was used to encourage lower-carbon and higher-occupancy trips:

<table>
<thead>
<tr>
<th>Modes</th>
<th>Points Awarded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive and park</td>
<td>1 point</td>
</tr>
<tr>
<td>Uber/Lyft</td>
<td>2 points</td>
</tr>
<tr>
<td>Carpool/vanpool</td>
<td>2 points</td>
</tr>
<tr>
<td>Dropped off</td>
<td>2 points</td>
</tr>
<tr>
<td>Transit</td>
<td>3 points</td>
</tr>
<tr>
<td>Telework</td>
<td>3 points</td>
</tr>
<tr>
<td>Walk or bike</td>
<td>3 points</td>
</tr>
</tbody>
</table>

**Prizes:**
Participants could redeem for TechCash at any point throughout the contest, or could redeem for lottery draws until two weeks after the close of the contest. The odds of winning the lottery will be published such that the expected value of winning each prize is the same. Such equivalency will allow researchers to determine how participants respond to deterministic versus probabilistic prizes.
Prize Point Necessary

<table>
<thead>
<tr>
<th>Prize</th>
<th>Points Necessary</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.50 TechCash</td>
<td>5 points</td>
</tr>
<tr>
<td>1 Lottery Draw for $100 TechCash</td>
<td>5 points</td>
</tr>
<tr>
<td>1 Lottery Draw for $500 Visa Gift Card</td>
<td>5 points</td>
</tr>
</tbody>
</table>

Contest Splash Page on AccessMyCommute:

Take advantage of your commuting choices and redeem points you've earned by commuting sustainably for various cash prizes below. Contest runs November 1 to December 9, 2016 (points redeemable until December 16, 2016).

**Here’s how to participate:**

1) **Log your commutes**
   - Trips using your AccessMIT CharlieCard or parking chip will automatically be uploaded.
   - Walking or cycling trips can be logged using the [Moves](https://www.moves-app.com/) mobile phone app. Link your account to AccessMyCommute by clicking on your name at the top right corner, and visiting “Edit Profile > Connected Apps”, then follow the instructions.
   - All trips can also be self-reported on the homepage.

2) **View your points and redeem prizes by checking the “Incentives” tab.**

You have until December 16, 2016 to redeem your points.

3) **Encourage your colleagues to participate!**

The departments with the most sustainable travel will receive special recognition.

4) **If you have questions, reach out to accessmycommute_help@mit.edu.**

Points are awarded for your daily (round-trip) commute as follows:

- Drive alone: 1 point/commute
- Uber/Lyft, etc.: 2 point/commute
- Dropped off: 2 points/commute
- Carpool/vanpool: 2 points/commute
- Transit: 3 points/commute
- Telework: 3 points/commute
- Walkers/Bikers: 3 points/commute

To ensure you are receiving all of the points you've earned make sure you've registered your carpool, signed up for the Moves app, or self-report your trips. Instructions can be found in the Help section.

Although you may redeem points at any time by pressing the "redeem" button below, lotteries will be conducted and prizes will be distributed at the end of the program. Points are redeemable through December 16, 2016. Look for TechCash rewards to appear on your MIT ID after the end of the program. The winner of the grand prize will be notified of their win, and provided instructions for picking up their gift card.

**Happy Commuting!**
Reminder email:

Now that you have even more ways to make flexible, low carbon commuting part of your work week, we encourage you to log on to AccessMyCommute, a new interactive tool that helps you better manage your commute, find nearby carpools, and win prizes for trying more sustainable modes.

You are also able to earn rewards by logging in and redeeming points that you accrue for your commuting modes. Prizes include:

- $1 TechCash directly exchanged for every ten points;
- Entry to win $100 in TechCash (5 available) at the end of the promotional period;
- Entry to win a grand prize of $500 (choice of Visa gift card or TechCash) at the end of the promotional period;

Every commute you make – whether you take the T or drive – will earn you points, with greater points available for more sustainable commuting modes. You can also set up a carpool with other MIT employees. Just enter your home and work address and select carpool matching preferences. Your address will not be visible, but other MIT community members can request to join your carpool if they have similar commutes.

More detailed information about the promotion can be found on AccessMyCommute at “Incentives > Point Programs.” Trips made between November 1 and December 9 were eligible for points, and the final day for points redemption is December 15, 2016.

And for days you don’t drive, remember to swap out your old ID card for a new card that has a free subway and local bus pass built right in. Find out more about this and additional new benefits here.

MIT Parking & Transportation Office

Note: The AccessMyCommute dashboard is brought to you by the MIT Parking and Transportation Office and the MIT Transit Lab. It is among a series of recently launched initiatives that are designed to enhance the commuting experience. This rewards program is made possible by a grant from the Federal Highway Administration (FHWA) Value Pricing Pilot Program.

