FINAL REPORT

Longitudinal tracking survey to understand changing consumer spending, telework and mobility patterns through the pandemic

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16. Abstract

Recognizing that the COVID-19 pandemic provided a unique natural experiment in the use of Information and Communication Technologies, this report describes a 7-wave longitudinal tracking survey conducted by the Tier I Center on Telemobility to monitor the evolving consumer spending, telework, and activity participation behavior through the COVID-19 pandemic. The goal is to gain insights on expected post-pandemic virtual and physical mobility. The 7-wave longitudinal tracking survey was conducted between December 2020 and March 2022 through an online platform (Prolific) and resulted in data from 1877 unique respondents in the United States. Details are presented regarding the 12 different categories of questions asked in the survey, survey dissemination strategy and incentives provided to the respondents, and the response rates across various waves of the survey. Also presented are results of an exploratory analysis using the collected data on changing consumer spending; telework behavior and related attitudes and experiences; and the use for various types of online entertainment, delivery, and local transit pass related subscription services at various time points including pre-pandemic, last three years and post-pandemic. The report concludes with a summary of several studies using the collected data.

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Executive Summary

Recognizing that the COVID-19 pandemic provided a unique natural experiment in the use of Information and Communication Technologies, a 7-wave longitudinal tracking survey was conducted by the Tier I Center on Telemobility to monitor the evolving consumer spending, telework, and activity participation behavior associated with the COVID-19 pandemic. The goal is to derive insights on expected post-pandemic telemobility patterns and its interaction with physical mobility. The 7-wave longitudinal tracking survey was conducted between December 2020 and March 2022 through an online platform named Prolific (Palan and Schitter, 2018) and resulted in data from 1877 unique respondents in the United States.

Questions on the following 12 categories were included in the survey: 1) weekly consumer spending on groceries, cooked food and non-food items; 2) monthly consumer spending on electronics, furniture, clothing and digital media; 3) home delivery frequency for groceries, cooked meals and other non-food items; 4) telework related travel frequency through the pandemic; 5) travel, trip-making and time use behavior; 6) attitudes, perceptions and experiences of the individuals with telework and e-commerce through the pandemic; 7) use of subscription services like amazon prime, streaming services as well as local transit pass; 8) additional related question on pre-pandemic and post-pandemic expected behavior; 9) individual intention to use contact-free deliveries like delivery robots in the post-pandemic era; 9) a detailed 24-hr activity diary data; 10) direct impact of the pandemic like job loss, and COVID-19 infections; 11) individual experiences with depression, anxiety or positivity in life as a result of the pandemic; and 12) socio-demographics.

Wave 1 of the survey started with 457 adults who were recruited to build a representative sample of the U.S. population by *age, gender, and ethnicity*. The respondent group was informed about the 5 more subsequent waves of the survey and how much they would be paid in each wave before they agreed to complete the survey. The 457 respondents were then later reinvited for waves 2 to 6, irrespective of whether they completed the previous wave of the survey. To make up for respondent attrition from the main sample, starting wave 2, a convenience sample with approximately 100 respondents was recruited in each wave till wave 6, who were then re-invited to participated in the subsequent waves, *if they have completed the previous wave.* In wave 7, everyone who joined waves 1 to 6 at least once was re-invited, along with a new U.S. population representative top-up of 905 individuals.

The incentives for the respondents varied from $1 to $2.5 across waves 1 to 6 and $3.5 to $7.5 in wave 7 and included a staggered incentive scheme to improve retention rate across waves, especially for ethnic minorities. Across these seven waves, 180 individuals participated in all 7 waves, 97 participated in 6 waves, 80 participated in 5 waves, 72 participated in 4 waves, 102 participated in 3 waves, 135 participated in 2 waves and 1211 participated in 1 wave (including wave 7). Out of the 972 respondents who participated in waves 1 to 6, who were then re-invited for wave 7, 386 returned to complete the survey. This corresponds to a return rate of 39.7%.

Spatially, data have been collected from 49 out of 50 states (excluding Vermont) and Washington D.C. A comparison of sample share and population share for a few selected states shows that the sample shares for data in each wave are within a few percentage points of the population share for a state. The survey respondents are slightly younger than the population at large. Specifically, the sample has a higher proportion of respondents in the 55-64 years age group compared to 65 years or older, which is generally expected from online panels since older individuals tend to find technology-based online surveys to be challenging (or annoying). Even though the samples were designed to be age-representative (at least in parts) this mismatch is also a likely manifestation of the fact that the oldest age group coded in the Prolific platform panel is 58 years or older instead of 65 years or older.

The study sample matches well with the population shares in terms of ethnicity, with a slight over-representation of respondents with Asian ethnicity. Politically, the sample is *liberal leaning*. This bias is likely the result of self-selection in online surveys. Finally, the sample has some under-presentation of high-income individuals, especially in the $100,000 or above income group.

The report presents preliminary exploratory analysis highlighting changing consumer spending across in-person and online channels of purchase, remote work trends, individual attitudes and satisfaction regarding remote work that may shape post-pandemic adoption of telework and use of various types of subscription services through and beyond the pandemic. Regarding spending, the data suggests that average spending appears to have generally stabilized at time of the first 6 waves of data collection. Besides spending on dining out and prepared food, spending on most categories and items are relatively similar to pre-pandemic spending, albeit with some shift in spending from in-person shopping towards pickup and delivery. On the telework end, the average number of days worked from home almost doubled from 2.14 to 4.04 due to the pandemic in wave 1 of the survey but has been in a decline since then. However, an interesting insight from this data is that the expected post pandemic rate of work from home is 2.75 days per week, compared to 2.14 days per week pre-pandemic, a 28.5% increase. This increase could potentially have wide ranging transportation related implications. Lastly, in regard to the use of online subscription and delivery services including local transit pass purchase, the only category where there seems to be a visible increase in the reported post pandemic era compared to pre-pandemic, is that of grocery delivery where 208 respondents reported using these services earlier, but that number increased by 35% in post pandemic intention to use.

The collected longitudinal data has been used for a number for a number of studies focused on understanding the changing telework, consumer spending and mobility trends as a result of the pandemic, including: 1) understanding employee satisfaction with telework using a multiple indicators multiple cause model; 2) understanding the trajectories of telework through and beyond the pandemic using a hierarchical clustering based analysis and implications for these changing trends for the future of cities; 3) understanding changes to shopping expenditure as well channel selection across online, in-person and pick-up options using a latent transition analysis and hurdle regression models; and 4) understanding the interaction between telework and non-work activity participation using activity diary data.

Chapter 1: Introduction

The issue of interaction between information and communications technologies (ICTs) and travel has fascinated transportation researchers and practitioners for over four decades. Early work in the late 1970s and 1980s (Mokhtarian, 1988; Mokhtarian, 1990a; Mokhtarian, 1990b; Nilles, 1988; Polishuk, 1975; Salomon and Salomon, 1984; Sullivan et al., 1994; Yen et al., 1994; Yen and Mahmassani, 1997) started with the idea of ICTs being a substitute for travel and that this could lead to significant energy savings and other societal benefits like congestion relief if a significant number of individuals decide to adopt the use of telecommunications technologies (Salomon, 1984). Most early work in this regard revolved around telecommuting, which led to some early experiments with incentivizing telecommuting (Joice, 2000) and later opened a pandora's box worth of questions regarding how to define telecommuting, who has the option to telecommute, who telecommutes given the option, and what kind of impact does it have on congestion (Mokhtarian et al., 1995; Mokhtarian and Salomon, 1996, 1997). The advent and increase in the penetration of internet made transportation researchers hopeful regarding the potential of ICTs to have a significant impact on urban congestion but ultimately transportation researchers identified and characterized a myriad of relationships between ICTs and travel like substitution versus complementarity, making it difficult to conclude whether ICTs have the potential to relieve congestion or reduce vehicle miles traveled (VMT) or emissions (Mokhtarian, 1990b; Salomon, 1985).

The work that started with telecommuting expanded over the years to include several new telemobility dimensions including e-shopping (Colaço and de Abreu e Silva, 2021; Gould and Golob, 1997; Le et al., 2022; Xi et al., 2020; Xue et al., 2021), tele-health (Butzner and Cuffee, 2021; Ellis et al., 2013; Loh et al., 2013), e-learning, and e-recreation. Despite this rapidly expanded spectrum of dimensions and early speculations regarding the ICTs leading to the so-called Death of Distance (Cairncross, 2001), widespread adoption of several of these dimensions had remained limited (leg. for e-learning and tele-health), or in cases where the adoption is high (telework and e-shopping), the ability of ICTs in reducing VMT has been questioned by many (Choo et al., 2005; Mokhtarian, 1998; Shabanpour et al., 2018; Walls and Safirova, 2004; Zhu and Mason, 2014). Regarding telecommuting, adoption largely remained limited to information workers but was still impacted by several issues like mentorship and supervision at the managerial end, personal need for socialization, visibility at workplace for career advancement and having appropriate environment to work from home at the individual end (Bélanger, 1999; Mokhtarian and Salomon, 1997; Noonan and Glass, 2012; Páez and Scott, 2007; Walls et al., 2007; Yen et al., 1994). Even when there was adoption of telecommuting, research suggested work trips were mostly replaced by an increase in non-work recreational or leisure trips, wiping out most of system level benefits in VMT and emissions (Bieser et al., 2021; Kim et al., 2015; Lachapelle et al., 2018; Pendyala et al., 1991; Zhu and Mason, 2014). In the case of e-shopping, while the advent of internet and mobile devices, improvements in available online product information and sometimes the ability to experience products using virtual or augmented reality increased adoption, evidence suggesting a multi-channel shopping behavior instead of a complete shift from physical to virtual shopping reversed most transportation-related benefits (Cao et al., 2010; Colaço

and de Abreu e Silva, 2021; de Andrade et al., 2016; Ding and Lu, 2017; Farag et al., 2003). In addition, e-shopping also led to increased freight activity related to delivery of goods, leading to increased infrastructure stress and additional congestion (Hammami, 2020; Howell, 2019; Urban, 2017). Overall, the field of telemobility and its ability to reduce congestion, VMT and emissions went from a period of hope to a period of lull, switching gears from "this could solve our problems" to "it's complicated".

In March 2020, the COVID-19 pandemic significantly disrupted the status quo, forcing millions of Americans into lockdown, significantly changing the way we work, travel, and spend our time and money for an extended period of time. The US national annual VMT estimates reached 2.84 trillion miles in 2021, dropping 13% compared to the previous year and lowest since 2001 (FHWA, 2022). On the demand/consumer end, the pandemic resulted in a tremendous growth in the adoption of tele-activities like telework, e-shopping, telehealth, e-learning and e-recreation. On the supply side, businesses and organizations positioned themselves to offer services online, employers became (or were forced to become) more accepting of remote work, and last mile delivery companies like Instacart and DoorDash expanded operations. Furthermore, global supply chains were significantly disrupted, a greater than usual number of individuals moved from cities to suburbs or across states, transit agencies across the nation reduced services, an unusually higher number of individuals resigned or moved jobs, and a visible uptick in use of active transportation modes such as biking and walking was evident. In the months to follow, COVID-19 vaccines were introduced, the economy recovered and VMT were back up significantly, almost to the pre-pandemic levels. After several months of adaptation, adoption, learning, and unlearning (regarding how to survive during these tough times, or how we really like our lives to be, or whether the choices we made during the pandemic are sustainable going forward), the landscape for work and telemobility remains in flux. While it is unlikely that all these pandemic-induced changes in the telemobility landscape will persist as cities open up and pandemic-related restrictions are removed, there remains strong inertia for at least some aspects of these changes to stay with us in the post-pandemic era. This is because a greater proportion of population is now exposed to these tele-activity options like e-shopping and understands the value these services bring to their lives. Further, the supply side providers of tele-activity services are also better prepared than they were in the pre-pandemic era. Given this strong inertia towards a "new-normal" than reverting to the "old normal" in the post-pandemic world, it is important for transportation agencies to gain a better understanding of the future of movement of goods and people so that appropriate transportation strategies can be devised to manage this expected change in travel demand patterns.

This report provides details regarding a 7-wave longitudinal tracking survey conducted to monitor the evolving consumer spending, telework, and activity participation behavior associated with the COVID-19 pandemic, with the goal of deriving insights on expected post-pandemic telemobility patterns and its interaction with physical mobility. The 7-wave longitudinal tracking survey was conducted between December 2020 and March 2022 through an online platform named Prolific (Palan and Schitter, 2018) and resulted in data from 1877 unique respondents from the United States.

We first present the details on the 12 categories of questions included in the survey; 1) weekly consumer spending on groceries, cooked food and non-food items; 2) monthly consumer spending on electronics, furniture, clothing and digital media; 3) home delivery frequency for groceries, cooked meals and other non-food items; 4) telework related travel frequency through the pandemic; 5) travel, trip-making and time use behavior; 6) attitudes, perceptions and experiences of the individuals with telework and e-commerce through the pandemic; 7) use of subscription services like amazon prime, streaming services as well as local transit pass; 8) additional related question on pre-pandemic and post-pandemic expected behavior; 9) individual intention to use contact-free deliveries like delivery robots in the post-pandemic era; 9) a detailed 24-hr activity diary data; 10) direct impact of the pandemic like job loss, and COVID-19 infections; 11) individual experiences with depression, anxiety or positivity in life as a result of the pandemic; and 12) socio-demographics. This is followed by information on the survey dissemination strategy and incentives provided to the respondents and the response rate across various waves of the survey. Next, we present preliminary exploratory analysis using the collected data on changing consumer spending; telework behavior and related attitudes and experiences; and the use for various types of online entertainment, delivery, and local transit pass related subscription services at various time points including pre-pandemic, last three years and post-pandemic. We end the report with a summary of several ongoing and completed studies using the collected data.

Chapter 2: Survey Design and Data Collection

The data collected through the longitudinal online panel survey totaled *seven waves* at the *following* time points, where the first six waves were disseminated about every two weeks between December 21, 2020, and March 8, 2021 and were followed by a seventh wave disseminated on March 28, 2022 *(about one year after wave 6)*:

- Wave 1: December 21, 2020
- Wave 2: January 11, 2021
- Wave 3: January 25, 2021
- Wave 4: February 08, 2021
- Wave 5: February 22, 2021
- Wave 6: March 08, 2021
- Wave 7: March 28, 2022

The choice of disseminating the survey every 2 weeks (in waves 1 to 6) strikes a balance between collecting data frequently enough to make nuanced observations on rapidly shifting behaviors during the pandemic while collecting data for a long enough period in the context of the pandemic (which had been declared a national emergency in the U.S. 9 months prior in March 2020). In the lead-up to the first wave of data collection, COVID-19 cases were on a record-breaking rise during November 2020, with over 100,000 new cases in a single day in the U.S. Indoor gatherings were heavily attributed to the rapid spread of the virus (Chang et al., 2021), especially with the colder weather during that period. December 2020 presented a period of positivity, with Pfizer and Moderna vaccines being granted Emergency Use Authorization from the FDA (U.S. Food and Drug Administration), with available vaccine doses being offered to healthcare workers, first respondents and other compromised groups. However, this was marred by the emergence of the Alpha variant of the COVID-19 virus.

During January 2021, the number of cases and deaths started dropping in the U.S. following another set of record-breaking numbers, with over 300,000 new daily cases (Johns Hopkins Coronavirus Resource Center, 2022). More variants of the virus started emerging, such as the Beta variant detected in the same month. In the following months, vaccines remained in short supply as doses were offered by age groups. At the time of the sixth wave in this study in March 2021, vaccines were still limited to only seniors over the age of 65 outside of the groups mentioned earlier and had not yet been mass adopted. Nonetheless, at this time, the number of cases was rather stable with roughly 50,000 new daily cases. In this period, Americans continued to see the pandemic as a pressing issue in the months to come but also expressed some optimism about the growing availability of vaccines (Deane et al., 2021).

