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The travel behavior, attitude, and sociodemographic characteristics of the teleworkers in post-pandemic era

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ABSTRACT

Teleworking (i.e., working from home), with the aid of teleworking technologies, became widespread over the world as an impact of COVID-19. The long-term impact of teleworking in the future on commuting and social equity is discussed by the experts. However, less attention has been paid to the factors that are associated with people's choice to start teleworking for the first time or existing teleworkers' choice to increase the current frequency. This study investigates the changes in preference for teleworking frequency in the post-pandemic era. From a survey of 301 respondents in New York City, respondents are split into three categories. These are (1) previous teleworkers who do not want to increase their teleworking frequency, (2) previous teleworker who want to increase their frequency (i.e., extended teleworker), and (3) previous non-teleworker who wants to start teleworking (i.e., prospective teleworker) as the city reopens. A multinomial logit model is used to predict these categories with the help of several sociodemographic, household, geographic, travel behavioral, and attitudinal characteristics of the respondents. The model suggests that younger people and non-Hispanic people are more likely to extend or start teleworking than their counterparts. Females, Blacks, low-income people, and people with a child under five years are more likely to start teleworking while their counterparts (i.e., males, non-Blacks, high-income people, and people with a child under five) are more inclined towards extending teleworking. More work-trip makers and public transit users (for grocery) have less probability to extend teleworking. People with more pro-street and pro-out-migration attitudes and less pro-safety attitudes are more interested in starting or extending teleworking. The findings help targeted investment for post-pandemic accessibility, travel demand management, and energy efficiency.

Introduction

The outbreak of the Coronavirus disease in Wuhan, China, and the consequent proclamation of the pandemic in 2020 left a substantial impact on people's lives and behavior. Many countries urged their citizens to exercise social separation and required preventive measures in an attempt to curb the spread of the disease. Most countries adopted similar measures, even if they did so at different times and to varying degrees of intensity. The measures include requiring people to wear masks in public, to stay at home, to practice social seclusion, and the closure of stores, restaurants, schools, and places of employment [1,2]. Because of these, working from home (i.e., teleworking) has developed into a crucial twofold solution that addresses both worldwide health concerns and the economic crisis [3].

The restrictions on mobility aimed at preventing the spread of COVID-19 have altered people's travel and activity patterns [4–7]. This is mostly attributable to telework [8], teleshopping [4,5], and ride-hailing [11]. The rise of teleworking is tied to changes in people's behavior and space-time usage. For example, there has been an increase in personal travel and non-work-related energy use [12]. These secondary journeys may be related to recreation, socializing, or childcare [13]. As a result, it appears that workers are more likely to take advantage of the extra free time they have because of working from home and not having to commute. Working from home enabled worker protection [3] and social isolation compliance, initially allowing families to remain at home with their children and dependents [8,9]. However, the experience was perceived inconsistently in terms of family and work harmony [10,11]. For instance, the epidemic and teleworking have shown the existing gender gap in work-life balance [14]. Also, access to energy, internet connection, or digital tools to study or work remotely can be a major reason for disparities in abilities to telework [15].

COVID-19 has catalyzed long-term changes by normalizing many activities that were considered extraordinary before the pandemic. The acceptability of teleworking has increased among both employees and

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employers. The desire for teleworking can perform as an identifying sign of people in need to reduce the negative externalities of traveling. Also, it can reflect people's ability to telework concerning their workplace's nature and household composition. Therefore, a comprehensive understanding of the workers who want to start or extend their teleworking, their demographics, travel behavior, attitude, and geography is necessary. Although previous studies focused on the demographic and behavioral attributes of teleworkers, researchers have paid scant attention to the teleworkers who want to extend teleworking or who want to be new teleworkers after the pandemic. Moreover, travel behavior and travel attitudes are less studied when it comes to identifying teleworkers. Therefore, the objective of this study is to identify people who want to extend or start teleworking in the post-pandemic era with the help of sociodemographic factors, travel behavior, and attitudes.

The rest of the study is divided into four more sections. The following section discusses the relevant literature on different demographics, employment, and travel-related aspects of teleworkers. The next section describes the data and the method of analysis. This is followed by the result section that reports the role of the predictor in identifying new or extended teleworkers. The last section discusses the result and makes concluding remarks.

Literature review

The concept of teleworking refers to an employment arrangement in which workers perform their duties away from the office while maintaining contact with their coworkers by means such as phone, email, or video conferencing. Employees who are allowed to work remotely are responsible for completing their work duties from a location other than the conventional office [16]. Due to its technological and geographic advantages, telework has emerged as a prominent trend in the present job market [17]. Telecommuting has become increasingly popular as a result of its economic advantages and better flexibility [18]. In the 1970s, the word "telecommuting" was used to describe working from home, mostly by phone [19]. Telework was a hot topic in the 1980s among workers, employers, transportation planners, communities, and the telecommunications industry [20]. It became popular in the 1990s and is currently, according to recent reports, one of the most common grounds for flexible work arrangements [15,16].