Summary of Program Results:

- 1,200 users logged on at launch
- 700 people redeemed earned points for potential prizes
- 427 individuals registered a carpool “favorite trip” after nudge
- Provided proof-of-concept for Sustainable Commuting @ MIT experiment in Fall 2017 (Chapter 6)

While the campaign attracted visitors to the AccessMyCommute dashboard, participants and rewards winners were generally non-drivers to begin with. Little mode shift was believed to occur as a result of the incentive program, but the lack of a clear causal link was motivation for the randomized controlled trial that took place the following spring.
Appendix B

Promotional Materials for AccessMIT

This Appendix includes visuals of TDM promotional materials. The following pages present a series of posters that were displayed on screens and print-outs across campus after the launch of AccessMIT.
Introducing access MIT

Your commute counts.

This fall, MIT has set out to redefine the commuting experience for its employees with new benefits.

We want to make it easier for you to love your commute. Save money, get some fresh air, and more.

What mode are you in today?

These new employee benefits are part of access MIT, a broader vision that seeks to provide staff, students, faculty, and visitors with flexible, affordable, and low-carbon choices. So, what’s new for employees this fall?

- **Ride the T for free**
  Your new MIT ID card lets you ride the subway & local bus for free

- **A Commuter Rail boost**
  Get a 60% subsidized monthly pass for commuter rail and boat

- **Park for less at the T**
  Get a 50% discount at station parking, up to $100 per month

- **Flexible daily parking**
  Only pay to park on the days you drive in (for MIT gated lots).
You choose... what mode are you in today?

WALK
- Walk to work
- Subway & bus
- Commuter Rail
- Commuter Boat
- Private transit
- Shuttles

RIDE
- Bike
- Hubway

BIKE
- Carpool
- Vanpool
- Parking by the day
- Zipcar
- Emergency Ride Home

I’m in climate action mode

John Sterman
Jay W. Forrester Professor of Management,
MIT Sloan School of Management

John Sterman is a professor who not only teaches about system dynamics and sustainability—he sees them in action, every day. He's committed to a healthy, low-carbon commute so he bikes to work rain, snow, or shine. Because driving less makes a big difference to our campus, community, and the planet.

Your commute counts. Switch it up.
web.mit.edu/accessmit
We’re in harbor cruising mode

For Kiley, commuting isn’t just about quality of life; it’s a way of life. After all, if you can bring your best friend on a beautiful MBTA ferry ride across Boston Harbor every morning, why wouldn’t you? And one less car on the road makes a big difference to our campus, community, and the planet.

Kiley Clapper (and Gunner)
Academic Administrator
Department of Civil and Environmental Engineering

Your commute counts. Switch it up.
web.mit.edu/accessmit

I’m never in bumper-to-bumper mode

As a staff accountant, Jarvis Smith knew that skipping the drive to MIT didn’t just make environmental sense—it makes financial sense. He loves the T ride from Ashmont Station so much, he’ll likely never drive his car to work again. Now he saves time, saves money on gas, and saves himself plenty of frustration.

Jarvis Smith
Staff Accountant
Office of the Vice President for Finance

Your commute counts. Switch it up.
web.mit.edu/accessmit
I’m in de-stress mode

Maureen Ratigan is Director of Benefits in Human Resources, so she knows that a great commute can save lots of precious resources—including time, money, and your state of mind. So she switched from her car to the commuter rail, and has loved the benefits ever since.

Your commute counts. Switch it up.
web.mit.edu/accessmit

I’m in keep it flexible mode

As Director of MIT Medical, Cecilia knows that an alternative commute is better for your health. So, whenever she can, she takes the Boston Express Bus to Boston—and leaves her car at the lot, and her stress far behind. See how switching up your commute improves our campus, community, and your well-being.

Your commute counts. Switch it up.
web.mit.edu/accessmit
Five tips to make your commute count...

① Consider ditching the car once a week.
② Ride for free – get the new MIT ID card/T-Pass in one!
③ Visit the AccessMyCommute dashboard on your Atlas page.
④ Explore commuter options on the Transportation & Parking site.
⑤ Switch it up! Try a new mode, like Bridj or Hubway!

It’s your turn...you choose!
Brought to you by

The MIT Parking and Transportation Office in partnership with:

- The MIT Office of Sustainability
- The MIT Transit Lab
- The Committee for Transportation & Parking
Appendix C

Survey Questionnaires

This appendix includes the web questionnaires for three surveys analyzed as part of this thesis: (1) the 2016 biennial MIT Transportation Survey (discussed in Chapters 3 and 4); (2) the 2017 survey conducted after the randomized controlled trial (Chapter 5); and (3) the Partners HealthCare employee survey (discussed in Chapter 6).