The choice to disseminate another wave of data collection in March 2022 was deemed appropriate since 77%, 66%, and 29% of U.S. population were partially, fully, and fully vaccinated with at least one booster shot, respectively; and the COVID-19 cases were also at its lowest level since last minima in June/July

2021. Further, this period also corresponds to the completion of 2 years of the beginning of the pandemic and is potentially a point where consumers had enough time to evaluate whether the behavioral choices that they were forced to make during the pandemic were worth continuing going forward.

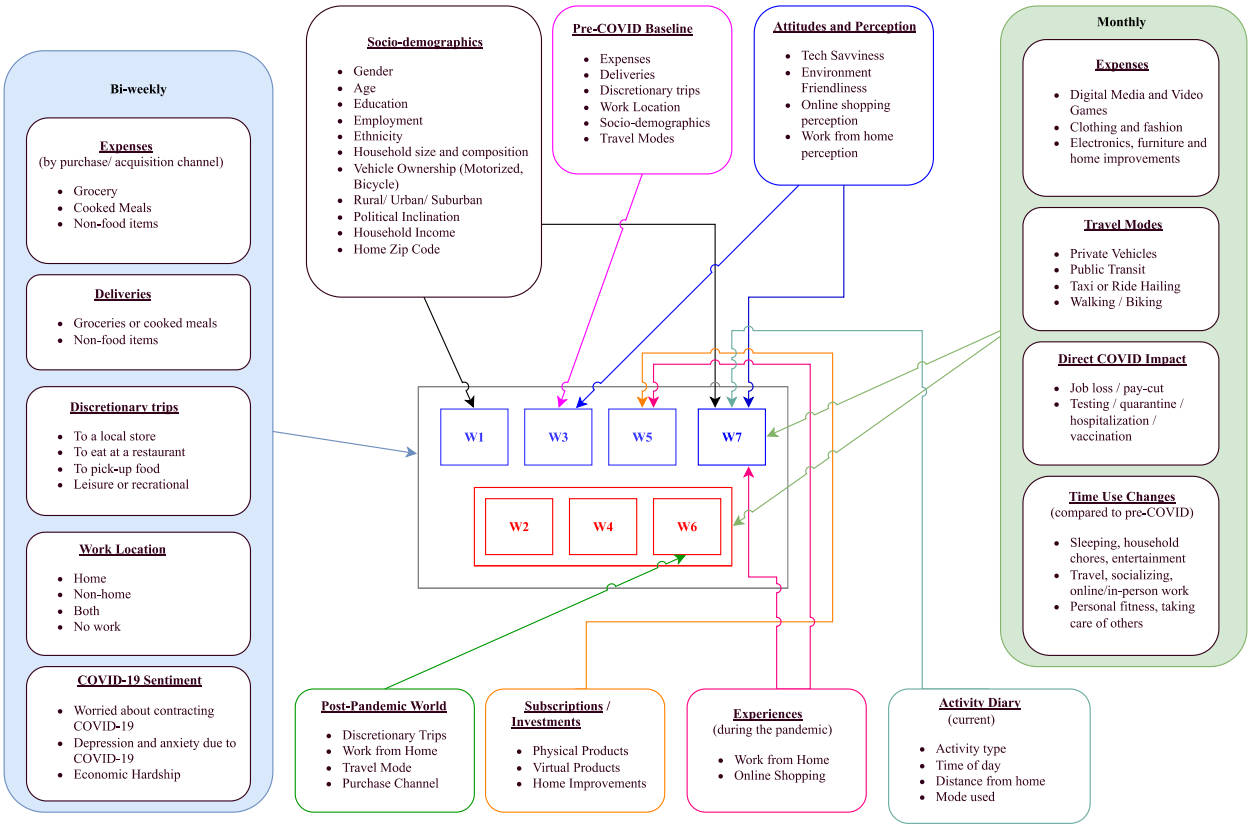

Figure 1 An overview of the 7-wave longitudinal survey

Survey Design

Figure 1 presents a summary of various blocks of questions asked in the 7-wave longitudinal survey, along with information on the waves in which they were asked. The 7-wave panel study consisted of several independent blocks of questions that allow for modularity across waves. Each survey is kept to a length of about **10 minutes (15-20 minutes for Wave 7)**. Several questions on household spending are included in every survey wave, representing a *core block* of the survey. Other questions were only included in a subset of the seven survey waves. We present details on the 12 categories of questions included in the survey; 1) weekly consumer spending on groceries, cooked food and non-food items; 2) monthly consumer spending on electronics, furniture, clothing and digital media; 3) home delivery frequency for groceries, cooked meals and other non-food items; 4) telework related travel frequency through the

pandemic; 5) travel, trip-making and time use behavior; 6) attitudes, perceptions and experiences of the individuals with telework and e-commerce through the pandemic; 7) use of subscription services like amazon prime, streaming services as well as local transit pass; 8) additional related question on pre-pandemic and post-pandemic expected behavior; 9) individual intention to use contact-free deliveries like delivery robots in the post-pandemic era; 9) a detailed 24-hr activity diary data; 10) direct impact of the pandemic like job loss, and COVID-19 infections; 11) individual experiences with depression, anxiety or positivity in life as a result of the pandemic; and 12) socio-demographics.

The waves in which these questions were asked is also mentioned in **[square brackets in boldface]** in each subsection. For some of the questions, a pre-COVID baseline version and the expected post-COVID behavior version were also asked, this information is also presented in the square brackets in **green** and **purple** colors, respectively. For example, if a question was asked in all waves and a pre-COVID baseline and post-COVID expected behavior version of the question as also asked, that (sub)-section of question has a phrase written as **[All waves, pre-COVID, post-COVID]**.

Consumer Spending on Groceries, Cooked Food and Non-food items
[All waves, pre-COVID, post-COVID]

This section queries respondents about their household spending in 3 different categories: (a) weekly grocery spending, (b) weekly prepared food spending, and (c) weekly spending on items other than grocery or food. The questions are presented to respondents as follows:

a. In the **past week**, how much has your household spent on **groceries** […] (including uncooked meal kits and alcoholic beverages, in-store, online or otherwise)?

   [Response categories: $0; $1-$49; $50-$99; $100-$199; $200-$299; $300 or more]

b. In the **past week**, how much has your household spent on **cooked meals** (such as a cooked meal kit or food from a restaurant) […]?

   [Response categories: $0; $1-$49; $50-$99; $100-$199; $200-$299; $300 or more]

c. In the **past week**, how much has your household spent on purchases **other than groceries or cooked meals** (such as electronics, books, or clothing) […]?

   [Response categories: $0; $1-$99; $100-$249; $250-$499; $500-$999; $1000 or more]

Respondents are asked to answer the above questions for each of the following access channels: ***in-person spending***, ***ordered online for pick-up*** **and** ***ordered online and delivered*****.** Additionally, in the case of groceries, respondents are asked about their *total* weekly spending across all channels.

Consumer Spending on Electronics, Furniture, Clothing, And Digital Media
[Waves 2, 4, 6, 7, pre-COVID, post-COVID]

This section seeks responses about household spending on the following *miscellaneous items*: (a) monthly spending on home improvement and electronics, (b) monthly spending on clothing and apparel, and (c) monthly spending on digital media and video games. The questions are presented below;

a. In the **past 30 days**, how much has your household spent on **electronics, furniture, or other home improvement purchases** in *total*?

   [Response categories: $0; $1-$249; $250-$499; $500-$999; $1000-$1499; $1500 or more]

b. In the **past 30 days**, how much has your household spent on **clothing, shoes, or other fashion accessories** in *total*?

   [Response categories: $0; $1-$49; $50-$99; $100-$199; $200-$299; $300 or more]

c. In the **past 30 days**, how much has your household spent on **digital media** (such as DVDs, Netflix, Spotify or Audible) and **video games** (such as disc purchases, digital purchases, or video game subscriptions) in *total*?

   [Response categories: $0; $1-$49; $50-$99; $100-$199; $200-$299; $300 or more]

The objective of these questions is to capture spending shifts for selected spending categories known to have been affected by the pandemic (Sherman and Huth, 2020). These questions are only presented to respondents once every two waves (i.e., once a month) and since it is expected that these expenses are not likely to occur at a similarly frequent cadence as spending on essential categories such as groceries or food. Later, these questions were also included in wave 7. Furthermore, respondents are only asked to report their *total* spending for the latter three categories, unlike earlier weekly spending questions, mainly to avoid respondent fatigue.

In addition to measuring spending throughout the pandemic, respondents are asked to recall their **spending prior to the pandemic to establish a *pre-COVID baseline***. Pre-COVID spending questions are only presented to respondents once across seven waves and mirror the latter spending questions in terms of categories, channels and wording. Using *total weekly grocery spending* as an example, the pre-COVID baseline question is;

"Before the COVID-19 pandemic, in a **typical week**, how much did your household spend on **groceries** in *total* (including uncooked meal kits and alcoholic beverages, in-store, online or otherwise)?"

To avoid erroneous responses and to facilitate visual differentiation, *pre-COVID baseline* questions have been presented to respondents in a consistently different color (green) across waves. This information was collected in waves 3 and 4. While the authors acknowledge the potential bias inherent in asking

respondents to recall past spending, the responses still offer valuable insight into the impact of the pandemic on spending behavior, especially in the absence of a practical alternative approach to obtain this information.

Home Deliveries
[All waves, pre-COVID, post-COVID]

In addition to the spending questions above, the following sections of questions were also included to gather information on frequency of home deliveries and packages received by a household. Specifically, we asked questions on a) number of deliveries received for groceries and cooked meals, and b) number of packages received for online deliveries other than groceries and cooked meals. These were asked to gain an understanding of the frequency of travel of the last-mile and package delivery drivers. The questions are presented below:

a. In the **past week**, how many deliveries has your household received for **groceries or cooked meals**? (asked separately for groceries and cooked meals)

   [Response categories: Not even one, 1-2 deliveries, 3-4 deliveries, 5-6 deliveries, 7 or more]

b. In the past week, how many packages has your household received from online deliveries **other than groceries or cooked meals** (from platforms such as Amazon, Ebay or others)?

   [Response categories: None at all, 1-3 packages, 4-8 packages, 8-14 packages, 15 packages]

Telework Related Travel Frequency

Apart from the spending and deliveries related questions, since the pandemic also heavily impacted the telework behavior, a section of questions were focused on understanding telework related behavior and included the following two questions on: a) work location on each day of the past week; b) work location at various time points in during the pandemic or in the future. This set of questions were only asked to individuals who were either employed (full-time or part-time) or were students at the time of the survey.

a. In the past week, on the following days, did you work or study mostly from …? (asked for each day of the week) **[All waves, pre-COVID, post-COVID]**

   [Response categories: Home, Non-home location, Both, Did not work or study]

   The pre-COVID version of the above question was worded as below:

   "**Before the COVID-19 pandemic**, in a typical week, how many days did you work or study from the following locations? Total must be equal to 7."

   [Response categories: Home, Non-home location, Both, Did not work or study]

Similarly, the post-COVID version was worked as below:

"Thinking about your life once the COVID-19 pandemic is **no longer a significant public health risk**, approximately how many days per week do you expect to work or study from the following locations? Total must be equal to 7."

[Response categories: Home, Non-home location, Both, Did not work or study]

b. In each of the dates, where have you been (or expect to be) working from? **[Wave 7]**
    - During 2019 (before the COVID-19 pandemic)
    - April 2019 (start of lockdown period, 1st peak in COVID-19 cases)
    - August 2020 (2nd peak in COVID-149 cases)
    - April 2021 (vaccine available for all adults)
    - July 2021 (COVID-19 cases at all time low)
    - December 2021 (surge in cases due to Omicron variant)
    - March 2022 (current month)
    - October 2022
    - April 2024

    [Response categories: Exclusively on-site / at the office, Mostly on-site /at the office, Sometimes at home and sometimes on-site / at the office, Mostly at home, Exclusively at home, Not Applicable]

Travel, Trip-making, and Time-Use

Another important aspect that was heavily impacted due to the pandemic was the physical mobility behavior of the individuals since the pandemic related lockdown as well individual's precautionary behavior ultimately led to a smaller number of trips for various purposes. In this regard, the survey included questions on a) frequency of visit for various discretionary trips, b) frequency of use of various modes, c) time use on various activities like personal fitness, online meeting for work etc. These questions are presented below.

a. In the past week, how many times did you leave the house for the following purposes? **[All waves, pre-COVID, post-COVID]**
    - To visit **a store** like a local grocery store, an apparel store, a drugstore or a hardware store
    - **To eat / drink** at a **restaurant**, a fast food chain or coffee shop
    - **To pick-up** food from a **restaurant**, fast food chain or coffee shop
    - For **leisure or recreational** purposes (such as exercising, socializing or going for a walk)

    [Response categories: Not even once, 1-2 times, 3-4 times, 5-6 times, 7 or more times]

The pre-COVID version of the above question was asked as follows:

"Before the COVID-19 pandemic, in a typical week, how many times did you leave the house for the following purposes?"

[Response categories: Not even once, 1-2 times, 3-4 times, 5-6 times, 7 or more times]

The post-COVID version of the above question was asked as following:

"How frequently will you **leave your house** for the following purposes once COVID-19 is no longer a significant public health risk (compared to your life before the COVID-19 pandemic)?"

[Response categories: Significantly less, Slightly less, About the same, Slightly more, Significantly more]

b. In the past 30 days, how often did you use the following modes for **trip-making**? **[Wave 2,4, 6, 7, pre-COVID, post-COVID]**
    - Private vehicle or motorcycle
    - Public Transport
    - Taxi or Ride Hailing Service (e.g. Uber, Lyft, …)
    - On-Food (excluding activities such as walking for leisure, pet-walking, exercise, etc.)
    - Bicycle (for purposes other than exercise or cycling for leisure)

    [Response categories: Nearly every day, 4 to 5 times a week, 1 to 3 times a week, Never]

The pre-COVID version of the above question was asked as follows:

"**Before the COVID-19 pandemic**, in a typical week, how often did you use the following modes for trip-making?"

[Response categories: Nearly every day, 4 to 5 times a week, 1 to 3 times a week, Never]

The post-COVID version of the above question was asked as following:

"How frequently will you use the following **transportation modes** once COVID-19 is no longer a significant public health risk (compared to your life before to the COVID-19 pandemic)?"