Teleworking is influenced by the work environment, sociodemographic characteristics, and travel habits. First, job function and industry determine telework availability [17,18]. It was increasingly common for office workers to telecommute. In other job functions, telework is on the rise [19,20] due partly to technological advancements [25]. In a survey of 160 major employers in New York, 78% of employers reported their preference towards moving to a hybrid office model in May'20 [26]. In the bigger firms, the rate of returning to the office is lower among employers. The survey reported that 2 out of 3 employers in Manhattan offered incentives to employers to return to the office. The nature of industry plays vital role. Dingel and Neiman [27] showed that the change in teleworking from during-pandemic to post-pandemic period varies widely among industry. The teleworking decisions may also be influenced by employees' teleworking preferences [22–24] and experiences [30]. Singh et al. discovered that living in metropolitan regions is positively associated with teleworking because telework-friendly enterprises are concentrated there, and the ICT infrastructure is superior [22]. There was a high level of employee satisfaction with telework, as seen in the Portugal study. Higher organizational trust and a sense of well-being at home were the most significant factors [31].

Secondly, several studies have shown that sociodemographic characteristics impact telework. People with higher income and educational attainment are more likely to work from home [4,27]. Peters et al. discovered that adults without children were likelier to telework [29], whereas others suggested that young children may favor telework [23,25]. Gender and age may also influence the decision to telework; however, results were inconsistent. A Canadian study found that the proportion of adults increases until 35 [33]. The age range for teleworkers is stretched in the US and Australia, where the lower age limit came down to 26 from 36 [22,28]. The preference for telework was found among the age group of 25–45 in North America and the European continent [29,30]. The researchers also found racial relations with telework which shows Asian and Non-Hispanic people show more eagerness to telework than White and Hispanic People [31,32]. Some research identified a positive link between men and teleworking [37]; however, others discovered that women were more inclined to work from home, primarily due to employment and care responsibilities [25,28,30–32]. In addition, researchers also found that married people are highly interested in teleworking opportunities compared to unmarried people [33,34].

Lastly, early travel behavior may influence the decision to telecommute after pandemic. Previous research has shown that automobile users are less likely to telecommute than public transit users [35]. Adjusted for sociodemographic characteristics, [40] found that car ownership reduces telecommuting. The commute distance also affects a person's decision to telecommute. Helminen and Ristimäki [41] discovered that lengthier commutes promote telecommuting.

Work has never been the same since the COVID-19 pandemic. The epidemic has forced governments worldwide to impose restrictions and regulations to prevent the disease from spreading, forcing many businesses to rely on teleworking [36,37]. In 2020, teleworkers accounted for 47% of the workforce in Australia, France, and the United Kingdom. Between December 2019 and May 2020, teleworking in Japan increased from 10% to 28% [43]. Several governments encouraged teleworking and provided help to employees and employers; the United Kingdom and the Netherlands waived home office expenses. The United States established a telework handbook for both employers and employees [44]. According to the UK's Scientific Advisory Group for Emergencies, working from home lowered viral exposure. Even though working from home has grown steadily over the last decade, the outbreak and lockdown have accelerated many firms' adoption of teleworking [45]. As traditional work has moved away from the office and toward an online presence, working from home has become the industry standard [38–42]. During the lockdown, teleworking was influenced by firm size, employee credentials, job characteristics, and even gender. According to an analysis by the OECD in 2021, more than half of people who worked in highly digitalized industries teleworked. Big firm employees were more likely to telework, as were people with good academic credentials. In most countries, more women than men work from home [43].

After this review, we found that the preference for teleworking during the pandemic is investigated in different capacities. However, knowledge about the preference for teleworking in the post-pandemic era is not much studied despite its importance. This study, putting this into its core aim, explores the sociodemographic characteristics of prospective teleworkers who never worked at home before the pandemic, which previous studies have not addressed. Moreover, it finds the travel behavioral and attitudinal correlates of teleworking to advance the knowledge about teleworkers in the new-normal future.

Data and methods

Data source and context

In this study, Citywide Mobility Survey (CMS) data was used to reveal the correlates of future teleworking choices. This survey was conducted by the New York City Department of Transportation (NYC DOT) from October 19, 2020, to November 2, 2020. New York is one of the US states that have been extremely affected by COVID-19. After detecting the first case on March 1, 2020, this city passed 1000 deaths in 31 days and 100,000 deaths in 3 months. After that, on June 8, 2020, the first phase of reopening started in the city. By September, most of the public and private services and stores reopened, followed by phase 4 reopening [48]. The timeline of CMS used in this study is situated after the reopening phases and thus, can capture the responses after the first

wave of 2020. Information on this specific period is important because wide-ranging studies have documented the impact of COVID-19-related behavioral inertia which is the change in behavior after reopening according to the stay-at-home period [43–45]. Wang et al. [51] has reported a survey finding that 59% of Americans are willing to continue teleworking after reopening. Therefore, the time of our survey data can be an important candidate to investigate people's behavioral preferences in post-pandemic time.