C.1 MIT 2016 Biennial Transportation Survey
Welcome,

The Parking and Transportation Office, the Environment, Health and Safety Office and the Office of the Provost are jointly sponsoring a survey on commuting to the MIT campus. The State of Massachusetts and the City of Cambridge require that MIT collect data related to how you get to MIT every day. This survey has multiple sections and should take about 10 minutes to complete. As an incentive to participate in this survey, we are offering several prizes. **MIT Community members who complete the survey will be entered into a lottery for a grand prize: $500 Visa Gift Card OR TechCASH OR Bicycle from Cambridge Bicycle (your choice)**

Other prizes include:

- 25 TechCASH credits valued at $100
- 50 TechCASH credits valued at $50
- 325 TechCASH credits valued at $25
- 10 $50 Zipcar Gift Certificates
- 10 Hubway annual memberships

The survey is voluntary. You may answer as few or as many questions as you wish.

Please be assured that the data are confidential, and the results of any research or analysis using the data will be presented in a way that individual respondents cannot be identified. For the purposes of analysis, we may combine other data with your responses to this survey.

Occasionally, we receive requests to use administrative datasets—including survey results—for academic research projects. Any researchers using these data for academic research are bound to the same rules of confidentiality and reporting stated above. That is, they may not report results in a way that identifies an individual respondent.
About You

1. Is MIT your primary employer/school?
   Yes  No, I am a student at another institution  No, MIT is my secondary employer  No, I am a visitor  Other, please specify:

2. How many hours do you normally work/study on campus each week?
   Less than 17 hours  17-30 hours  31-40 hours  More than 40 hours a week

3. What time do you usually arrive on campus?

4. What time do you usually depart from campus?

5. Do you have flexibility in scheduling your work hours?
   Yes  No

Your Commute

We are interested in learning how long it takes you to get to and from MIT. Using whatever method of transportation you normally use, please indicate your estimated commute time door-to-door under different conditions.

1a. First tell us about your commute TO MIT

Normal Day
Good / Fast Day
Bad / Slow Day

1b. Your commute FROM MIT

Normal Day
Good / Fast Day
Bad / Slow Day

2. What are your CURRENT commuting method(s) to MIT?
Select your primary method, and if applicable, a secondary method (e.g. during nice weather, flexible hours, etc.).

<table>
<thead>
<tr>
<th>Method</th>
<th>Primary (e.g. typical day)</th>
<th>Secondary (only if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive alone the entire way</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Drive alone, then take public transportation</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Walk, then take public transportation</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
3. Did you use different commuting method(s) to MIT in the PREVIOUS academic year (2015-2016)?

   Yes  No

   Was not at MIT during the previous academic year.

3a1. Are you considering changing the way you commute to MIT over the next year?

   Yes  No

3a2. Please tell us what commuting method(s) you are considering. Check all that apply.

   Drive alone the entire way  
   Ride in a vanpool (5 or more commuters) or private shuttle (e.g. TechShuttle, SafeRide)
Drive alone, then take public transportation  
Dropped off at work

Walk, then take public transportation  
Take a taxi or ride service (e.g., Uber, Lyft)

Share ride/dropped off, then take public transportation  
Bicycle

Bicycle and take public transportation  
Walk

Ride in a private car with another person  
Work at home

Ride in a private car with 2-4 commuters  
Other, please specify

Timing

These page timer metrics will not be displayed to the recipient.
First Click: 21.773000000000003 seconds
Last Click: 23.428 seconds
Page Submit: 16.533 seconds
Click Count: 2 clicks
Your Commute

We are interested in learning how long it takes you to get to and from MIT. Using whatever method of transportation you normally use, please indicate your estimated commute time door-to-door under different conditions.

1a. First tell us about your commute TO MIT

Normal Day
Good / Fast Day
Bad / Slow Day

1b. Your commute FROM MIT

Normal Day
Good / Fast Day
Bad / Slow Day

2. What are your CURRENT commuting method(s) to MIT?
Select your primary method, and if applicable, a secondary method (e.g. during nice weather, flexible hours, etc.).

<table>
<thead>
<tr>
<th>Option</th>
<th>Primary (e.g. typical day)</th>
<th>Secondary (only if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive alone the entire way</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Drive alone, then take public transportation</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Walk, then take public transportation</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
</tbody>
</table>
3. Did you use different commuting method(s) to MIT in the PREVIOUS academic year (2015-2016)?

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

3a. What were your commuting method(s) to MIT in the PREVIOUS academic year (2015-2016)?
Select your primary method, and if applicable, a secondary method (e.g. during nice weather, flexible hours, etc.).

<table>
<thead>
<tr>
<th>Method</th>
<th>Primary (e.g. typical day)</th>
<th>Secondary (only if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive alone the entire way</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td>Drive alone, then take public transportation</td>
<td>○</td>
<td></td>
</tr>
</tbody>
</table>
### 3b. Why have you changed your commuting methods since the previous academic year? Check all that apply.