[Response categories: Significantly less, Slightly less, About the same, Slightly more, Significantly more]

c. In comparison to life before COVID-19, in the **past 30 days**, have you spent more or less time on the following activities? **[Wave 2, 4, 6]**
    - Sleeping
    - Personal care and hygiene
    - Digital entertainment (e.g., movies, videogames, podcasts, music, …)
    - Internet browser (e.g., online shopping, social media, …)

- Household chores and errands (e.g., cleaning, laundry, cooking, …)
- Attending to pets (e.g., feeding, walking, grooming, …)
- Work-related **online** meetings or collaborations
- Work-related **in-person** meetings or collaborations
- Socializing with friends and family **online**
- Socializing with friends and family (who are not household members **in person**
- Attending religious services **online**
- Attending religious services **in-person**
- Travel for business
- Travel for leisure
- Hobbies
- Personal fitness
- Volunteering
- Helping kids with schoolwork
- Attending to kids for matters other than schoolwork
- Caring for family member or friend (other than kids)
- Attending classes or coursework online
- Attending classes or coursework in-person

[Response categories: Much less, Somewhat less, About the same, Somewhat more, Much more, Not applicable]

d. Please select all that apply. **[Wave 6]**

- I took a passenger flight for travel at least once since the beginning of the pandemic
- I would fly today if I needed to
- I will fly only once I am vaccinated
- I will fly once a significant share of the population is vaccinated
- I will never fly again
- I rarely ever take passenger flights regardless of the pandemic
- None of the above

Attitudes, Perceptions, and Experiences

Given that prior research has shown that individual attitudes, perceptions, and experiences often drive the behavior one participates in, our survey has numerous questions to gauge an understanding of individual attitudes and experiences with; a) technology and environment, b) online shopping, c) work from home. Some of these questions were asked in more than one waves to track the evolving nature of these attitudes and perceptions because of changing pandemic related context as well as human level learning.

a. Please indicate your level of agreement with the following statements related to **<u>technology and environment.</u> [Wave 4 and 7]**

- Technology is changing society for better
- I am excited to learn about new technologies in the market
- I pay more to get more technologically advanced products
- I would be willing to make personal sacrifices for the sake of protecting the environment
- The environmental issues facing humankind have been exaggerated
- I am concerned with the news about climate change

b. Please indicate your level of agreement with the following statements related to **<u>online shipping.</u> [Wave 4 and 7]**

- Online shopping is more convenient than shopping in-store
- It is difficult to compare similar products online
- I prefer to shop in-store than online
- I don't find online product reviews to be trustworthy
- Having items delivered directly to my doorstep is an advantage of online shopping
- Online shopping is harmful for small local businesses
- Ordered items online is better for the environment

c. Please indicate your level of agreement with the following statements related to **<u>work from home.</u> [Wave 4 and 7]**

- Flexibility to work from home helps me live a better life
- It is difficult to handle work-life balance working from home
- Working from home is better for the environment
- The quality of my work since working from home has degraded
- I find it difficult to communicate with my colleagues while working from home
- Working from home will negatively affect my career in the long run

[Response categories for all three sets of questions: Strongly disagree, Disagree, Neither agree or disagree, Agree, Strongly agree]

d. Imagine that your employer has committed to a future work program allowing a hybrid workforce with an option of remote work for 2 days a week. In your opinion, what effects will such a program have on the following? **[Wave 7]**

- Your productivity
- Your creativity
- Your ability to innovate
- Your effectiveness to get the job done
- Your ability to receiving / delivering appropriate mentoring
- Your ability to receiving / delivering appropriate feedback
- Your teamwork and ability to collaborate

- Your career advancement
- Social interaction with colleagues
- Your employer's ability to accomplish its goals
- Your employer's profit
- Your employer's public image

[Response categories: Very negative, somewhat negative, Neither negative nor positive, Somewhat positive, Very positive, Not Applicable]

e. Please indicate your level of agreement with the following statements about working from home. **[Wave 5]**
    - The following factors hinder my ability to work from home…
        - … lack of appropriate technology like a laptop or a webcam at home
        - … distraction from other household members
    - The following factors improve my ability to work from home…
        - … ability to set my own work hours
        - … not needing to commute to work
    - I have been more productive working from home
    - I prefer to work on-site / at the office than to work from home
    - The option to work from home after the pandemic would improve my quality of life

    [Response categories: Strongly disagree, Somewhat disagree, Neither agree nor disagree, Somewhat agree, Strongly agree, Not applicable]

f. How satisfied are you with your experience of working from home? **[Wave 5 and 7]**

    [Response categories: Very dissatisfied, Somewhat dissatisfied, Neither satisfied nor dissatisfied, Somewhat satisfied, Very satisfied]

g. Please indicate how much the following factors affect your decision to purchase items **in-person** (at-store) versus ordering **online** (for delivery or pickup)? **[Wave 5]**

    - Overall product quality
    - Overall availability of products
    - Overall price of products and additional fees
    - Option to return goods
    - Item size is large
    - Item is expensive
    - Proper social-distancing
    - Being in a rush to get an item

[Response categories: Much more likely in-person, Somwhat more likely in-person, Equally likely in-person or online, Somewhat more likely online, Much more likely online]

Subscription, Services and Life at Home

The survey also included questions to gather an understanding of household level investment in subscription services like Amazon Prime or a transit pass and investing in items that my improve life at home pre, during and after the pandemic since this potentially may have an impact on short term or long-term choices. Specifically, the survey included questions on a) whether or not a household spend money on various types of subscription services pre, during and post pandemic; b) how spending on subscription services has changed since he beginning of the pandemic, c) spending on items that improve life at home including office furniture or electronics.

a. Please indicate whether or not you have used the following services prior to or during the pandemic. Also indicate if you indent to keep using them after the pandemic. Select all that apply **[Wave 5 and 7]**
    - Amazon
    - Online retailers other than Amazon (such as Walmart, Target or eBay)
    - Restaurant delivery services (such as Uber Eats, DoorDash or restaurant-provided delivery)
    - Cook-at-home meal kits (such as HelloFresh or Blue Apron)
    - Grocery delivery services (such as Instacart, goPuff or store provided delivery)
    - Movie and Tv show streaming (such as Netflix, Disney+ or Hulu)
    - Music streaming (such as Spotify, Apple Music or Tidal)
    - Video game subscriptions (such as PlayStation+, Xbox Game Pass or Twitch)
    - Amazon Prime subscription
    - Local Transit pass

    [Response categories: Never used nor plan to use in future, Used it before the pandemic, Used it earlier in the pandemic, Currently use it, Indent to use it after the pandemic]

b. Compared to life before COVID-19, please indicate how much your household spending (in $/month) on the following subscriptions has roughly changed as a result of the pandemic. If your answer is $0, note that you need to click on the slider to select $0. **[Wave 5]**
    - Movie and Tv show streaming (such as Netflix, Disney+ or Hulu)
    - Music streaming (such as Spotify, Apple Music or Tidal)
    - Video game subscription (such as PlayStation+, Xbox Game Pass or Twitch)
    - Local Transit pass

    [Response categories: -$50 to +$50 on a $10 sliding scale]

c. Please indicate how much your household has roughly spent on the following items **as a result of the pandemic**, even if the purchase was reimbursed by your employer. **[Wave 5]**
    - **Home office furniture** (such as work desk, chair or monitor arm)
    - **Home office electronics** (such as laptop, webcam or headphones)
    - **Entertainment-related electronics** (such as TV, home theatre or gaming consoles)
    - **Home improvements** (such as repairs, construction etc.)

    [Response categories: Nothing at all, $1-$99, $100-$249, $250-$499, $500-$999, $1000 or more]

Additional Post-Pandemic Behavior Questions
[Wave 6]

Apart from the several post-pandemic behavior questions mentioned earlier, the survey also included the following three questions to gather information on individuals' preferences on a) purchasing and acquiring groceries, b) purchasing and acquiring cooked meals, c) purchasing and acquiring various types of non-food items like clothing, small or large appliances etc. in the future when the COVID-19 pandemic is no longer a significant public health risk.

a. Please **rank** the following options to **purchase and acquire groceries** once COVID-19 is **no longer a significant public health risk**. (**Drag and drop** to re-order ranking, **higher ranking is more preferred option**)
    - Order online for **pick-up**
    - Purchase **in-store**
    - Order online for **home delivery**
b. Please **rank** the following options to **purchase and acquire cooked meals** like food from restaurants once COVID-19 is **no longer a significant public health risk**. (**Drag and drop** to re-order ranking, **higher rank is more preferred option**)
    - At restaurant or in-store purchase for **dine-in**
    - At restaurant or in-store purchase for **take-out**
    - Online order via phone call for **pick-up**
    - Online order or via phone call for **delivery**
c. Thinking about your life once the COVID-19 pandemic is **no longer a significant public health risk**, select your **most preferred** way to **purchase and acquire product** in the following categories.
    - **Clothing**, shoes, or other fashion accessories
    - **Small home appliances** like a microwave or an air fryer
    - **Large home appliances** like a refrigerator
    - **Technology equipment** like a laptop, a mobile phone, a hard drive etc.
    - **Furniture** like a sofa or a dinner table

- **High value jewelry** like a ring or a necklace

[Response categories: Purchase in-store, home delivery, pick-up, no preference]

Contact-Free Deliveries

[Wave 6]

Since the pandemic potentially resulted in individuals to refrain from close contact with others, a hypothesis involved was that the pandemic may accelerate the acceptability of contact-free delivery services like autonomous robots or drones and that this behavior might trickle down the post pandemic era. To gather data to find evidence to support this hypothesis, following two questions were added to the survey.

a. For services that typically require contact delivery personnel (such as grocery delivery or food delivery), how likely are you to choose **contact-free delivery** instead of receiving your delivery in-person…?
    - Today, during the pandemic
    - After COVID-19 is no longer a significant public health risk

    [Response categories: Very unlikely, Unlikely, Neither likely nor unlikely, Likely, Very Likely]

b. Is your preference for contact-free delivery driven by (or related to)… ?
    - Contact-free delivery is more convenient
    - I like not having to interact with delivery people
    - I seek to maintain social distancing
    - I worry about my items getting stolen
    - None of the above

Activity diary

[Wave 7]

To understand how individual activity behavior has potentially changed as a result of the pandemic and how this behavior differs across various groups like teleworks and non-teleworks, an activity diary was also included in wave 7 of the survey where individuals were asked to report a detailed account of the activities they participated in on the day prior to the day survey was filled. The activity diary included drop-down 6 menu columns with the option to report activity type, start and end time of the activity, activity location, distance of the activity location home and mode used to reach the activity location. Table 1 presents the options available to the respondents for each response column.

a. Record the activities you participated in yesterday starting at 4AM this morning

Table 1: Structure of the activity diary

Activity	Start Time	End Time	Activity Location	Distance from home	Mode used to reach activity location if not home
• Sleeping • Personal Maintenance • Entertainment / Leisure • Working at main job • Working at other job • Preparing meals or snacks • Eating and drinking • Household Chores • Grocery or other shopping • Caring for others • Socializing • Driving / Traveling • Exercise • Other	4 AM (yesterday) to 3 AM (today)	5 AM (yesterday) to 4 AM (today)	• In-Person • Online / virtual	• At Home • Less than a mile • 1-2 miles • 2-5 miles • 5-10 miles • 10-20 miles • More than 20 miles	• Private car • Public Transit • Bicycle • Uber/Lyft/Taxi • Airplane • Walking • Scooter • Other • Not applicable

Direct Impacts of COVID-19 Pandemic

[Wave 2, 4, 6, pre-COVID]

The goal of this section is to query respondents about major events or disruptions that may have occurred due to the pandemic, as it is hypothesized that such major changes are likely to affect habits and spending. Respondents are asked every two waves if in the prior month they or their household members (a) have lost a job due to the pandemic, (b) have received a pay cut due to the pandemic, (c) have been tested for COVID-19 and the result of the test, and d) have moved their place to residence and the zip code of the new residence location. They are also asked individually if they (e) have taken the COVID-19 antibody test and the result of the test, and (f) have taken at least one dose of a COVID-19 vaccine.

Pandemic Related Worry

[All waves]

Given that the pandemic severely impacted mental health of many individuals, potentially related to lockdown, lack of socialization and isolation, we also added statements to gauge an understanding of the impact of the pandemic on mental health, depression, anxiety and individual ability to live their lives the best they can. The first two statements were adapted from Patient Health Questionnaire – 4 (PHQ-4) (Löwe et al., 2010), tailored towards measuring anxiety and depression, while others were designed to gauge more positive impact of the pandemic on everyday life.

- As a result of the current COVID-19 situation, I feel **nervous, anxious or on edge**
- As a result of the current COVID-19 situation, I have **little interest or pleasure in doing things**
- While the COVID-19 situation is concerning, I concentrate on **living my life as best as I can**
- While the COVID-19 situation is concerning, it has led to some **positive changes** in my life

[Response categories: Strongly disagree, Disagree, Neither agree nor disagree, Agree, Strongly agree]

Socioeconomics and Demographics

Finally, respondents are presented with questions related to their socioeconomic status and demographics. Respondents are asked about (a) gender, (b) age, (c) education, (d) employment status, (e) ethnicity, (f) household size, (g) number of children under 12 years old in household, (h) number of household vehicles, (i) number of household bicycles, (j) location of residence, (k) political views, and (l) household income.

Questions for some of the above attributes are repeated across waves to monitor possible adjustments, mainly (d) employment status, (f) household size, (j) location of residence, and (k) political views. Other questions are not repeated as they are assumed to be fixed within the timeframe of the data collection (such as age or number of children in the household) or to avoid respondent fatigue (such as household income).

Additionally, respondents are asked about their pre-COVID baselines for several socioeconomic and demographic variables, specifically (d) employment status, (f) household size, (h) number of household vehicles, (j) location of residence, and (l) household income.

Table 2: Overview of Longitudinal Survey Design and Respondent Recruitment

Wave	Date*	New Respondents	Returning Respondents	Total Responses	Cumulative Unique Respondents
1	Dec 21	457	-	457	457
2	Jan 11	107	372	479	564
3	Jan 25	103	421	524	667
4	Feb 08	101	466	567	768
5	Feb 22	103	485	588	871
6	Mar 08	101	516	617	972
7	Mar 28	905	386	1291	1877

* Wave 1 was disseminated in the year 2020; waves 2-6 were disseminated in 2021; wave 7 was disseminated in 2022

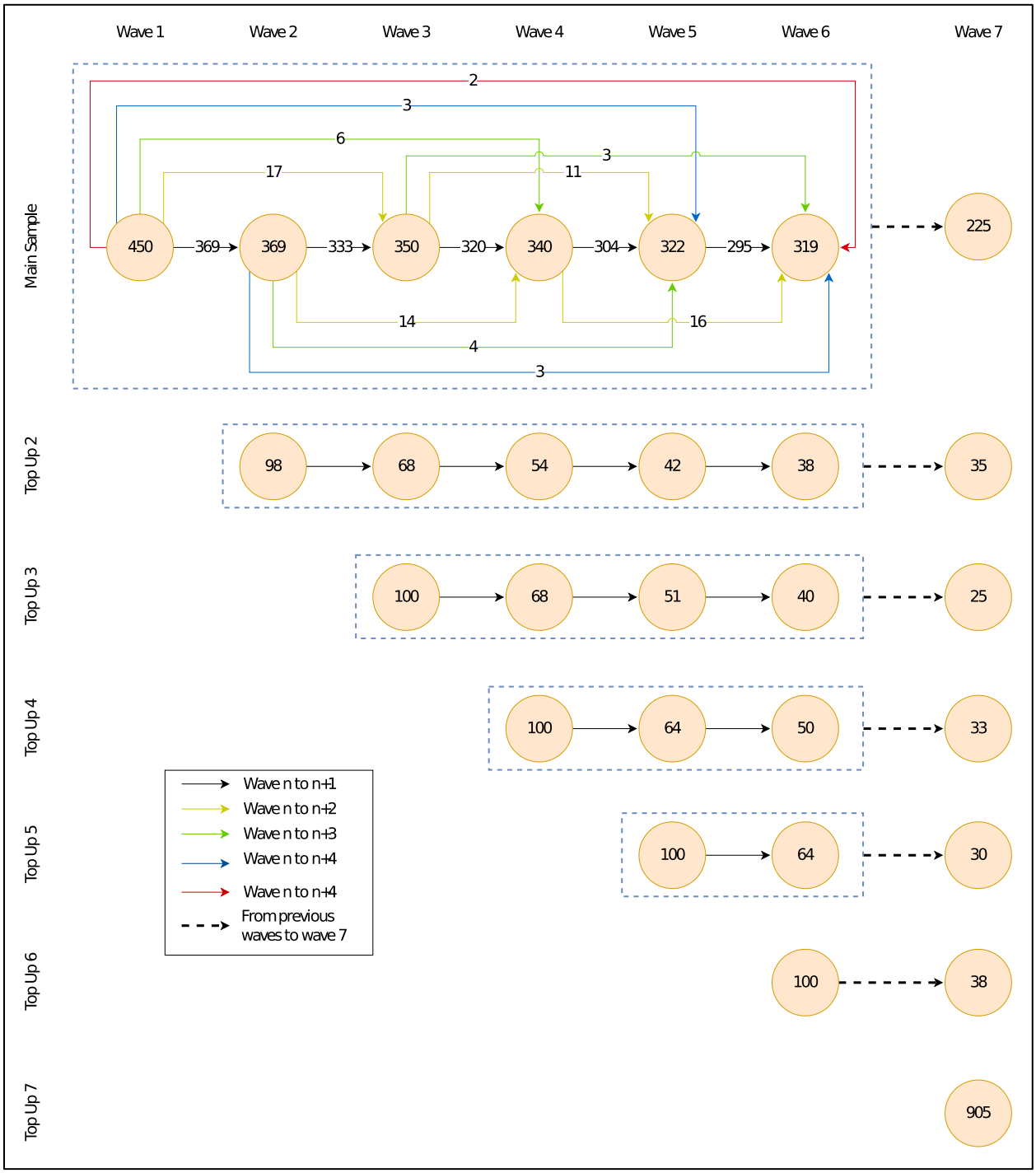

Figure 2: Respondents' retention / return dynamics across the 7 waves of the survey