The observations of this survey were collected from the respondents of the CMS conducted in 2019. The sampling methodology of the 2019 survey was address-based sampling where the city was divided into ten zones with a specific number of target samples and compensatory oversampling where the target was not met. The October CMS data comprises 905 respondents. After removing the missing responses and logical skips for six variables (i.e., teleworking before the pandemic, teleworking in the future, income, gender, and ethnicity), we retained 301 responses. Since the respondents are chosen by addressed-based sampling from with a geographic quota, we used the weights prepared by the data provider to avoid sampling biases like self-selection, nonresponse, and undercoverage bias. Previous studies utilizing this datasets have also used the survey weights [46,47,52,53]. The data, metadata, and questionnaire of the survey are open to the public and can be accessed from Ref. [54].

Outcome variable

The objective of this study is to model the change in teleworking frequencies in the post-pandemic era. To measure these changes, we used two questions from the survey questionnaire. Respondents recorded their teleworking frequency before mid-March 2020. They also expressed their preferred teleworking frequency as the city reopens. The following Table 1a shows the cross-tabulation of these two frequencies. We then divided these changes into three broad categories, which were performed as the outcome variable of this study. They are:

1 No increase (base category): The first category is for the people who teleworked before the pandemic and either want the frequency to decrease or remain the same.
2 Extended teleworker: The second category is for the people who teleworked before the pandemic and now want to increase the frequency.
3 Prospective teleworker: The third category is for the people who never teleworked before the pandemic and now want to start teleworking in different frequencies.

Predictor variable

We have used four types of predictor variables to model the choice of future teleworking. The first type consists of the seven sociodemographic variables. We used income, race, ethnicity, and gender in different categories. Although age was originally in categories, we coded it and used it as a continuous variable. We have used dummies to indicate if the household has any vehicle and any children under five and 12 years. The second type of predictor variables includes two travel behavioral information. We have coded the work trip frequency into three dummies which are zero days a week, one to three days a week, and more than three days a week. The other variable is to capture the non-work travel. We coded if the last mode used for food or groceries by the respondent were home delivery, motorized vehicle (e.g., car, motorcycle, taxi), public transport (e.g., bus, subway, rail), or non-motorized

Table 1a
Number of respondents with different Teleworking Frequency.

Telework frequency before Mid-March	Preferred telework frequency							
	Less than monthly	1-3 days a month	1 day a week	2-3 days a week	4 days a week	5 days a week	6-7 days a week	total
6-7 days a week	0	0	0	1	0	2	1	4
5 days a week	0	0	1	7	4	10	2	24
4 days a week	0	0	0	2	0	4	1	7
2-3 days a week	0	0	0	12	1	7	1	21
1 day a week	0	0	0	4	3	8	1	16
1-3 days a month	0	0	0	11	3	9	4	27
Less than monthly	0	3	0	20	5	15	5	48
Never	4	4	8	45	19	61	12	153
total	4	7	9	102	35	116	27	301

Notes:
Red highlighted cells: Preferred no increase in telework frequency
Green highlighted cells: preferred increase in telework frequency who teleworked before the pandemic
Blue highlighted cells: preferred to start teleworking who never teleworked before the pandemic

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Blue highlighted cells: preferred to start teleworking who never teleworked before the pandemic.

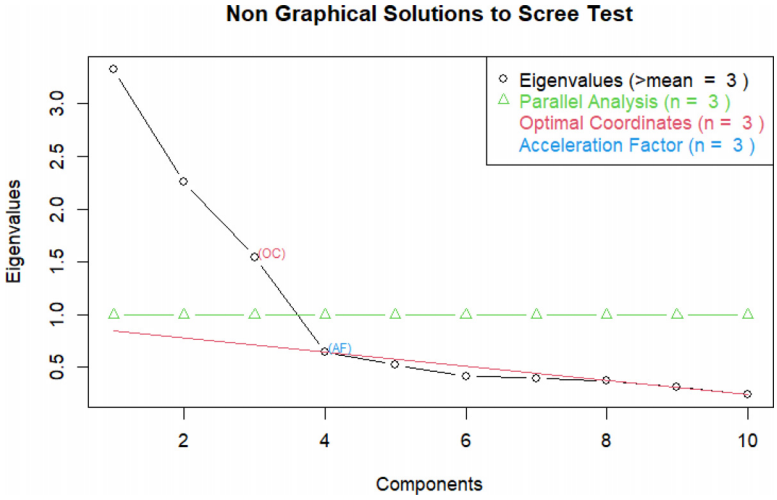

Fig. 1. Eigenvalues of the total number of components (factors).

transport (e.g., walking, biking, scooting). The third variable type is the geographic distribution of the respondents. The five boroughs (i.e., Manhattan, Bronx, Brooklyn, Queen, and Staten Island) and outsiders of New York City (NYC) were the categories of this variable.