<table>
<thead>
<tr>
<th>Option</th>
<th>Primary (e.g. typical day)</th>
<th>Secondary (only if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walk, then take public transportation</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Share ride/dropped off, then take public transportation</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Bicycle and take public transportation</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Ride in a private car with another person</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Ride in a private car with 2-4 commuters</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Ride in a vanpool (5 or more commuters) or private shuttle (e.g., TechShuttle, SafeRide)</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Dropped off at work</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Take a taxi or ride service (e.g., Uber, Lyft)</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Bicycle</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Walk</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Work at home</td>
<td>[ ]</td>
<td>[ ]</td>
</tr>
<tr>
<td>Other</td>
<td>N/A</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

**Other, please describe:**

- Moved place of residence
- Life event (e.g. family structure)
- Changed jobs and/or hours
- Availability of a vehicle (e.g. purchased a car)
- New MIT commuter benefits, please describe:
- Other, please describe:

https://mitresearch.qualtrics.com/SE/?SID=SV_cTLCdCFPaUeaerzQ_CHL=preview&Preview=Survey
Please indicate how you commuted TO CAMPUS each day LAST WEEK.

1. Please make one entry for each day of the week.

<table>
<thead>
<tr>
<th>Day</th>
<th>Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td></td>
</tr>
<tr>
<td>Tuesday</td>
<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td></td>
</tr>
<tr>
<td>Friday</td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
</tr>
</tbody>
</table>

1a. If you indicated you used another method to get to campus on at least one day last week, please describe that method:


2. On any day last week, did you travel BACK TO YOUR HOME from MIT using a different mode than indicated above?

   Yes   No

2a. If YES, how many days last week did you use a different method to get home?

   1  2  3  4  5  6  7
3. How many times a month, on average, do you work from a remote location instead of working on campus?

<table>
<thead>
<tr>
<th>Frequency</th>
<th>1 to 4 times per month</th>
<th>5-8 times per month</th>
<th>9-12 times per month</th>
<th>More than 12 times a month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Options</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Timing

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- First Click: 4.948 seconds
- Last Click: 18.686999999999998 seconds
- Page Submit: 4.952 seconds
- Click Count: 9 clicks

< Back

Save & Continue >

Powered by Qualtrics
Use of Transportation Services

The following questions relate to MIT’s new transportation benefit program called AccessMIT, which includes free unlimited MBTA local bus and subway, as well as increased commuter rail subsidy, MBTA parking subsidy, daily parking pricing at MIT gated lots, and incentive programs. This program supplements existing commuter benefits at MIT.

To what extent have the new AccessMIT commuter benefits influenced your commuting decisions?

<table>
<thead>
<tr>
<th>No influence</th>
<th>Small influence</th>
<th>Moderate influence</th>
<th>Large influence</th>
<th>N/A - Was not aware of new AccessMIT commuter benefits</th>
</tr>
</thead>
</table>

Have you swapped your MIT ID card for a new card with free unlimited MBTA subway and local bus access?

| Yes | No | I am a prior MobilityPass trial participant (e.g. my MIT ID has an MBTA chip) | Not Eligible |

Why have you not swapped your MIT ID?
Timing

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First Click: 3.463 seconds
Last Click: 5.415 seconds
Page Submit: 0 seconds
Click Count: 3 clicks
For each of the following new AccessMIT benefits, how important is the benefit towards influencing your commuting methods, even on an occasional basis?

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Not Important</th>
<th>Very Important</th>
<th>Unaware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free unlimited MBTA local bus and subway</td>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>New MBTA Parking Subsidy</td>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Increased commuter rail subsidy</td>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>Daily parking pricing</td>
<td></td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>AccessMyCommute dashboard &amp; incentives</td>
<td></td>
<td>0</td>
<td>10</td>
</tr>
</tbody>
</table>

Timing

These page timer metrics will not be displayed to the recipient.
First Click: 0 seconds
Last Click: 0 seconds
Page Submit: 0 seconds
Click Count: 0 clicks
MIT offers a number of transportation services and would like to know how many community members are aware of and use the services.

Please indicate if you have used or are aware of the following services.