Survey Dissemination Strategy, Incentive Structure and Response Rate

Survey Dissemination

Table 2 presents the number of new, returning, total and cumulative unique respondent in each wave of the survey. Wave 1 of the survey started with 457 adults who were recruited to build a U.S. population representative sample by age, gender, and ethnicity. The respondent group was informed about 5 more subsequent waves of the survey and how much they would be paid each wave before they agreed to complete the survey. The 457 respondents were then later reinvited for waves 2 to 6, irrespective of whether they completed the previous wave of the survey. We can this the main sample of respondents.

To make up for respondent attrition from the main sample, starting wave 2, a convenience sample with approximately 100 respondents was recruited in all waves till wave 6, who were then re-invited to participated in the subsequent waves, *if they have completed the previous wave*. We call this convenience sample as the top-up sample of respondents. Note that while the respondents in the main sample were reinvited for the subsequent waves regardless of whether they completed the previous wave, the respondents in the top-up sample were only invited if they had completed the previous wave of the survey.

In wave 7, everyone who joined waves 1 to 6 at least once was re-invited, along with a new U.S. population representative top-up of 905 individuals. Overall, the seven waves of data from 1877 individuals, with a smallest size of 457 respondents in wave 1 and the largest sample size of 1291 in wave 7. Figure 2 presents detailed dynamics of the respondents' return in various waves of the survey, (which excludes individuals who either returned for a wave of the survey but didn't complete that wave or individuals whose responses didn't pass the quality checks like straight lining, failing the attention check question etc.).

Table 3: Incentive structure for various waves of the survey

Wave	Main Sample - Static	Main Sample - Growing	Top up
1	$1.00	$1.00	NA
2	$1.80	$1.25	$1.00
3	$1.80	$1.50	$1.00
4	$1.80	$1.75	$1.00
5	$1.80	$2.00	New Respondents = $1.00 Returning Respondents = $1.50
6	$1.80	$2.50	New Respondents = $1.00 Returning Respondents = $1.50
7	Ethnic minorities^ = $7.50 Others = $5.00 New Respondents = $3.50		

NA = not applicable since no top-up data were collected

^ethnic minorities include those who reported their ethnicities to non-white or non-asian

Incentive Structure

Table 3 presents the information on monetary incentives provides to the respondents in each wave of the survey. The sample initially started with $1 incentive in wave 1 but was randomly split into two group; 1) a group with a growing incentive payment amount for each subsequent wave starting from $1.25 in wave 2 to $2.50 in wave 6; 2) a group with a static incentive structure of $1.80 in each wave. This was done to test whether changing the incentive structure could potentially lead to better return rate than usual. In the top-up sample, a $1 incentive was offered for waves 2 to 4 for both the new respondents as well as the returning respondents. However, in wave 5 and 6, the returning respondents were offered $1.50 to help improve retention. For wave 7, since the survey as sightly longer than the previous surveys due to inclusion of the activity diary, everyone who was re-invented from the previous 6 waves (both main sample and top-up sample) was offered an incentive of $5 if the respondent was of White or Asian ethnicities but was offered an incentive of $7.5 otherwise. This was done to improve the return rate from ethnic minorities since our data from the previous waves showed lower return rate from ethnic minorities. Lastly, new respondents in wave 7 were offered an incentive of $3.50.

Response Rate

As summarized in Table 2 and Figure 3, a total of 1877 unique respondents participated in the survey over the seven waves. Across these seven waves, 180 individuals participated in all 7 waves, 97 participated in 6 waves, 80 participated in 5 waves, 72 participated in 4 waves, 102 participated in 3 waves, 135 participated in 2 waves and 1211 participated in 1 wave (including wave 7 top-up). Out of the 972 respondents who participated in waves 1 to 6, who were then invited for wave 7, 386 returned to complete the survey. This corresponds to a return rate of 39.7%.

Chapter 3: Sample Description & Statistics

Table 3 presents the sample statistics of respondents from each of the 7 waves and its comparison with the U.S. population statistics. Further, Figure 3 presents the location of centroids of the zip codes of the respondents' residential locations are the time when they first joined the panel. If size of the markers is proportional to the number of respondents who joined from a zip code. Collectively, several important observations can be made from Table 3 and Figure 3 which highlights the quality of the data collected across the 7 waves of the data collected. Spatially, the respondents are well distributed across the United States and data have been collected from all 49 out of 50 states (excluding Vermont) and Washington D.C. A comparison of sample share and population share for a few selected states is presented in Table 3 where the sample shares for data in each wave is within a few percentage points of the population share.

Respondents to the survey were slightly younger than the population at large. Specifically, the sample has a higher proportion of respondents in the 55-64 years age group compared to 65 years or older, which is generally expected from online panels since the older individuals tend to find technology-based online surveys somewhat challenging. Even though our samples were designed to be age representative (at least in parts) this mismatch is also a likely manifestation of the fact that oldest age group coded in the Prolific platform panel is 58 years or older instead of 65 years or older.

Our sample matches well with the population shares in terms of ethnicity, with (an expected) slight over-representation of respondents with Asian ethnicity. Politically, the sample is *liberal leaning*. This bias is likely the result of self-selection in online surveys (Heen et al., 2014; Huff and Tingley, 2015; Zhang and Gearhart, 2020). Finally, the sample has some under-presentation of high-income individuals, especially in the $100,000 or above income group.

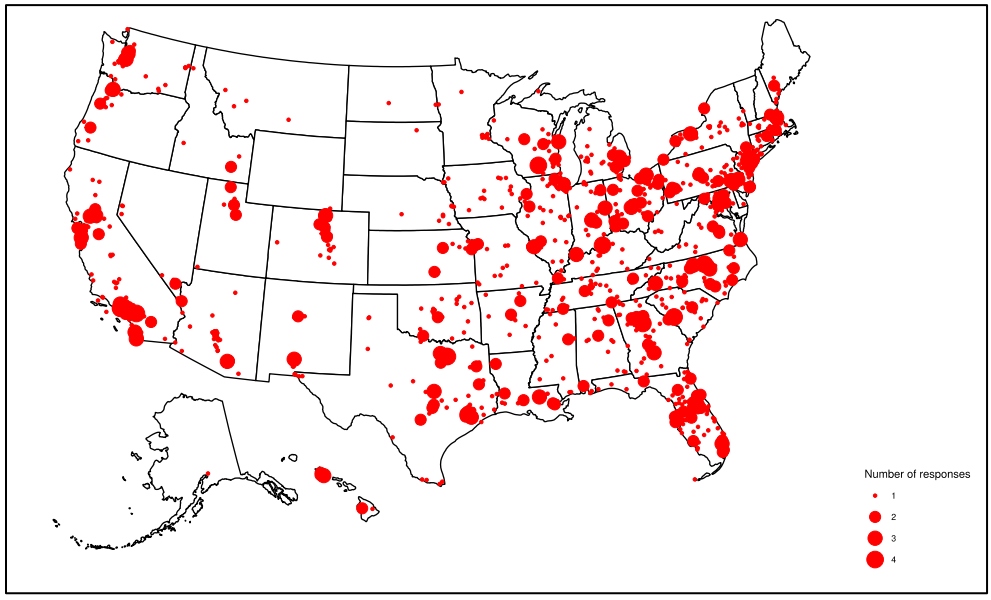

Figure 3: Zip Code centroid of respondent's location at the time of recruitment

Table 3: Sample statistics per wave compared with U.S. population

Statistics[†]	Wave 1	Wave 2	Wave 3	Wave 4	Wave 5	Wave 6	Wave 7	U.S. population / other sources[*] (%)
State								
California	10.5%	10.5%	11.4%	10.5%	12.5%	11.6%	11.2%	12.0%
Florida	8.7%	7.8%	8.3%	9.1%	7.6%	7.6%	8.1%	6.7%
New York	8.0%	8.5%	8.3%	8.2%	8.0%	7.6%	6.0%	6.2%
Texas	6.7%	7.6%	6.7%	6.9%	7.6%	8.5%	7.9%	8.3%
Gender								
Male	48.7%	48.7%	48.0%	48.0%	48.4%	48.8%	47.5%	49.2%
Female	50.0%	50.2%	50.4%	50.2%	50.0%	50.6%	50.8%	50.8%
Non-Binary	1.3%	1.1%	1.6%	1.8%	1.6%	0.7%	1.54%	-
Age								
18-24 years	10.9%	12.9%	12.0%	11.1%	11.1%	11.1%	11.7%	11.9%
25-34 years	19.3%	20.4%	21.3%	20.0%	20.2%	19.6%	20.0%	17.9%
35-44 years	19.1%	18.2%	18.4%	18.9%	19.6%	19.3%	18.0%	16.4%
45-54 years	16.7%	15.3%	14.4%	15.8%	15.6%	16.7%	16.7%	16.0%
55-64 years	19.6%	19.6%	19.8%	20.0%	19.6%	19.6%	19.0%	16.6%
65 years or older	14.4%	13.6%	14.0%	14.2%	14.0%	13.8%	14.6%	21.2%
Race & Ethnicity								
White	70.2%	69.6%	70.2%	69.8%	70.2%	70.9%	73.2%	74.1%
Black	14.4%	12.9%	12.7%	13.3%	12.7%	12.2%	11.7%	12.3%
Asian	8.0%	9.8%	8.7%	8.9%	8.7%	8.7%	6.7%	5.7%
Hispanic or Latino[‡]	4.4%	4.9%	5.6%	5.3%	5.1%	4.7%	5.3%	-
Other	2.9%	2.9%	2.9%	2.7%	3.3%	3.6%	3.1%	7.8%
Political Leaning								
Liberal	53.6%	56.3%	56.0%	57.9%	60.4%	58.8%	57.9%	26.0%
Moderate	19.2%	18.2%	18.7%	16.7%	16.6%	16.6%	19.9%	36.5%
Conservative	27.1%	25.5%	25.3%	25.5%	23.1%	24.6%	22.3%	37.5%
Income								
< $25,000	14.4%	15.5%	16.1%	16.5%	16.2%	16.4%	17.6%	14.9%
$25,000 - $49,999	25.6%	26.9%	26.6%	25.2%	26.3%	24.9%	24.5%	19.1%
$50,000 - $99,999	30.8%	32.8%	31.6%	34.0%	32.6%	33.1%	37.6%	32.0%
$100,000 - $149,999	16.0%	14.1%	14.9%	14.2%	14.2%	13.7%	12.7%	17.3%
≥ $150,000	13.2%	10.7%	10.8%	10.1%	10.7%	11.9%	7.6%	16.7%

[‡]*Survey inquired about race and ethnicity as a single category, whereas the census inquires about Latin/Hispanic origins separately (18.4% of the population)*

[*]*Sources: U.S. Census (U.S. Census Bureau, 2019): state, gender, age, race, ethnicity, and income*
Gallup 2020 Sample (Saad, 2021): political leaning

Chapter 4: Exploratory Analysis

This chapter presents an exploratory analysis of the data collected to gauge an initial understanding of changing telemobility trends through the pandemic and how they may look like in the future. Specifically, we present exploratory analysis on: 1) changes in weekly spending across various product categories and acquisition channels; 2) changes to telework trends through the pandemic and expected post-pandemic behavior; 3) individual attitude data on remote work; 4) individual satisfaction with remote work during the pandemic, which may like shape post pandemic adoption; and 5) changing trends in use of online services' subscription like Amazon prime, Netflix and transit pass purchases.

Consumer Spending

As discussed earlier, household spending data has been collected for three different buying *channels* (in-person, pickup, and delivery) for different product *categories* (groceries, prepared food, and items other than grocery or food). For simplicity, this chapter will refer to items other than groceries or food as *other spending*. Additionally, spending data have been collected on three further areas of spending (referred to as *miscellaneous*), particularly relevant in the work-from-home and social distancing period, namely home improvement and electronics, clothing and apparel, and digital media and video games.

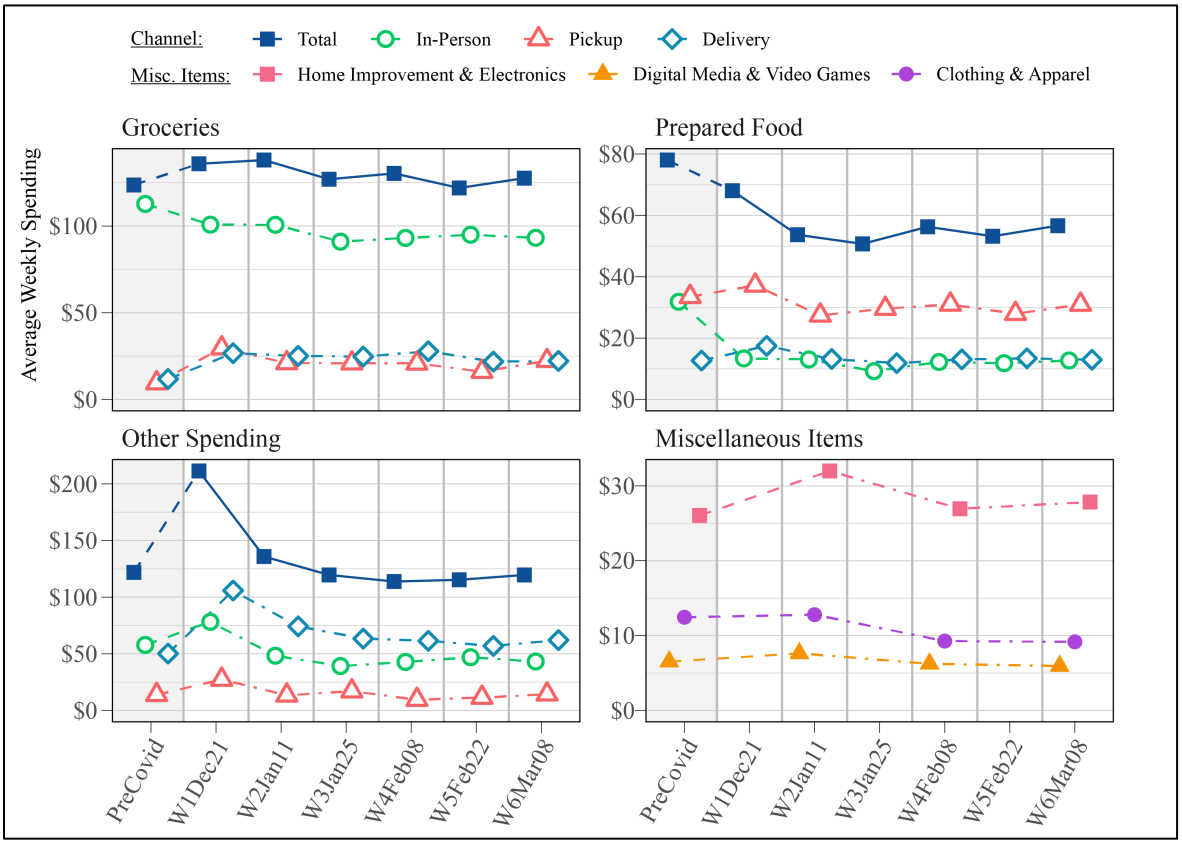

Figure 4: Weekly spending by item category by acquisition channel at different time points

The average spending for the latter categories and items across different channels is shown in Figure 4. The average percent change in spending during the pandemic compared to pre-COVID is presented in Figure 5a-c as a function of different household and respondent attributes. Average values are calculated by using the midpoint values for each spending category. Responses from Latino/a respondents have been grouped with the *other* ethnicity category due to insufficient responses for the pre-COVID baseline (12 responses).