The final type of variable consists of the attitudes of respondents towards travel and allocating street space, captured by 13 statements. These statements were in five-scale Likert points ranging from "very likely" to "very unlikely". We used exploratory factor analysis to factorize the 13 statements. Fig. 1 shows the eigenvalue and the number of factors with these statements. The lowest eigenvalue above one can be found with three factors.

We used the varimax orthogonal rotation method to get uncorrelated factors from the statements. The result of the factor analysis is shown in Table 1b. We have included the loadings above 0.40. The first factor includes the statements regarding allocating street space for protected bike lanes, bike parking, bus lanes, outdoor dining, and outdoor classrooms. We have removed the statement regarding trash containers on the sidewalk (instead of trash bags) for its low factor loading. The high value of the first factor broadly represents people who support activity near streets and safe dedicated space allocation for bicyclists and bus users. Next, high values of the second factor indicate the tendency of out-migration from NYC due to decreased employment and recreational activities and to remain safe. Finally, the third factor consists of attitudes that direct at safety concerns (e.g., staying at home, wearing a mask). Except for a few statements, factor loadings are of high values. Also, the deviance explained by each factor is in a satisfactory range (15.1%–

Table 1b
Factor loadings of the variables.

Variables	Statement	mean	St. dev.	Factor one	Factor two	Factor three
attitude_street_bike_lanes	street space: protected bike lanes	2.22	1.27	0.832		
attitude_street_bike_parking	street space: bike parking	2.44	1.25	0.848		
attitude_street_bus_lanes	street space: bus lanes	2.11	1.14	0.614		
attitude_nyc_surge	Travel: I am likely to move out of New York City to try to avoid future surges of COVID-19 cases	3.99	1.24			0.818
attitude_nyc_activities	Travel: I am likely to move out of New York City due to decreased arts, recreation, and entertainment opportunities and activities	3.85	1.29			0.817
attitude_nyc_employment	Travel: I am likely to move out of New York City due to decreased employment opportunities	3.84	1.28			0.731
attitude_stay_home	Travel: I think everyone should stay home as much as possible until there is a vaccine for COVID-19	2.19	1.23		0.731	
attitude_mask_indoor	Travel: I think people should wear masks when they are around other people in public indoor spaces	1.29	0.76		0.643	
attitude_mask_outdoor	Travel: I think people should wear masks when they are around other people in public outdoor spaces	1.65	1.09		0.720	
attitude_order	Travel: I think stay-at-home orders should be reinstated if there are future surges of COVID-19 cases in New York City	1.89	1.2		0.727	
attitude_street_dining	street space: outdoor dining space for restaurants	2.03	1.19	0.544		
attitude_street_classroom	street space: outdoor classrooms for students	2.6	1.32	0.511		
attitude_street_containers	street space: containers for trash collection (as opposed to placing bags on the sidewalk for collection)	2.12	1.19			
Factor diagnosis						
Proportion variance				0.202	0.165	0.151
Cumulative variance				0.195	0.367	0.518

20.2%) with a cumulative variance of 0.518. These three factors were then used in further analysis.

Statistical model

A multinomial logit model is used to model the choices of future teleworking. The three mutually exclusive outcome variables are already mentioned above, where the first category (i.e., no increase) will be the base category. The model will separately explain the probability for a respondent to be an extended teleworker and a prospective teleworker over the base category. The equation of the model is as follows:

For each class of outcome variable k = 1, …, K, a linear score z_k is computed with explanatory variables j = 1, …, d. β_{jk} is the coefficient for j predictor and k outcome variable (Eq. (1)).

$$z_k = \beta_k + \sum_{j=1}^{d} x_j \beta_{jk} \tag{1}$$

Then this linear score is used to calculate the probability of the outcome variable to be a particular category over the base category (Eq. (2)).

$$P\,(y = k|z) = \frac{e^{z_k}}{\sum_{k=1}^{K} e^{z_k}} \tag{2}$$

The coefficients are estimated using the maximum likelihood function. To assess the goodness of fit of the model, we computed McFadden's pseudo rho square with log-likelihood of reduced and intercept-only models. We also calculate the accuracy of the predicted categories.

Result

Descriptive statistics

Table 2 shows the statistics of the variables used in this study. We have presented the sampling frequency, sample percentage, and weighted percentages for the variables. The dependent variable has three categories; 12.7% of the population is not interested in increasing their teleworking frequency. 42.3% population teleworked before the pandemic and prefer an increase in telework frequency. The majority of the weighted sample (45%) had not worked from home before the pandemic but now are willing to start teleworking in different frequencies.

Among the sociodemographic predictor variable, the race of the majority of people is white (44.1%), which is followed by Asian (27.4%) and Black (15.6%) community. A large part of the city (21.8%) has a Hispanic population coming from Mexico, Puerto Rico, Cuba, etc. We retained the income categories from the survey questionnaire. In NYC, around 56% of people have an income above $100,000. The gender distribution and vehicle ownership among weighted samples are very competitive within them, with the dominance of being female and having one vehicle, respectively. Around 6% and 30% of people have reported having at least one child under five years and under 12 years, respectively. In the weighted sample, we have people from 18 to 84 years old, whereas mid-aged people (35–44) are the highest percentage.