<table>
<thead>
<tr>
<th>Service</th>
<th>Aware of service, USE IT</th>
<th>Aware of service, DO NOT USE IT</th>
<th>Not aware of service</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT Parking and Transportation Office website</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AccessMIT Commuting Benefits</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AccessMyCommute Dashboard</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subsidized MBTA Pass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zipcar (car sharing)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric Vehicle Charging Stations</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexible hours to accommodate schedules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Ride Home Program</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Transit Subsidy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpools/Vanpool Parking Programs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hubway (bike sharing)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secure bicycle storage and/or repair facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locker and/or shower facilities for runners and bicyclists, other than in DAPER facilities (e.g., Z-center)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Qualified Bicycle Commuter Benefit</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIT Shuttles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EZ Ride / Northwest Shuttle</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

https://login.qualtrics.com/SE/?SID=SV_cTLCdCFPaUeaerz&Preview=Survey&Q_CHL=preview&BrandID=mitresearch&Role=Employee&BenefitsEligible=Yes
Timing

These page timer metrics will not be displayed to the recipient.
First Click: 2.255 seconds
Last Click: 14.21 seconds
Page Submit: 0 seconds
Click Count: 18 clicks
Please indicate your level of satisfaction with the services you use.

<table>
<thead>
<tr>
<th>Service</th>
<th>Very satisfied</th>
<th>Generally satisfied</th>
<th>Generally dissatisfied</th>
<th>Very dissatisfied</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIT Parking and Transportation Office website</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AccessMIT Commuting Benefits</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>AccessMyCommute Dashboard</td>
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<tr>
<td>Subsidized MBTA Pass</td>
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<tr>
<td>Zipcar (car sharing)</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Electric Vehicle Charging Stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flexible hours to accommodate schedules</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency Ride Home Program</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private Transit Subsidy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carpools/Vanpool Parking Programs</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Hubway (bike sharing)</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Secure bicycle storage and/or repair facilities</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Locker and/or shower facilities for runners and bicyclists, other than in DAPER facilities (e.g., Z-center)</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Qualified Bicycle Commuter Benefit</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIT Shuttles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EZ Ride / Northwest Shuttle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MIT Mobile Shuttle Tracking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In general, how satisfied are you with MIT’s transportation services?
Timing

These page timer metrics will not be displayed to the recipient.
First Click: 0 seconds
Last Click: 0 seconds
Page Submit: 0 seconds
Click Count: 0 clicks
Do you use any smartphone apps to plan your commute?

Yes  No

Which apps do you use to plan your commute? Select all that apply.

MIT Mobile App  Google Maps  NextBus  MBTA Tracker  CityMapper  Other (please specify)

Timing

These page timer metrics will not be displayed to the recipient.
First Click: 0.998 seconds
Last Click: 0.998 seconds
Page Submit: 0 seconds
Click Count: 1 clicks
Driving, Car Ownership, and Bicycling

If you live off-campus: How many total licensed drivers reside in your current household?

0 1 2 3 4 5+ Not applicable; I live on campus

How many total motor vehicles are CURRENTLY registered to members of your household?

0 1 2 3 4 5+ Not applicable

If you drive to campus, where is your motor vehicle usually parked?

MIT Parking Facility Other paid parking lot or garage On-street parking Other (please specify) Not applicable

Would any of the following make you more inclined to bike to campus (whether you currently bike to campus or not)?
Locker and/or shower facilities in or near your building
Better weather
Nothing would make me more inclined to cycle to campus

More bike routes to campus
Better bike parking facilities
Not an option (e.g., health reasons, safety concerns, not near a bike path)

Safer bike routes to campus
Shorter commute distance
Other (please specify)

Timing

These page timer metrics will not be displayed to the recipient.
First Click: 0 seconds
Last Click: 0 seconds
Page Submit: 0 seconds
Click Count: 0 clicks
Last Section

What is the most important thing MIT could do to improve commuting?

May we follow up with you if we have questions about your commuting patterns for additional MIT research? (By answering Yes, your survey response will include your email address when shared with researchers.)

Yes
No

As our thanks for completing the survey, all survey completers will be entered into a drawing. Please tell us which grand prize you would prefer:

- $500 MIT TechCash
- $500 Visa Gift Card
- Bicycle from Cambridge Bicycle
- I do not wish to be entered in the drawing.

Timing

These page timer metrics will not be displayed to the recipient.

First Click: 3.888 seconds
Last Click: 3.888 seconds
Thank you for taking the time to answer the survey.

The MIT Parking and Transportation Office offers a wide variety of options for the MIT community to commute. MIT encourages the community to carpool, use public transportation, bike, and walk when traveling to work or learn in Cambridge or MIT. More information may be found at here.

More information on new AccessMIT benefits can be found here.

And finally, a reminder for faculty and staff to log into the AccessMyCommute dashboard to track your commutes and have the chance to win prizes for sustainable travel.
C.2 MIT 2017 Sustainable Commuting Post-Experiment Survey
Intro

The MIT Transit Lab would like your feedback on the Sustainable Commuting @ MIT initiative.