The data show that grocery and other spending are the most sizeable categories of weekly household spending, mostly in the range of $100 and $150 per week on average. Total grocery spending is generally stable over time, with a slight increase around the holidays (Probasco, 2021). Instead, on the side of delivery channel preference, we observe adaptations with grocery spending shifting from in-person spending to pickup and delivery. This reflects a tendency to prefer acquisition of groceries through channels that do not require in-store presence. Looking more closely at household factors, several trends are noted. Figure 5a-c shows both item and channel type broken down by the most impactful household characteristics.

Households with more vehicles have a greater uptick in expenditure on grocery delivery and pickup. Food spending, however, decreased noticeably during the pandemic, from $78/week pre-COVID to $56/week on average during the pandemic. This shift is mainly the result of decreased spending at restaurants in person, which has not been offset via increased pickup or delivery orders. Households with higher income and higher education have a larger percentage decrease in spending on dining out, in part due to their higher spending on dining out pre-pandemic. Liberal-leaning respondents more significantly decreased their in-person spending on prepared food and dining during the pandemic. Similarly, older respondents live in households with a larger decrease in in-person spending on prepared food and dining out.

For items other than groceries or food, a significant increase in spending of about 1.7 times is observed during the holidays (wave 2) compared to other waves and pre-pandemic, likely the result of holiday shopping (Probasco, 2021). The largest increase is for delivery orders, in line with the popularity of e-commerce during the pandemic (Fareeha, 2021; Food, 2020). Excluding the holidays, however, there is a slight decrease in in-person spending, as also observed in (Ben Hassen et al., 2021). Unlike that work, we observe an increase in delivery channel spending compared to pre-COVID, suggesting a moderate substitution also for non-food spending.

Overall, a decrease in in-person spending is observed across all categories, in line with other observations and reports regarding the shift in spending channels during the pandemic (Popper, 2020). Whether due to lingering fear towards COVID-19 (Grashuis et al., 2020; Harper et al., 2021) or due to mobility restrictions, in-person spending remains lower than pre-COVID even a year into the pandemic. Excluding the holiday period of data collection, spending is mostly stable across the three months during which data was collected. This stability may be an indicator of adaptation and normalization during the pandemic (Hamilton et al., 2019) and is in line with recent work by Mishra et al. (2021). Earlier research has

suggested that periods of restriction caused by disruptions can, over time, lead consumption behaviors to become less reactive and more resilient (Hamilton et al., 2019).

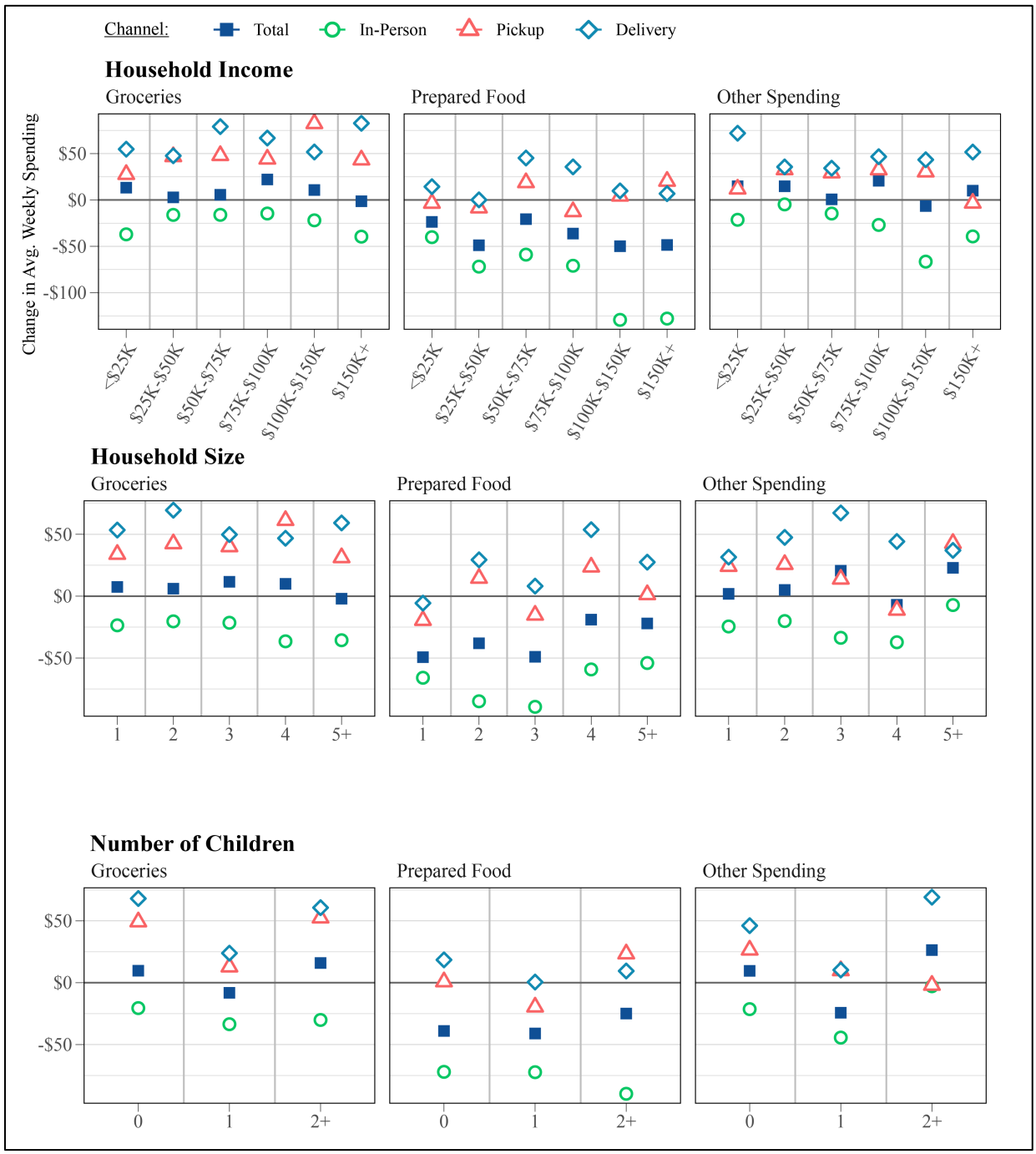

Figure 5a Change in weekly spending by item category and acquisition channel during the pandemic compared to pre-COVID

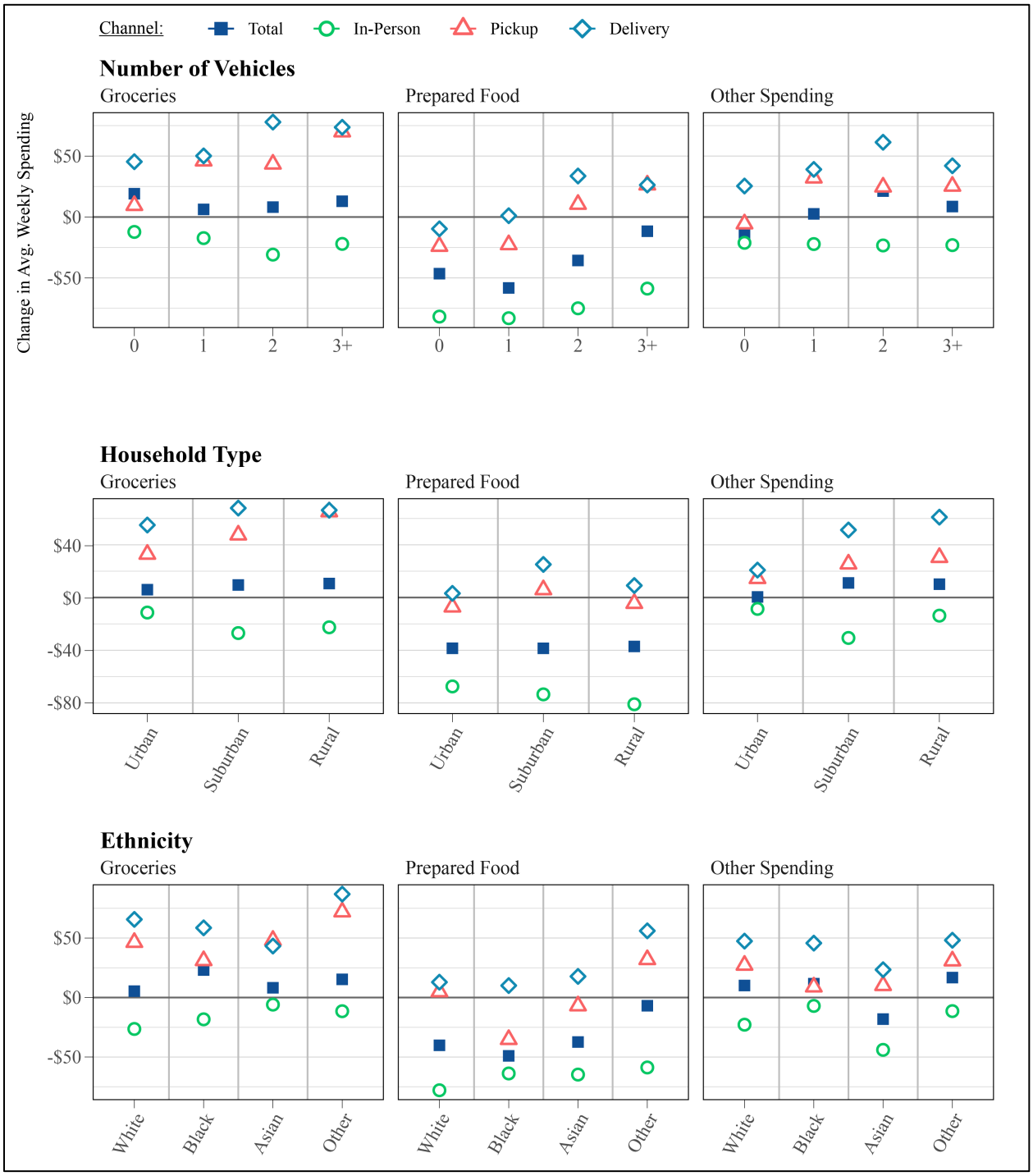

Figure 5b Change in weekly spending by item category and acquisition channel during the pandemic compared to pre-COVID

Looking at the *miscellaneous* items, the category with the highest spending is home improvement and electronics. A small increase in holiday spending is observed for this category from roughly $112/month pre-pandemic to $137/month on average, attributed to holiday spending on gifts, home decorations, and other household items (Probasco, 2021). Nonetheless, spending in waves 4 and 6 ($117/month) is similar to pre-pandemic levels. This observation is contrary to reports early in the pandemic which showed a noticeable increase in average home improvement expenditure (Sherman and Huth, 2020). Alternatively, the data from waves 4 and 6 seem to suggest that the surge in home improvement expenditure has been limited to the early months of the pandemic. As discussed in the next section, this discrepancy is the result of fewer households spending on home improvement and electronics, while those households that still spend on home improvement spend almost 1.7 times as much during the pandemic compared to pre-pandemic.

For clothing and apparel, a decrease in spending is observed in later waves (4 & 6), with spending outside of the holidays being lower than pre-pandemic spending – in line with other data (Ghosh, 2020; Sherman and Huth, 2020). This decrease is mainly due to a decline in the number of respondents who spent on clothing and apparel at the time of data collection. Prior to COVID-19, 83% of respondents have spent some amount on clothing and apparel, compared to 56% during the pandemic. This reduction is likely the result of limiting expenditures on non-essential services (Gu et al., 2021).

For digital media and videogames, while reports show increased spending in this category during the pandemic (Sherman and Huth, 2020), little variation in spending is observed in the data, even in comparison to pre-pandemic spending. Unlike the latter cases, spending in this category is accompanied by a smaller shift in the fraction of households that spend on media and gaming, with a change from 71% pre-pandemic to 61% during the pandemic and a 16% increase in spending for households that still spend on this category.

All in all, average spending appears to have generally stabilized at this stage of the pandemic. Besides spending on dining out and prepared food, spending on most categories and items are relatively similar to pre-pandemic spending, albeit with some shift in spending from in-person shopping towards pickup and delivery.