Around 70% of the respondents had no work-related trip in the week when the data was collected. The mode share for food and grocery-related trip varied. Most respondents used non-motorized transport or private motorized transport for it. Public transport and home delivery were equally used with a lesser frequency than the other two modes. The weighted geographic distribution of the respondents varied as well. People from the Bronx, Staten Island, and outsiders of NYC relatively less participated in this study compared to Manhattan, Brooklyn, and Queens. The summary statistics for three latent factors (i.e., pro-street activity, pro-out-migration, pro-safety) are also provided in Table 2.

Model result

We have built a Multinomial Logit Regression model which is provided in Appendix. In Table A1, the odds ratios are reported along with their standard error and significance. The odds ratios report the probability for a respondent to be an extended or prospective teleworker over the person with no increase in teleworking. In short, it shows how a factor affects the chances of a person increasing or starting teleworking. In this section, we discuss the probability of the outcome categories in the model using predicted probability plots. After estimating the model, the predicted probabilities for the observations are calculated for each outcome category. For categorical predictors, the average probability for each category across the observations is shown in the plot. For covariates, the probabilities associated with different values are shown in scatter plots with fitted lines. On balance, these plots allow us to compare the probability of being different types of teleworkers associated with different categories of categorical predictor variables and values of continuous predictor variables.

Age, gender, ethnicity, income, and race

The socioeconomic characteristics of the respondents include age, gender, ethnicity, household income, and race. Figure 2 shows that respondent's probability of being a prospective teleworker starts to increase with age and reaches the maximum for the age group 35–44. Afterwards, it starts to fall with an increase in age. For the last age group (75–84), it's close to zero. The probability of extending teleworking is the highest among the youngest age group (18–24). For the later age groups, it's pretty much consistent up to 75 years old. After that, the probability of being an extended teleworker drops sharply for the 75–84 years age group. Overall, the probability of being an extended or prospective teleworker is higher than that of not increasing teleworking for all the age groups except for the eldest group (75–84). While the probability of being a prospective teleworker is high among females than males, males want to extend their current teleworking frequency more than females. Non-Hispanics want to start or extend teleworking more than Hispanics. For Asians and Blacks, the probability of starting teleworking is higher than extending the current frequency. For Whites and other races, extending teleworking is more common than starting it. Among all the races, Blacks have the highest probability of starting teleworking while Whites have the lowest. The predicted probabilities for different income groups show complex trends. The probability of being a prospective teleworker first increases from the lowest income group (under 25,000 USD) to the next group (25,000–49,999 USD). Afterward, with the increase in income, the probability drops in general with a sudden dip for the income class of 50,000–74,999 USD. Very opposite to this trend, the probability of extending telework first drops after the lowest income class and then starts to increase for the subsequent income classes. Again, for the income class of 50,000–74,999 USD, we observe an unusual spike in the probability of extending teleworks, even more than starting it.

Household-related variables

The household-related variables in the model include the number of children and vehicles in households (Figure 3). People with at least one child under 5 years old in the household have a higher probability of starting teleworks and a lower probability of extending telework than people without a child under five. The probability of extending teleworks does not differ too much among people who have or who do not have a child under 12 years old. However, starting teleworking is less common in people with a child under 12 than people without them in the household. Similarly, having a vehicle or not does not affect too dif-

Table 2
Descriptive statistics of the variable used in this study.