This survey should take about 5 minutes to complete. As an incentive to participate in this survey, we are offering several prizes. MIT Community members who complete the survey will be entered into a lottery for a grand prize: **$500 Visa Gift Card**

Other prizes include:
- 5 TechCASH credits valued at **$100**
- 50 TechCASH credits valued at **$20**

The survey is voluntary. You may answer as few or as many questions as you wish. Please be assured that the data are confidential, and the results of any research or analysis using the data will be presented in a way that individual respondents cannot be identified. For the purposes of analysis, we may combine other data with your responses to this survey.

The MIT Transit Lab would like to learn more about your commute, as a follow-up to the 2016 Commuting Survey.

This survey should take about 3 minutes to complete. As an incentive to participate in this survey, we are offering several prizes. MIT Community members who complete the survey will be entered into a lottery for a grand prize: **$500 Visa Gift Card**

Other prizes include:
- 5 TechCASH credits valued at **$100**
- 50 TechCASH credits valued at **$20**

The survey is voluntary. You may answer as few or as many questions as you wish.
Please be assured that the data are confidential, and the results of any research or analysis using the data will be presented in a way that individual respondents cannot be identified. For the purposes of analysis, we may combine other data with your responses to this survey.

**Awareness**

Over the last 6 weeks, you were sent weekly emails from the MIT Transit Lab. **How did you interact with these messages?**

- ○ Never saw
- ○ Saw but never opened
- ○ Opened but seldom read
- ○ Sometimes read
- ○ Usually read
- ○ Always read

Please state your **awareness** and/or **use** of the following benefits:

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Use frequently</th>
<th>Use occasionally</th>
<th>Never use but aware</th>
<th>Not aware</th>
<th>N/A (e.g. not eligible)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free MBTA subway &amp; local bus pass</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Subsidized commuter rail</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Subsidized MBTA station parking</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Private transit subsidy</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>AccessMyCommute Dashboard &amp; trip planner</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

Please state your **use** and **awareness** of the following benefits.
Impact of Experiment

Were you away from MIT for any of the last six weeks?
(e.g. at least 3 days/week away from campus, such as vacation or travel. Select all that apply.)

☐ April 10-14
☐ April 18-21
☐ April 24-28
☐ May 1-5
☐ May 8-12
☐ May 15-19
☐ None

Over the last six weeks, how many weeks did you park on campus less often than you normally do?

☐ Not at all
☐ 1 week
☐ 2 weeks
In general, when you didn’t drive alone to campus over the last six weeks, what primary alternative did you choose?

- I always drive alone to campus
- Public Transit
- Carpool / passenger / shared ride
- Bicycle
- Walk
- Work from home
- Other: __________________________

Please rate each item’s influence on your decision to reduce your frequency of parking on campus:

<table>
<thead>
<tr>
<th>Least influence</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Most influence</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>TechCASH Rewards</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Increased awareness of benefits</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Desire to reduce carbon footprint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peer influence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (please specify)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other comments:
Which of the Commuter Digest emails did you find particularly **interesting** or **helpful**? (Pick all that apply)

- [ ] **Week 1: Commuting Myths & Facts**  
  *Highlighting common misperceptions about transportation benefits*

- [ ] **Week 2: Your Parking Benefits**  
  *Outlining the perks of daily pricing*

- [ ] **Week 3: A New Way to Carpool**  
  *Introducing the AccessMyCommute carpool partner matching tool.*

- [ ] **Week 4: Riding the Rails to MIT**  
  *Highlighting the flexibility of commuter rail and its subsidies.*

- [ ] **Week 5: Something for Everyone's Commute**  
  *Introducing the Bike Benefit, private transit subsidy and Emergency Ride Home.*

- [ ] **Week 6: How We're Doing**  
  *Results of the initiative & recognition to top departments.*

Your weekly digests included both (a) a notification of **rewards** and (b) an **informational campaign** of commuting tips.

What did you find more **impactful** on your commuting decisions over the last six weeks?

- [ ] TechCASH Rewards
- [ ] Information Campaign
- [ ] Both

Are you aware of how and where to spend TechCASH?

- [ ] Yes
- [ ] No
Were you aware that some staff were randomly selected to receive TechCASH rewards as part of this email campaign?

- Yes
- No

Do you talk with your colleagues about MIT’s commuting benefits?

- Yes
- No

Carpooling

Do you ever carpool or share a ride (e.g. with a friend or relative) to campus?

(Excluding UberPOOL/Lyft Line)

- Never
- Rarely
- Sometimes
- Most of the time
- Always

What would make you more likely to try carpooling?

Have you ever used the trip planner on AccessMyCommute to look for potential carpool/rideshare partners at MIT that live along your commuting route?

- Yes and we’ve shared a ride at least once
Daily Parking Pricing

To what extent has the switch to daily pricing influenced your decision to park on any given day?