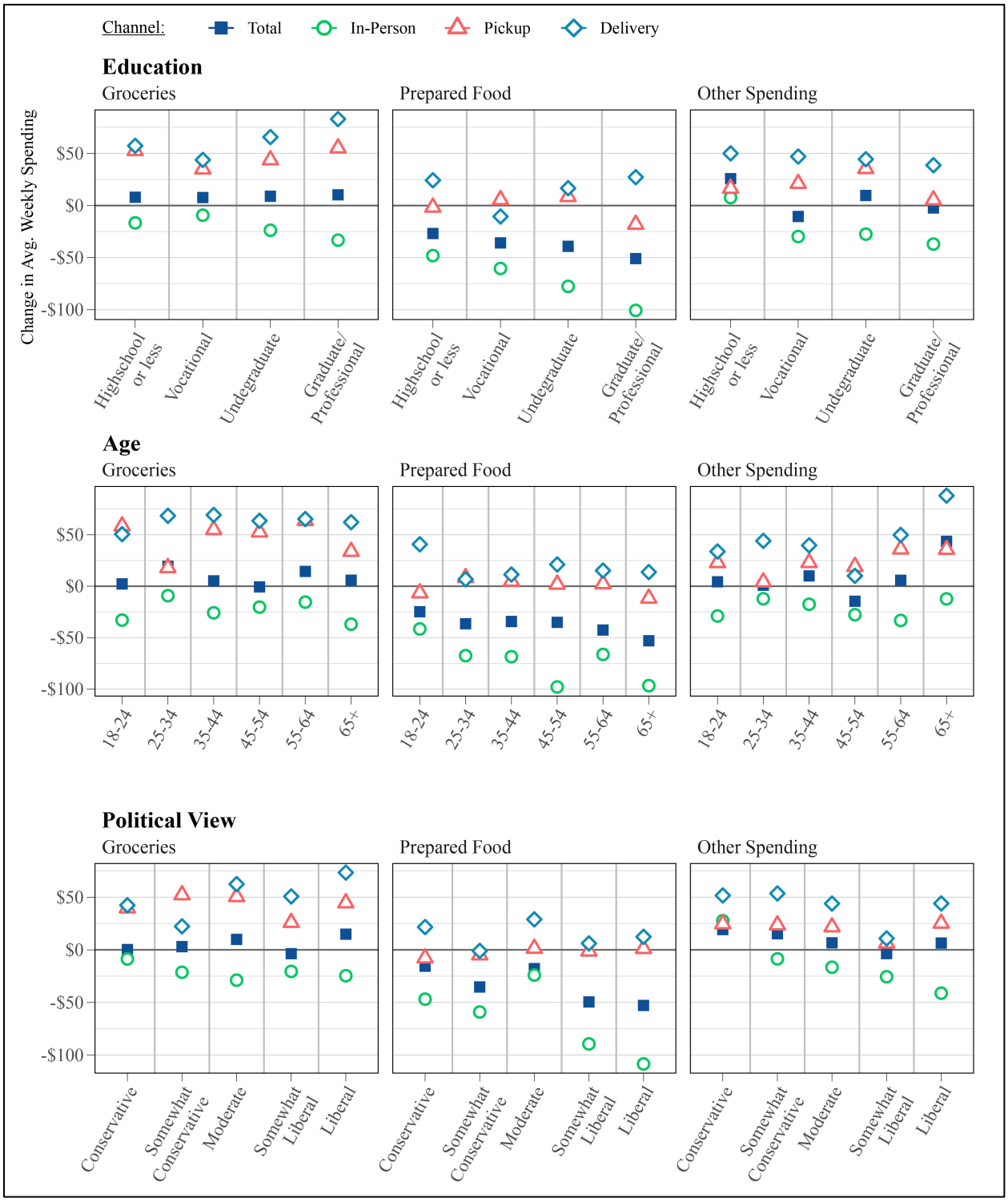

Figure 5c Change in weekly spending by item category and acquisition channel during the pandemic compared to pre-COVID

Telework Through the Pandemic

Figure 6 presents results from responses to a question asked in Wave 7 to all respondents who were either employed or were students at the time of the survey. Specifically, the respondents were asked work location at different time points pre and during and post pandemic. The data capture several interesting trends which acts as a sanity check for the quality of the data as well as builds a comprehensive picture regarding the evolution of telework through and beyond the pandemic. Our data captures the fact that many individuals lost their jobs at the early phase (April 2020) of the pandemic (gray color). The trends of economic recovery over time can also be seen as COVID-19 cases reduced and economy was slowly re-opened. The number of individuals working exclusively from office reduced from 52% in 2019 to 17.5% in April 2020 and then is slowly increasing since then with 31.4% in March 2022 and 32% (expected) in April 2024. The data also captures the expected trend of higher uncertainty at farther time point than at a time point only a few months away (3.9% don't know response in October 2022 and 15.1% in April 2024). Other interesting trends include an increase in exclusively at home work from 18.9% in 2019 to 53.2% in April 2020, 31.4% in March 2022 and 21.9% (expected) in April 2024. Comparing 2019 and April 2024, even if everyone with a don't know response switches to exclusively working from office, there is a clear expected shift toward exclusively at home and hybrid work arrangements going forward.

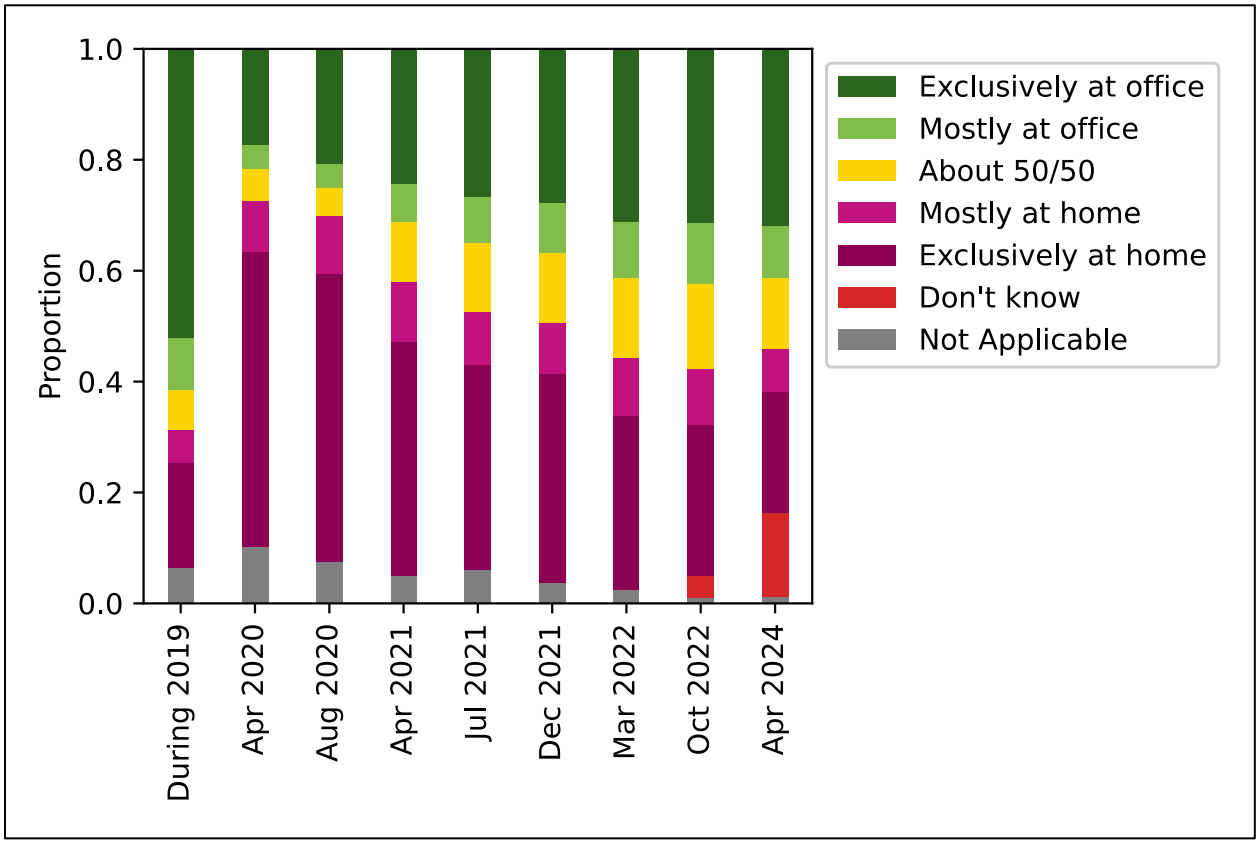

Figure 6: Work location proportions before, during and post-pandemic

Figure 7 presents the number of days worked from home in the past week, averaged across all respondents who participated in a particular wave, respondents' pre-COVID remote work rate (asked in wave 3) and their expected post-COVID remote work rate (asked in wave 6). Similar to the previous figure, the data captures an increase in work from home since the beginning of the pandemic and a reduction in this rate overtime as COVID-19 cases reduced and vaccinations were available. Specifically, the average number of days worked from home almost doubled from 2.14 to 4.04 due to the pandemic in wave 1 of the survey but has been in a decline over time. However, an interesting insight from this data is that the expected post pandemic rate work from home is 2.75 days per week, compared to 2.14 days per week pre-pandemic, a 28.5% increase. This increase could potentially have wide ranging transportation related implications.

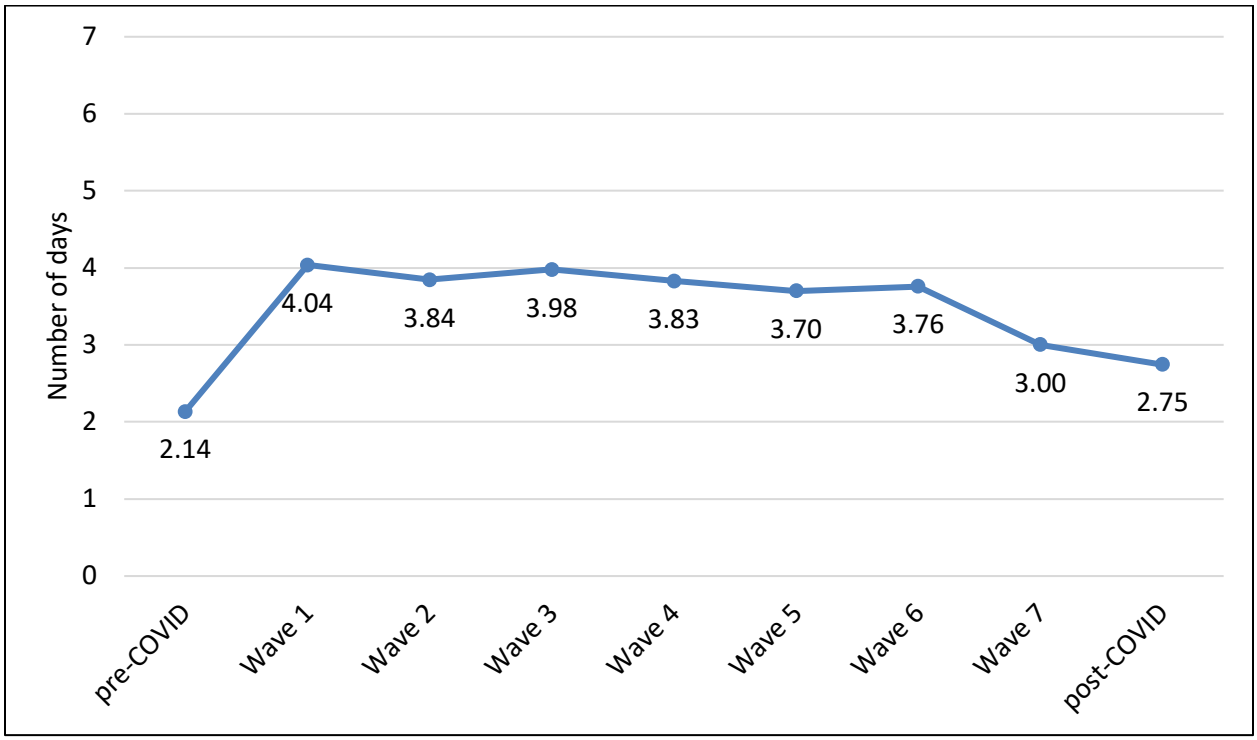

Figure 7: Number of days worked from home in the past week across various waves of the survey, pre-COVID and post-COVID time periods.

Given that attitudes, perceptions, and experiences likely shape future behavior, a number of questions in the survey were tailored towards gathering information on respondents' outlook towards various entities of interest. Figure 8 presents respondents attitudes regarding the impact of 2-days a week remote work program on 12 different aspects of work. Specifically, respondents were asked: "*Imagine that your employer has committed to a future work program allowing a hybrid workforce with an option of remote work for 2 days a week. In your opinion, what effects will such a program have on the following [12 aspects*

related to work]?" The respondents were asked to report their response on a 5-point Likert scale varying from Very Negative to Very Positive with "Not Applicable" as a possible option to choose from for cases where a particular response item was not relevant for an individual. The 5-point scale was converted to a 3-point scale to reduce complexity. It is not surprising that most respondents agree that a 2-days a week remote work program will have negative effect on social interaction with colleagues, neutral to negative effect on career advancement, mentoring, collaboration and a positive impact on productivity, creativity, and effectiveness to get the job done.

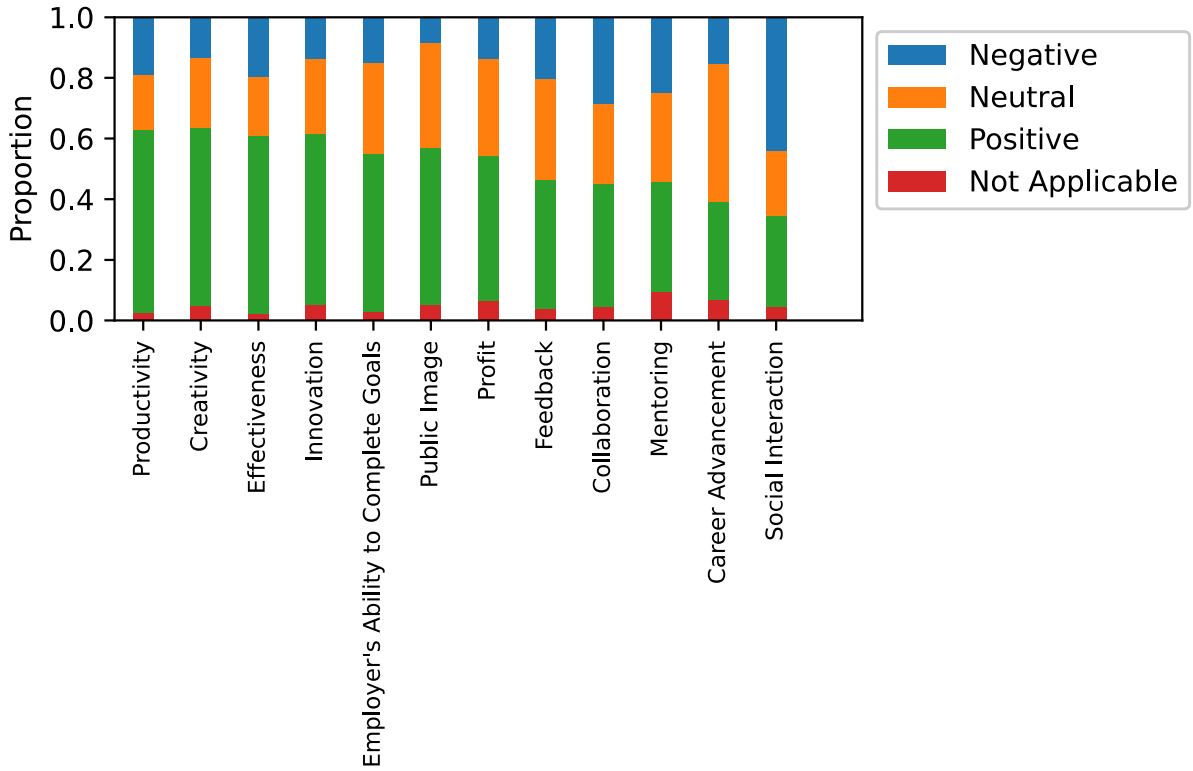

Figure 8: Respondents' attitudes regarding the impact of 2-days a week remote work on various aspects of work

Figure 9 presents responses to a question asking respondents to report their work from home experience during the pandemic (if remote work was an option) or expected satisfaction (if it is available in the future). This question was asked in both waves 5 and 7. It is interesting to note that 25.79% and 20.71% of the respondents neutral to very dissatisfied with their work from home experience in waves 5 and 7, respectively, highlighting mixed experiences with telework. Interestingly, the average satisfaction with remote work seems to be higher in wave 7 compared to wave 5, which could potentially shape how remote work will look like in the future.