Variable	Frequency (sample)	Percentage (sample)	Percentage (Weighted)
Outcome variable	301		
Extended Teleworker	107	35.50%	42.30%
No increase*	41	13.60%	12.70%
Prospective Teleworker	153	50.80%	45%
Race	301		
Asian*	79	26.20%	27.40%
Black	39	13%	15.60%
Other	28	9.30%	12.90%
White	155	51.50%	44.10%
Ethnicity	301		
Hispanic*	59	19.60%	21.80%
Not Hispanic	242	80.40%	78.20%
Household income	301		
under $24,999*	9	3%	13.90%
$25,000-$49,999	27	9%	5.20%
$50,000-$74,999	49	16.30%	10.90%
$75,000-$99,999	46	15.30%	13.70%
$100,000-$199,999	134	44.50%	47.50%
$200,000 or more	36	12%	8.70%
Gender	301		
Female*	174	57.80%	55%
Male	127	42.20%	45%
child 5 years (in HH)	301		
No*	261	86.70%	93.40%
Yes	40	13.30%	6.60%
child 12 years (in HH)	301		
No*	265	88%	69.80%
Yes	36	12%	30.20%
Age classes (original age range)	301		
4 (18–24)	8	2.70%	1.20%
5 (25–34)	107	35.50%	20.40%
6 (35–44)	85	28.20%	51.80%
7 (45–54)	57	18.90%	20.20%
8 (55–64)	39	13%	5.90%
9 (65–74)	4	1.30%	0.30%
10 (75–84)	1	0.30%	0.20%
Grocery mode	301		
Home delivery*	46	15.30%	15%
Non-motorized transports	123	40.90%	37.10%
Motorized private vehicle	113	37.50%	34%
Public transport	19	6.30%	13.80%
HH vehicle	301		
no vehicle*	151	50.20%	45.50%
one vehicle	150	49.80%	54.50%
Workday	301		
no work trip*	201	66.80%	69.70%
1 to 3 days	67	22.30%	22.40%
4 day or more	33	11%	7.90%
Home location	301		
Bronx*	52	17.30%	6.80%
Brooklyn	53	17.60%	18.20%
Manhattan	69	22.90%	38.20%
Outside	14	4.70%	6.60%
Queens	84	27.90%	27.50%
Staten_Island	29	9.60%	2.60%
Attitudinal factors	Mean (Std. Dev.)	Minimum	Maximum
Factor 1: pro street activity	0.0 (0.927)	−1.507	2.843
Factor 2: pro safety	0.0 (0.896)	−1.086	4.152
Factor 3: pro out-migration	0.0 (0.918)	−2.577	1.23

* Base categoryHH: Household.

ferently for extending teleworking. However, people with no household vehicle are more likely to be prospective teleworkers.

Travel behavior

Two variables related to travel behavior have effects on teleworking (Figure 4). People who travel to work for at least one day a week have a higher probability of starting teleworking than extending the current frequency. The probability of starting to telework is pretty consistent with the number of travel days in a week. The people who do not travel to work have a similar probability of starting and extending teleworking. With the increase in working trip days, people's likelihood of extending their teleworking diminishes. People who make work trips for 4–7 days are less willing to extend than people who travel less than four days. The reason for this could be a unique effect of the workplace where firms requiring employees to come more frequently have less room extension of teleworking. The modal usage for one non-commuting trip (i.e., a trip for grocery/food) has also been examined. People who use online delivery or non-motorized transport have slightly less likelihood of starting teleworking than extending it. Conversely, public and private (motorized) transport users have a higher likelihood of starting teleworking

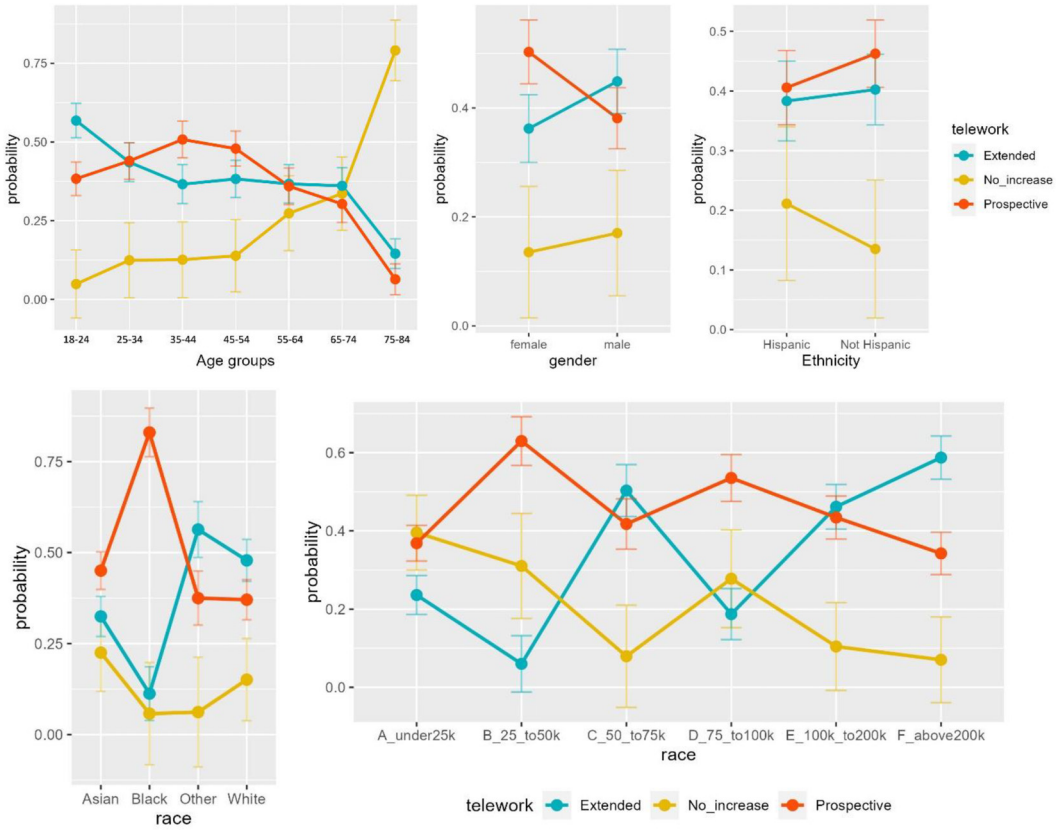

Fig. 2. Predicted probability with 95% confidence level for (from top left; clockwise) Age code (4 (18–24), 5 (25–34), 6 (35–44), 7 (45–54), 8 (55–64), 9 (65–74), 10 (75–84)), Gender, Ethnicity, Income, and Race.