<table>
<thead>
<tr>
<th>No influence</th>
<th>Strong influence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Comment:

Do you think you will hit the annual cap on daily parking fees?
*The annual cap for 2016-2017 is set at $1,760 for regular permits or $880 for economy lots.*

- Yes
- No
- Not sure
- Unaware of cap

Final Comments

Do you have any other comments?
C.3 Partners HealthCare 2017 Employee Commuting Survey
Partners Commuter Survey

Intro

Partners HealthCare is requesting employees complete a 10-minute survey on commuting habits. Respondents will be entered to win one of four $50 gift cards valid at participating Assembly Row stores and restaurants.

The survey will serve three purposes:

- Validate and inform enhancements to commuter services and benefits for employees
- Analyze how the consolidation of offices into the Assembly Row campus has impacted the commute of Partners employees
- Collect commuting data for required filings to local and state authorities

Please complete the survey by Friday, December 22 to be eligible to win one of the $50 gift cards.

Questions? Contact PHSCommuterServices@partners.org.

Browser Meta Info

This question will not be displayed to the recipient.

Browser: Chrome
Version: 64.0.3282.186
Operating System: Macintosh
Screen Resolution: 1280x800
Flash Version: -1
Java Support: 0
User Agent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10_12_6) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/64.0.3282.186 Safari/537.36

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First Click: 0 seconds
1) About You

**About You**

Please provide your 3 to 5-character username (e.g. ph123):

---

Is Partners HealthCare your primary employer?
Please select Yes if you are employed by a Partners HealthCare entity.

- Yes
- No, Partners is my secondary employer
- Other, please specify:

Is Assembly Row your primary worksite?

- Yes
- No (please indicate primary worksite location)

How many hours do you normally spend at work each week?

- Less than 17 hours
- 17-30 hours
- 31-40 hours
- More than 40 hours a week

What time do you usually arrive at Assembly Row?

---
What time do you usually depart from Assembly Row?

Do you have flexibility in scheduling your work hours?

Yes  [ ]  No  [ ]

These page timer metrics will not be displayed to the recipient.
First Click: 0 seconds
Last Click: 0 seconds
Page Submit: 0 seconds
Click Count: 0 clicks

2) Your Commute

Your Commute

We are interested in learning how long it takes you to get to and from Assembly Row. Using whichever method of transportation you normally use, please indicate your estimated commute time door-to-door.

TO Assembly Row (e.g. morning commute)  
FROM Assembly Row (e.g. afternoon commute)  

What are your CURRENT commuting method(s) to work?
Select your primary method, and if applicable, a secondary method (e.g. during nice weather, flexible hours, etc.).

Primary (i.e. typical day)  Secondary (only if applicable)

Drive alone the entire way  [ ]  [ ]
You selected 'Other' as your commuting method; please describe:

On a typical public transit commute, how many transfers between MBTA lines (bus, subway or commuter rail) do you typically make?

- e.g. walking to Orange Line = zero transfers
- e.g. Commuter Rail to Orange Line = one transfer
- e.g. bus to Green Line to Orange Line = two transfers
How often do you commute between Assembly Row and other Partners entities and/or Partners worksites?

- Never or rarely
- A few times per month
- Once a week
- Multiple times per week

If so, how do you typically travel between Assembly Row and other Partners entities and/or Partners worksites?
Select your primary method, and if applicable, a secondary method.

<table>
<thead>
<tr>
<th></th>
<th>Primary (i.e. typical day)</th>
<th>Secondary (only if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive alone</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Public transportation</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Partners shuttle</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Shared ride</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Bicycle</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Taxi or ride service</td>
<td>○ (e.g. Uber/Lyft)</td>
<td>○</td>
</tr>
<tr>
<td>Other</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

You selected 'Other' as your commuting method; please describe:

Move to Assembly Row
The following questions relate to your commute prior to relocating at Assembly Row.

**Where were you working PRIOR to moving to Assembly Row?**

- I was not working at Partners HealthCare (please enter work ZIP code)
- Shraffts Building - 529 Main Street, Charlestown
- 1 Constitution Center, Charlestown
- 253 Summer Street / 27 Melcher Street, Boston
- Wellesley Gateway - 93 Worcester Street, Wellesley
- 101 Huntington Avenue, Boston
- 1 Cabot Road, Medford
- 115 4th Avenue, Needham
- 101 Merrimac Street, Boston
- 25 New Chardon Street, Boston
- The Prudential, Boston
- 100 Cambridge Street, Boston
- 50 Staniford Street, Boston
- 116 Huntington Avenue, Boston
- Lafayette City Center (LCC) - 2 Avenue de Lafayette, Boston
- 2 Longfellow Pl, Boston
- Other (please list)

**Did you change your commuting mode(s) (primary or secondary) when you moved to Assembly Row?**

- Yes
- No
- N/A (I did not work at Partners before the move to Assembly Row)

**What were your commuting method(s) at your PRIOR work location?**
Select your primary method, and if applicable, a secondary method (e.g. during nice weather, flexible hours, etc.).