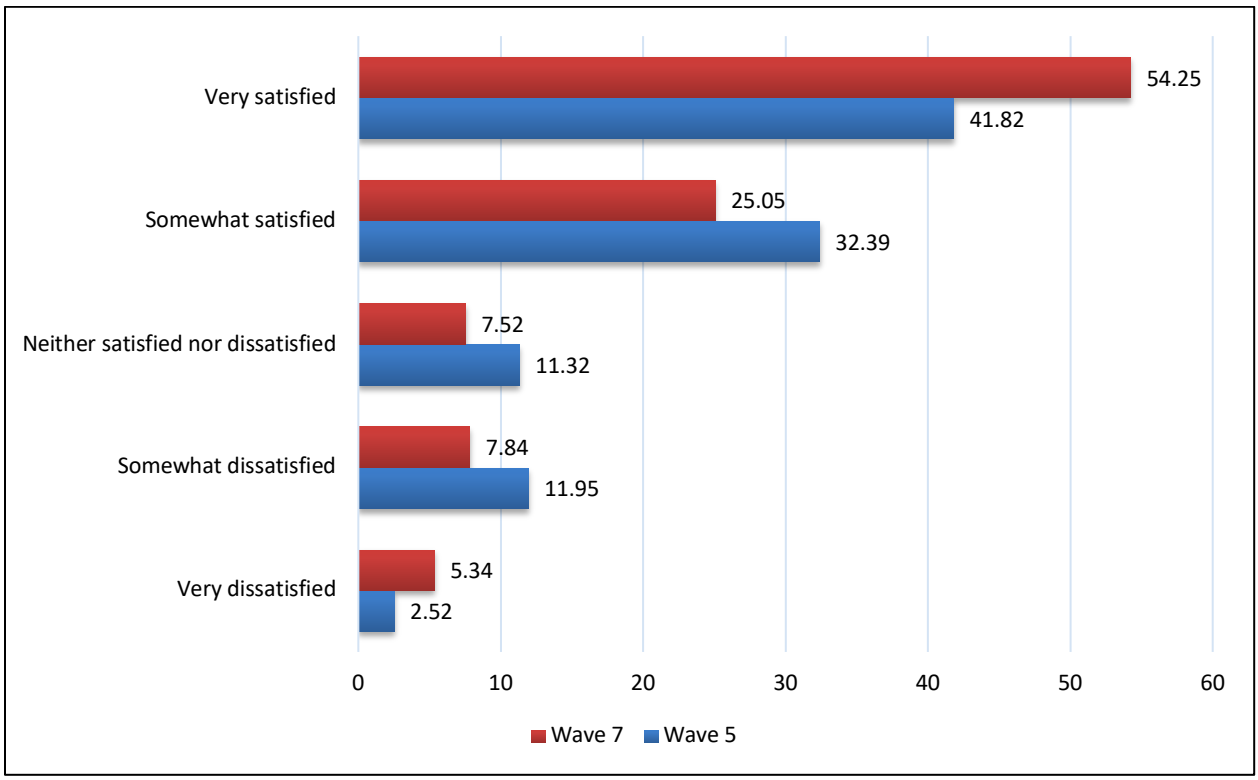

Figure 9: Individual satisfaction with remote work

Digital Content, Transit Pass and Delivery Services Usage Through The Pandemic

Figure 10 presents data on individual response to the question of the use of various types of subscription services like movie or music streaming and transit pass before the pandemic, in 2020, 2021, 2022 and after the pandemic. Similarly, Figure 11 presents data on individual response to the question of the use of online delivery services like amazon, restaurant, or grocery delivery services at various time points. Several interesting insights can be seen from these two figures. First, given that only 173 respondents reported planning to purchase a local transit pass after the pandemic compared to 265 respondents before the pandemic, it is likely that transit ridership may be slow to recover from the pandemic forced decline. This could potentially be related to several factors including increase in remote work leading to not needing to commute to work, or individual precautionary behavior of social distancing continuing well beyond the pandemic. Second, there seems to be a consistent pattern of the reduction in the number of individuals planning to use movie, music, video game or amazon prime subscription compared to pre-pandemic levels. This pattern is also visible in the use of amazon, or other online retailers, restaurant delivery as well as in the use of meal kits, potentially indicating either shifting individual intentions to redirect this expenditure toward more experiential activities given that these were suppressed by the

pandemic for a long time, or may be cut down in extraneous spending due to a recent rise in inflation. Interestingly, the only category where there seems to be a visible increase in the reported post pandemic era compared to pre-pandemic, is that of grocery delivery where 208 respondents reported using these services earlier, but that number increased to 323 post pandemic intention, an increase of 35%.

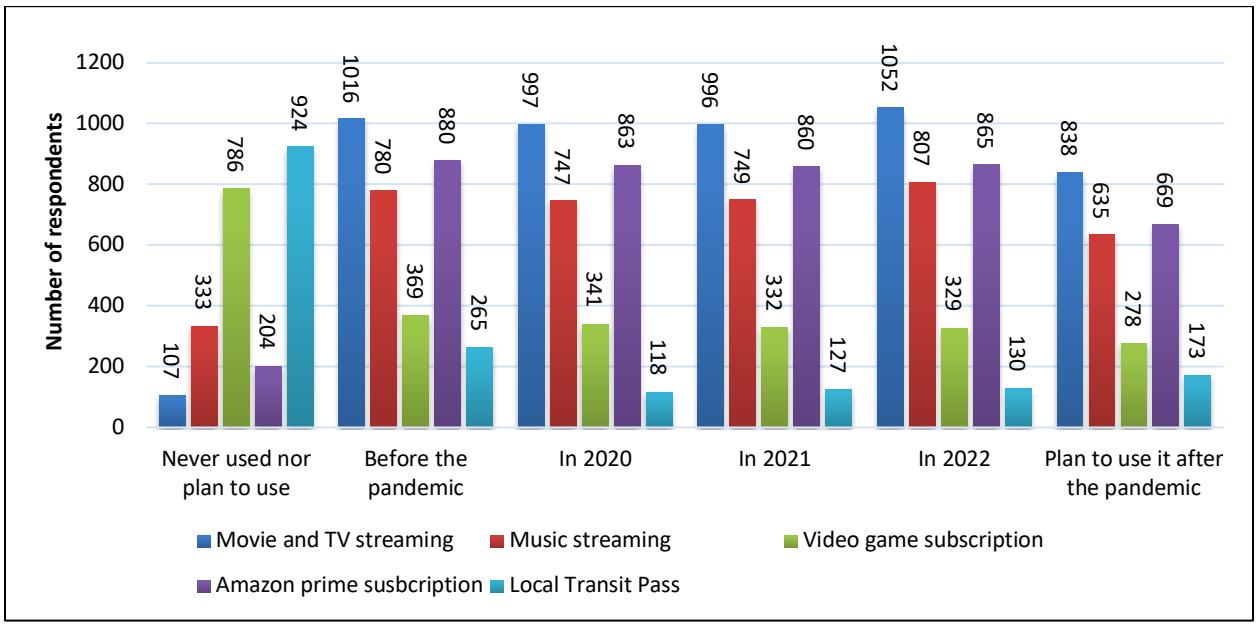

Figure 10: Respondent's usage history and future usage intention of online subscription services and transit pass

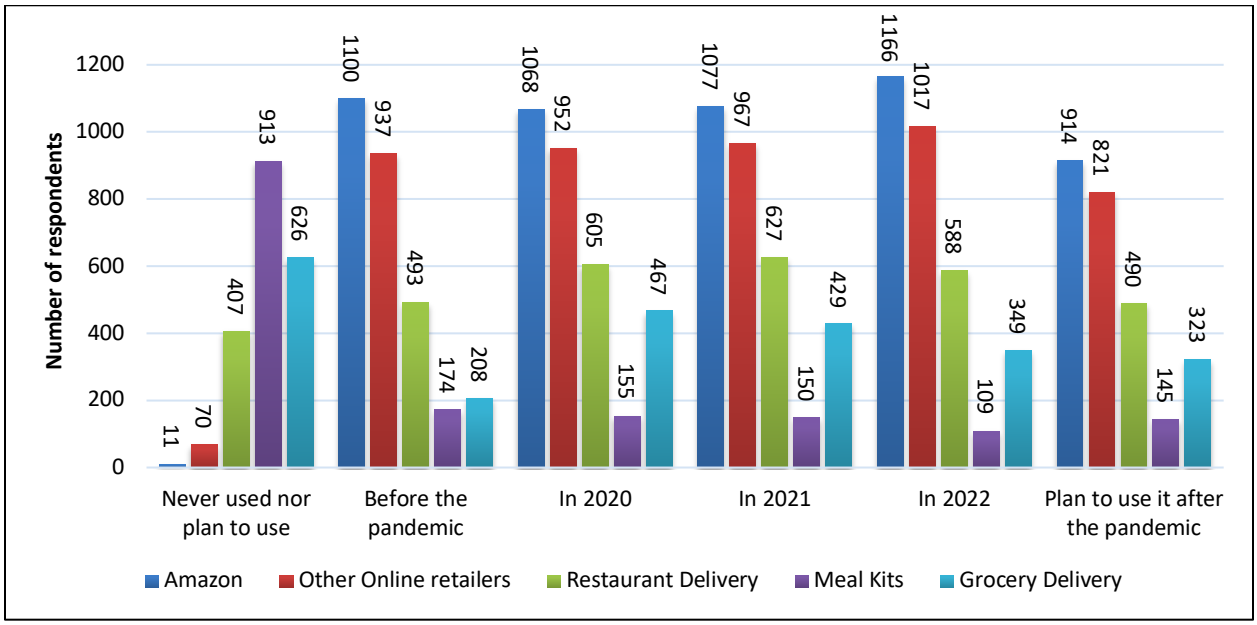

Figure 11: Respondent's usage history and future usage intention of delivery services

Chapter 5: Summary and Ongoing Work

Summary

This report provides details regarding a 7-wave longitudinal tracking survey conducted to monitor the evolving consumer spending, telework, and activity participation behavior because of the COVID-19 pandemic, with the goal of deriving insights on expected post-pandemic telemobility patterns and its interaction with physical mobility. The 7-wave longitudinal tracking survey was conducted between December 2020 and March 2022 through an online platform named prolific (Palan and Schitter, 2018) and resulted in data from 1877 unique respondents from the United States.

Questions on the following 12 categories were included in the survey; 1) weekly consumer spending on groceries, cooked food and non-food items; 2) monthly consumer spending on electronics, furniture, clothing and digital media; 3) home delivery frequency for groceries, cooked meals and other non-food items; 4) telework related travel frequency through the pandemic; 5) travel, trip-making and time use behavior; 6) attitudes, perceptions and experiences of the individuals with telework and e-commerce through the pandemic; 7) use of subscription services like amazon prime, streaming services as well as local transit pass; 8) additional related question on pre-pandemic and post-pandemic expected behavior; 9) individual intention to use contact-free deliveries like delivery robots in the post-pandemic era; 9) a detailed 24-hr activity diary data; 10) direct impact of the pandemic like job loss, and COVID-19 infections; 11) individual experiences with depression, anxiety or positivity in life as a result of the pandemic; and 12) socio-demographics.

Wave 1 of the survey started with 457 adults who were recruited to build a representative sample of the U.S. population by *age, gender, and ethnicity*. The respondent group was informed about the 5 more subsequent waves of the survey and how much they would be paid in each wave before they agreed to complete the survey. The 457 respondents were then later reinvited for waves 2 to 6, irrespective of whether they completed the previous wave of the survey. To make up for respondent attrition from the main sample, starting wave 2, a convenience sample with approximately 100 respondents was recruited in each wave till wave 6, who were then re-invited to participated in the subsequent waves, *if they have completed the previous wave.* In wave 7, everyone who joined waves 1 to 6 at least once was re-invited, along with a new U.S. population representative top-up of 905 individuals.

The incentives for the respondents varied from $1 to $2.5 across waves 1 to 6 and $3.5 to $7.5 in wave 7 and included a staggered incentive scheme to improve retention rate across waves, especially for ethnic minorities. Across these seven waves, 180 individuals participated in all 7 waves, 97 participated in 6 waves, 80 participated in 5 waves, 72 participated in 4 waves, 102 participated in 3 waves, 135 participated in 2 waves and 1211 participated in 1 wave (including wave 7). Out of the 972 respondents

who participated in waves 1 to 6, who were then re-invited for wave 7, 386 returned to complete the survey. This corresponds to a return rate of 39.7%.

Spatially, data have been collected from 49 out of 50 states (excluding Vermont) and Washington D.C. A comparison of sample share and population share for a few selected states shows that the sample shares for data in each wave is within a few percentage points of the population share for a state. Respondents to the survey are slightly younger than the population at large. Specifically, our sample has higher proportion of respondents in the 55-64 years age group compared to 65 years or older, which is generally expected from online panels since the older individuals tend to find technology driven online survey to be difficult. Even though our samples were designed to be age representative (at least in part) this mismatch is also a likely manifestation of the fact that oldest age group coded in the Prolific platform panel is 58 years or older instead of 65 years or older.

The sample matches well with the population shares in terms of ethnicity, with slight over-representation of respondents with Asian ethnicity. Politically, the sample is *liberal leaning*. This bias is likely the result of self-selection in online surveys. Finally, the sample has some under-presentation of high-income individuals, especially in the $100,000 or above income group.

We present preliminary exploratory analysis highlighting changing consumer spending across in-person and online channels of purchase, remote work trends, individual attitudes and satisfaction regarding remote work that may shape post-pandemic adoption of telework and use of various types of subscription services through and beyond the pandemic. Regarding spending, our data suggests that average spending appears to have generally stabilized at time of the first 6 waves of data collection. Besides spending on dining out and prepared food, spending on most categories and items are relatively similar to pre-pandemic spending, albeit with some shift in spending from in-person shopping towards pickup and delivery. On the telework end, the average number of days worked from home almost doubled from 2.14 to 4.04 due to the pandemic in wave 1 of the survey but has been in a decline since then. However, an interesting insight from this data is that the expected post pandemic rate of work from home is 2.75 days per week, compared to 2.14 days per week pre-pandemic, a 28.5% increase. This increase could potentially have wide ranging transportation related implications. Lastly, in regard to the use of online subscription and delivery services including local transit pass purchase, the only category where there seems to be a visible increase in the reported post pandemic era compared to pre-pandemic, is that of grocery delivery where 208 respondents reported using these services earlier, but that number increased to 323 in post pandemic intention to use, an increase of 35%.

Ongoing Work

The longitudinal dataset obtained in this study has been used for a number of studies focused on understanding the changing telework, consumer spending and mobility trends associated with the pandemic, including: 1) understanding employee satisfaction with telework using a multiple indicators multiple cause model; 2) understanding the trajectories of telework through and beyond the pandemic using a hierarchical clustering based analysis and implications for these changing trends for the future of

cities; 3) understanding changes to shopping expenditure changes as well channel selection across online, in-person and pick-up options using a latent transition analysis and hurdle regression models; and 4) understanding the interaction between telework and non-work activity participation using activity diary data.

In Tahlyan et al. (2022b), we present *multiple indicators multiple cause* (MIMIC) model to build a clearer picture of how the pandemic induced telework experience and perceptions impacted *telework satisfaction* with the general idea that those who were more satisfied with their experiences during the pandemic are going to be more likely to continue telework post-pandemic, given telework being an available option. Our main findings include that younger and older aged individuals experienced/perceived lower benefits and higher barriers to teleworking compared to middle aged individuals and suggest a disproportionate impact on Hispanic or Latino and Black respondents as well as on those with children attending online school from home.