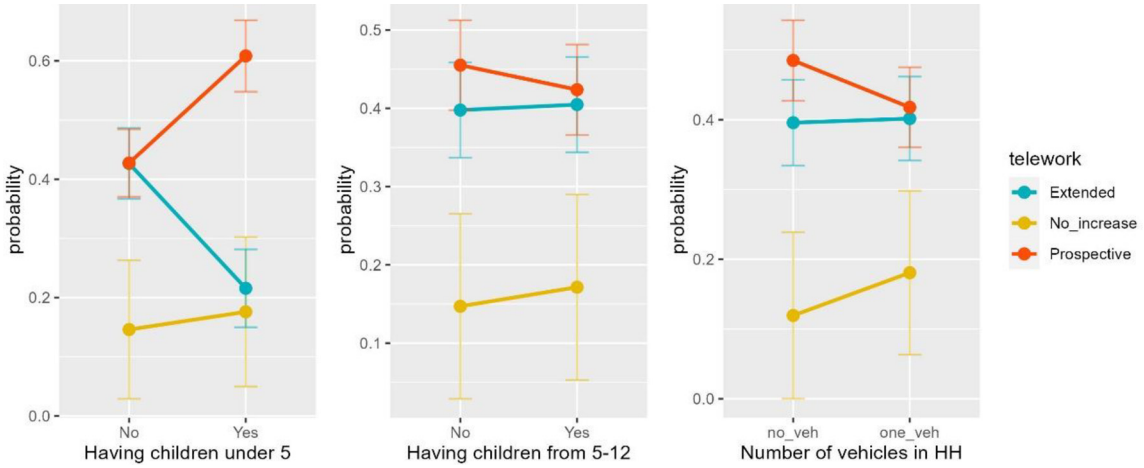

Fig. 3. Predicted probability with 95% confidence level for (from left) having children under five years old, having children under 12 years old, having at least one vehicle in household.

than extending it. Among all mode users (for grocery trips), the public transport users are the one group that has the highest inclination towards starting teleworking.

Geographic variation

The preference for teleworking is not geographically homogenous (Figure 5). The probability of starting teleworking is substantially higher for people in the Bronx and outside of NYC than in the other four boroughs (i.e., Brooklyn, Manhattan, Queens, Staten Islands) of the city. People of these four boroughs, however, have a higher likelihood of extending their current teleworking frequency than people of the Bronx and outsiders. In fact, in the Bronx, the probability of extending teleworking is the lowest among the categories (i.e., starting teleworking and no increase in teleworking).

Attitude toward street activity, migration, and safety

The probabilities associated with the factor scores are plotted in Figure 6. The first factor includes statements regarding allocating street space for bus lanes, bicycle lanes, bicycle parking, street dining, and on-street classrooms. Values greater than 0.5 include people who support the statements. These people have a greater likelihood of starting or extending teleworking than the likelihood of not increasing the current teleworking frequency.

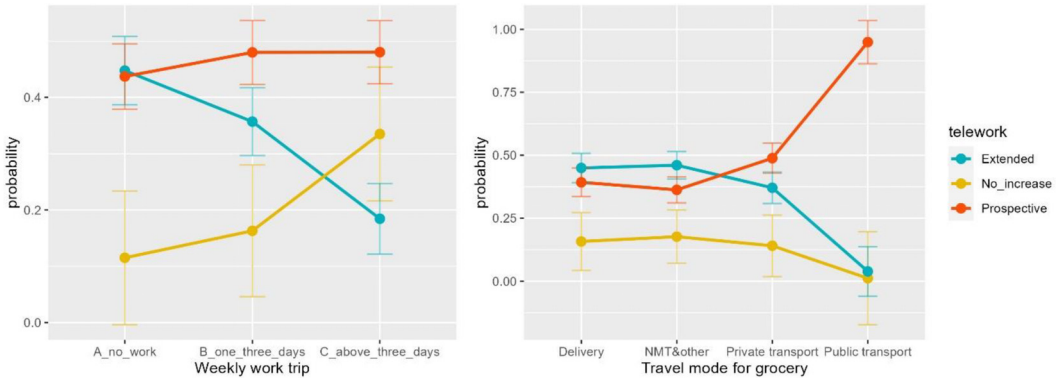

Fig. 4. Predicted probability with 95% confidence level for (from left) the number of days in a week when the work-related trip is made and travel mode for food/grocery-related trips.