<table>
<thead>
<tr>
<th>Primary (e.g. typical day)</th>
<th>Secondary (only if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive alone the entire way</td>
<td>○</td>
</tr>
<tr>
<td>Drive alone, then take public transportation</td>
<td>○</td>
</tr>
<tr>
<td>Walk, then take public transportation</td>
<td>○</td>
</tr>
<tr>
<td>Share ride/dropped off, then take public transportation</td>
<td>○</td>
</tr>
<tr>
<td>Bicycle and take public transportation</td>
<td>○</td>
</tr>
<tr>
<td>Take a taxi or ride service (e.g., Uber, Lyft)</td>
<td>○</td>
</tr>
<tr>
<td>Ride in a private car with another person</td>
<td>○</td>
</tr>
<tr>
<td>Ride in a private car with 2-4 commuters</td>
<td>○</td>
</tr>
<tr>
<td>Ride in a vanpool (5 or more commuters) or private shuttle</td>
<td>○</td>
</tr>
<tr>
<td>Bicycle</td>
<td>○</td>
</tr>
<tr>
<td>Walk</td>
<td>○</td>
</tr>
<tr>
<td>Work at home</td>
<td>○</td>
</tr>
<tr>
<td>Other</td>
<td>○</td>
</tr>
<tr>
<td>N/A</td>
<td>○</td>
</tr>
</tbody>
</table>

You selected 'Other' as your commuting method, please describe:

How often do you typically park at Assembly Row?
How often did you park at your PRIOR workplace location?

Why have you changed your commuting methods since moving to Assembly Row?
Check all that apply.

- MBTA transit accessibility
- Parking price/availability
- Change in job hours or role
- Life event (e.g. family structure)
- Availability of a vehicle (e.g. purchased/sold a car)
- Other

Please elaborate:

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3) How You Get to Work

Please indicate how you commuted to work each day during the week of December 4-10.

Please make one entry for each day of the week of December 4-10.
How many **full days** a month, on average, do you work from a remote location instead of working at Assembly Row?

<table>
<thead>
<tr>
<th></th>
<th>Never</th>
<th>1 to 4 times per month</th>
<th>5-8 times per month</th>
<th>9-12 times per month</th>
<th>More than 12 times a month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday</td>
<td></td>
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<td></td>
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<tr>
<td>Wednesday</td>
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<tr>
<td>Friday</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Saturday</td>
<td></td>
<td>Scheduled day off (e.g., weekend)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunday</td>
<td></td>
<td>Scheduled day off (e.g., weekend)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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4) **Partners Transportation Services**

**Use of Transportation Services**

The following questions relate to the changes in commuting benefits offered by Partners HeathCare since moving to Assembly Row. These include:

- Parking fees charged daily (on-site) or monthly (off-site)
- MBTA transit subsidies increased to 50% (e.g. LinkPass, Commuter Rail, etc.)
- Employee shuttles
- Bicycle storage and shower facilities
- Flexible schedules
To what extent have the changes in commuter benefits influenced your commuting decisions?

- No influence
- Small influence
- Moderate influence
- Large influence
- N/A - Was not aware of changes to commuter benefits

How important is each item in influencing your commuting methods?

(1 = Not Important; 5 = Very Important)

- Not Important
- Very Important
- Not Applicable

- 50% subsidized MBTA transit passes
- Proximity to Orange Line
- Bicycling amenities
- Daily pay-as-you-park pricing
- Employee shuttles

(Optional) Please list any other important factors influencing your commute.

Overall satisfaction

In general, how satisfied are you with Partners transportation services?

- Very dissatisfied
- Somewhat dissatisfied
- Neither satisfied nor dissatisfied
- Somewhat satisfied
- Very satisfied
5) Driving & Automobile Ownership

Driving, Car Ownership, and Bicycling

How many licensed drivers reside in your current household?

0 1 2 3 4 5+

How many motor vehicles are currently registered to members of your household?

0 1 2 3 4 5+

If you drive to Assembly Row, where is your motor vehicle usually parked?

Not applicable On-site parking (Assembly Row) Off-site parking (80 Station Landing) Other off-site parking On-street parking Other (please specify)

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6) Last Section

Last Section

What is the most important thing Partners could do to improve commuting?

May we follow up with you if we have questions about your commuting patterns for additional research?

- [ ] Yes (please enter email address)
- [ ] No

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References


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McDonald, J. (2002). Parking on Campus: It’s Really a Numbers Game. MIT Faculty Newsletter, 26–27.


Somerville Mayor’s Office of Strategic Planning and Community Development. (2014). *Planning Staff Report on Assembly Row Block 11* (Tech. Rep.). Somerville, MA.