In Tahlyan et al. (2023), we take a *trajectory clustering analysis* based approach to understand the evolution of telework landscape using data from 905 individuals regarding their work location at various time points before, during and post-pandemic. We identify four distinct cluster of telework trajectories with differing levels of telework adoption, ranging from a group that maintained significantly high in-person work participation even at the height of the pandemic, to a group that worked exclusively from home for an extended period in the pandemic and shows little sign of rebounding back to their pre-pandemic behavior. We also present predictive model relating socio-demographic and sector of operations related variables with various trajectories of telework, and another set of models to understand the telework landscape in April 2024, about four years since the beginning of the pandemic.

In Tahlyan et al. (2022c) we present a sophisticated *latent transition analysis* focused at understanding the dynamics of spending patterns across three different acquisition channels (in-person, delivery, and pick-up) and various product categories (grocery, cooked food, and non-food items) over four times point before and during the pandemic. We identified 5 different clusters of spending behavior patterns (primarily in-person shoppers, in-person shoppers with suppressed outside food demand, multi-channel shoppers, delivery dependents and pick-up dependents) with a significant increase in the demand for delivery and pick-up services since the beginning of the pandemic, especially in the grocery segment.

Complementing the results from latent transition analysis, in Said et al. (2022), we use spending data from a sample of 720 U.S. households during the start of the confinement and early vaccine rollout to understand changes in total and acquisition specific spending behavior one year into the pandemic using hurdle regression models. We find that overall spending is similar to pre-pandemic levels, except for a 28% decline in prepared food spending. More educated and higher income households with children have shifted away from in-person spending, whereas politically conservative respondents are more likely to shop in-person and via pickup.

Lastly, in Hamad et al. (2023) we analyze the interaction between telework and non-work activity participation using activity diary data from 747 individuals. The three main questions addressed are: What is the effect of telework on the duration spent on out-of-home non-work activities? Does telework increase or decrease the average distance traveled from home to reach out-of-home non-work activities? Is there a telework effect on the time of day chosen to engage in out-of-home non-work activities? Results show that individuals who telework spend less time on out-of-home activities than individuals who do not. Furthermore, individuals who telework chose to perform these activities in the late morning and early afternoon, compared to other times of the day. The findings of Tahlyan et al. (2023) and Hamad et al. (2023) are included in Tahlyan et al. (2022a).

Overall, while some of these telemobility related trends are still evolving, there seems to be strong evidence that the future of work will likely be hybrid, and that a good proportion of pandemic-accelerated demand for e-commerce services will stick well beyond the pandemic. As these trends persist, there will be systematic changes to mobility patterns in the U.S., which transportation planners and policy makers should consider in planning and designing future transportation and urban systems.

References

Bélanger, F. (1999) Workers' propensity to telecommute: An empirical study. *Information & Management* 35, 139-153.

Ben Hassen, T., El Bilali, H., Allahyari, M.S., Berjan, S., Fotina, O. (2021) Food purchase and eating behavior during the COVID-19 pandemic: A cross-sectional survey of Russian adults. *Appetite* 165, 105309.

Bieser, J.C., Vaddadi, B., Kramers, A., Höjer, M., Hilty, L.M. (2021) Impacts of telecommuting on time use and travel: A case study of a neighborhood telecommuting center in Stockholm. *Travel Behaviour and Society* 23, 157-165.

Butzner, M., Cuffee, Y. (2021) Telehealth interventions and outcomes across rural communities in the United States: narrative review. *Journal of medical Internet research* 23, e29575.

Cairncross, F. (2001) The death of distance: How the communications revolution is changing our lives.

Cao, X.Y., Douma, F., Cleaveland, F. (2010) Influence of E-Shopping on Shopping Travel Evidence from Minnesota's Twin Cities. *Transportation Research Record*, 147-154.

Chang, S., Pierson, E., Koh, P.W., Gerardin, J., Redbird, B., Grusky, D., Leskovec, J. (2021) Mobility network models of COVID-19 explain inequities and inform reopening. *Nature* 589, 82-87.

Choo, S., Mokhtarian, P.L., Salomon, I. (2005) Does telecommuting reduce vehicle-miles traveled? An aggregate time series analysis for the US. *Transportation* 32, 37-64.

Colaço, R., de Abreu e Silva, J. (2021) Exploring the interactions between online shopping, in-store shopping, and weekly travel behavior using a 7-day shopping survey in Lisbon, Portugal. *Transportation Research Record* 2675, 379-390.

de Andrade, J.B.S.O., Ribeiro, J.M.P., Fernandez, F., Bailey, C., Barbosa, S.B., da Silva Neiva, S. (2016) The adoption of strategies for sustainable cities: A comparative study between Newcastle and Florianópolis focused on urban mobility. *Journal of Cleaner Production* 113, 681-694.

(2021) *A Year of U.S. Public Opinion on the Coronavirus Pandemic*.

Ding, Y., Lu, H.P. (2017) The interactions between online shopping and personal activity travel behavior: an analysis with a GPS-based activity travel diary. *Transportation* 44, 311-324.

Ellis, I., Cheek, C., Jaffray, L., Skinner, T.C. (2013) Making a case for telehealth: measuring the carbon cost of health-related travel. *Rural and Remote Health* 13, [185]-[191].

Farag, S., Dijst, M., Lanzendorf, M. (2003) Exploring the use of e-shopping and its impact on personal travel behavior in the Netherlands. *Transport Res Rec*, 47-54.

Fareeha, A. (2021) Ecommerce trends amid coronavirus pandemic in charts. Digital Commerce 360.

FHWA (2022) Travel Monitoring. Office of Highway Policy Information, Federal Highway Administration.

Food, E. (2020) COVID-19 impact on consumer food behaviours in Europe.

Ghosh, I. (2020) How Consumers are Spending Differently During COVID-19. Visual Capitalist.

Gould, J., Golob, T.F. (1997) Shopping without travel or travel without shopping? An investigation of electronic home shopping. *Transport reviews* 17, 355-376.

Grashuis, J., Skevas, T., Segovia, M.S. (2020) Grocery Shopping Preferences during the COVID-19 Pandemic. *Sustainability* 12, 5369.

Gu, S., Ślusarczyk, B., Hajizada, S., Kovalyova, I., Sakhbieva, A. (2021) Impact of the COVID-19 Pandemic on Online Consumer Purchasing Behavior. *Journal of Theoretical and Applied Electronic Commerce Research* 16, 2263-2281.

Hamad, N., Tahlyan, D., Said, M., Mahmassani, H., Stathopoulos, A., Shaheen, S., Walker, J. (2023) Modeling the Effects of Telework on the Duration, Distance, and Time of Day of Out-ofHome Non-Work Activities. *102nd TRB Annual Meeting*, Washington D.C.

Hamilton, R.W., Mittal, C., Shah, A., Thompson, D.V., Griskevicius, V. (2019) How financial constraints influence consumer behavior: An integrative framework. *Journal of Consumer Psychology* 29, 285-305.

Hammami, F. (2020) The impact of optimizing delivery areas on urban traffic congestion. *Res Transp Bus Manag* 37.

Harper, C.A., Satchell, L.P., Fido, D., Latzman, R.D. (2021) Functional Fear Predicts Public Health Compliance in the COVID-19 Pandemic. *International Journal of Mental Health and Addiction* 19, 1875-1888.

Heen, M., Lieberman, J.D., Miethe, T.D. (2014) A comparison of different online sampling approaches for generating national samples. *Center for Crime and Justice Policy* 1, 1-8.

Howell, A. (2019) E-Commerce, Urban Delivery, and Congestion.

Huff, C., Tingley, D. (2015) "Who are these people?" Evaluating the demographic characteristics and political preferences of MTurk survey respondents. *Research & Politics* 2, 2053168015604648.

Johns Hopkins Coronavirus Resource Center (2022) COVID-19 Overview.

Joice, W. (2000) The evolution of telework in the federal government.

Kim, S.-N., Choo, S., Mokhtarian, P.L. (2015) Home-based telecommuting and intra-household interactions in work and non-work travel: A seemingly unrelated censored regression approach. *Transportation Research Part A: Policy and Practice* 80, 197-214.

Lachapelle, U., Tanguay, G.A., Neumark-Gaudet, L. (2018) Telecommuting and sustainable travel: reduction of overall travel time, increases in non-motorised travel and congestion relief? *Urban Studies* 55, 2226-2244.

Le, H.T., Carrel, A.L., Shah, H. (2022) Impacts of online shopping on travel demand: a systematic review. *Transport Reviews* 42, 273-295.

Loh, P., Sabesan, S., Allen, D., Caldwell, P., Mozer, R., Komesaroff, P.A., Talman, P., Williams, M., Shaheen, N., Grabinski, O. (2013) Practical aspects of telehealth: financial considerations. *Internal Medicine Journal* 43, 829-834.

Löwe, B., Wahl, I., Rose, M., Spitzer, C., Glaesmer, H., Wingenfeld, K., Schneider, A., Brähler, E. (2010) A 4-item measure of depression and anxiety: validation and standardization of the Patient Health Questionnaire-4 (PHQ-4) in the general population. *Journal of affective disorders* 122, 86-95.

Mishra, P.S., Chopra, S., Stamatopoulos, I., Malcolm, S. (2021) Empirical evaluation of persistence in changing trends in customer shopping behaviors due to COVID-19. *Kellogg School of Management*.

Mokhtarian, P.L. (1988) An empirical evaluation of the travel impacts of teleconferencing. *Transportation Research Part A: General* 22, 283-289.

Mokhtarian, P.L. (1990a) The state of telecommuting. *ITS Review (Institute of Transportation Studies)* 13.

Mokhtarian, P.L. (1990b) A typology of relationships between telecommunications and transportation. *Transportation Research Part A: General* 24, 231-242.

Mokhtarian, P.L. (1998) A synthetic approach to estimating the impacts of telecommuting on travel. *Urban studies* 35, 215-241.

Mokhtarian, P.L., Handy, S.L., Salomon, I. (1995) Methodological issues in the estimation of the travel, energy, and air quality impacts of telecommuting. *Transportation Research Part A: Policy and Practice* 29, 283-302.

Mokhtarian, P.L., Salomon, I. (1996) Modeling the choice of telecommuting: 3. Identifying the choice set and estimating binary choice models for technology-based alternatives. *Environment and Planning A* 28, 1877-1894.

Mokhtarian, P.L., Salomon, I. (1997) Modeling the desire to telecommute: The importance of attitudinal factors in behavioral models. *Transportation Research Part A: Policy and Practice* 31, 35-50.

Nilles, J.M. (1988) Traffic reduction by telecommuting: A status review and selected bibliography. *Transportation Research Part A: General* 22, 301-317.

Noonan, M.C., Glass, J.L. (2012) The hard truth about telecommuting. *Monthly Lab. Rev.* 135, 38.

Páez, A., Scott, D.M. (2007) Social influence on travel behavior: a simulation example of the decision to telecommute. *Environment and Planning A* 39, 647-665.

Palan, S., Schitter, C. (2018) Prolific. ac—A subject pool for online experiments. *Journal of Behavioral and Experimental Finance* 17, 22-27.

Pendyala, R.M., Goulias, K.G., Kitamura, R. (1991) Impact of telecommuting on spatial and temporal patterns of household travel. *Transportation* 18, 383-409.

Polishuk, P. (1975) Review of the impact of telecommunications substitutes for travel. *IEEE Transactions on Communications* 23, 1089-1098.

Popper, N. (2020) Americans Keep Clicking to Buy, Minting New Online Shopping Winners. New York Times.

Probasco, J. (2021) Average Cost of American Holiday Spending. Investopedia.

Saad, L. (2021) Americans' Political Ideology Held Steady in 2020. Gallup.

Said, M., Tahlyan, D., Stathopoulos, A., Mahmassani, H., Walker, J., Shaheen, S. (2022) In-Person, Pick Up or Delivery? Evolving Patterns of Household Spending Behavior Through the Early Reopening Phase of the COVID-19 Pandemic. *4th Bridging Transportation Researchers Conference*, Virtual.

Salomon, I. (1984) Man and his transport behaviour part 1a. telecommuting—promises and reality. *Transport Reviews* 4, 103-113.

Salomon, I. (1985) Telecommunications and travel: substitution or modified mobility? *Journal of transport economics and policy*, 219-235.

Salomon, I., Salomon, M. (1984) Telecommuting: The employee's perspective. *Technological Forecasting and Social Change* 25, 15-28.

Shabanpour, R., Golshani, N., Tayarani, M., Auld, J., Mohammadian, A.K. (2018) Analysis of telecommuting behavior and impacts on travel demand and the environment. *Transportation Research Part D: Transport and Environment* 62, 563-576.

Sherman, M., Huth, L. (2020) How We Spent Our Money in 2020. *Wall Street Journal*.

Sullivan, M., Mahmassani, H.S., and Yen, J-R (1993) A Choice Model of Employee Participation in Telecommuting Under A Cost-Neutral Scenario. *Transportation Research Record* 1413, pp. 42-48, 1993

Tahlyan, D., Hamad, N., Said, M., Mahmassani, H., Stathopoulos, A., Shaheen, S., Walker, J. (2022a) Analysis of Teleworkers' Experiences, Adoption Evolution and Activity Patterns Through the Pandemic.

Tahlyan, D., Said, M., Mahmassani, H., Stathopoulos, A., Shaheen, S., Walker, J. (2023) Trajectories of Telework Through the Pandemic: Outlook and Implications for Cities. *102nd TRB Annual Meeting*, Washington D.C.

Tahlyan, D., Said, M., Mahmassani, H., Stathopoulos, A., Walker, J., Shaheen, S. (2022b) For whom did telework not work during the Pandemic? understanding the factors impacting telework satisfaction in the US using a multiple indicator multiple cause (MIMIC) model. *Transportation Research Part A: Policy and Practice* 155, 387-402.

Tahlyan, D., Said, M., Mahmassani, H., Stathopoulos, A., Walker, J., Shaheen, S. (2022c) Latent Transition Analysis of Consumer Spending Behavior and Adaptation Across Online and In-Person Channels Through the Pandemic. *101st Transportation Research Board Annual Meeting*, Washington D.C.

U.S. Census Bureau (2019) ACS 5-Year Estimates.

Urban, A. (2017) With online shopping on the rise, cities look to address congestion impacts of deliveries.

Walls, M., Safirova, E. (2004) A review of the literature on telecommuting and its implications for vehicle travel and emissions.

Walls, M., Safirova, E., Jiang, Y. (2007) What drives telecommuting? Relative impact of worker demographics, employer characteristics, and job types. *Transportation Research Record* 2010, 111-120.

Xi, G., Zhen, F., Cao, X., Xu, F. (2020) The interaction between e-shopping and store shopping: empirical evidence from Nanjing, China. *Transportation Letters* 12, 157-165.

Xue, C., Wu, Q., Sun, M., Bai, P., Chen, Y. (2021) The Interaction between E-Shopping and Shopping Trips: An Analysis with 2017 NHTS. *Complexity* 2021.

Yen, J-R, Mahmassani, H.S. and Herman, R. (1994) Employer Attitudes and Stated Preferences Towards Telecommuting: An Exploratory Analysi. *Transportation Research Record*, 1463, pp. 15-25.

Yen, J-R and Mahmassani, H.S. (1997) Telecommuting Adoption: Conceptual Framework and Model Estimation. *Transportation Research Record* 1606, pp. 95-102.

Zhang, B., Gearhart, S. (2020) Collecting Online Survey Data: A Comparison of Data Quality among a Commercial Panel & MTurk. *Surv. Pract* 13.

Zhu, P., Mason, S.G. (2014) The impact of telecommuting on personal vehicle usage and environmental sustainability. *International Journal of Environmental Science and Technology* 11, 2185-2200.