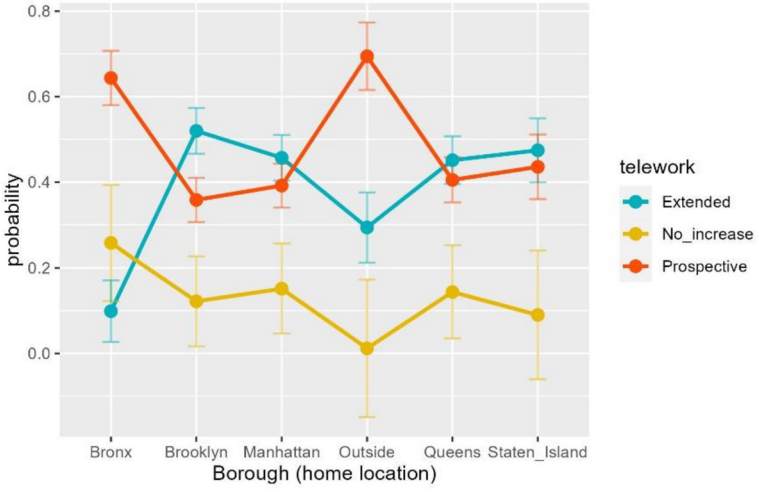

Fig. 5. Predicted probability with 95% confidence level for teleworking of people from different home locations.

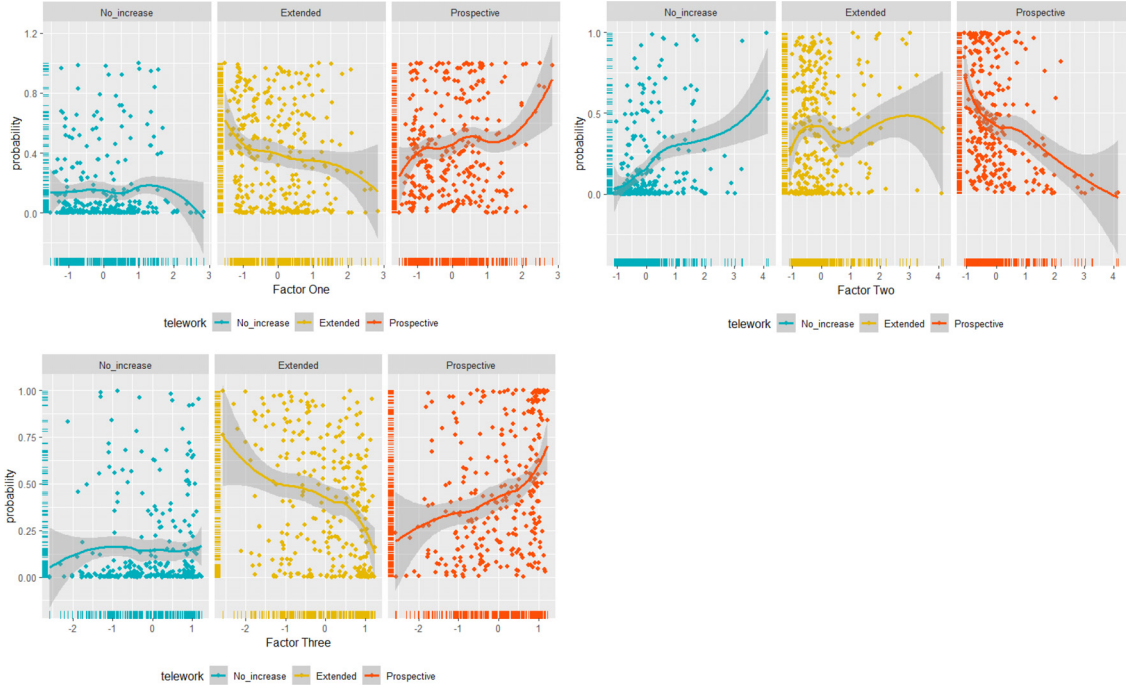

Fig. 6. Predicted probability for (from the left top; clockwise) Factor one (pro-street-space), Factor two (pro-safety), and Factor three (pro-migration).

The second factor consists of the safety statements regarding using mask and staying at home. Values greater than 0.5 dominently include people who agree that people should wear masks indoors and outdoors and that more stay-at-home should be implemented. Counterintuitively, these pro-safety people are less likely to start or extend teleworking. Instead, their likelihood of not increasing their current teleworking frequency is higher. An explanation for this finding could be that these pro-safety people are not against in-person jobs for themselves, but they want people to take protective measures like wearing masks and staying at home more seriously and making the environment safe.

The third factor consists of the statements regarding migration from NYC due to a further surge of COVID-19 and decreased activities, opportunities, and employment. Values greater than −0.5 indicate people's pro-migration attitude. People with a mindset to move out have a greater likelihood of starting or extending teleworking than of not increasing their current teleworking frequency. Also, with more agreement to migrate, the likelihood of starting teleworking increases while the likelihood of extending teleworking diminishes. This is sensemaking since if the people with greater motivation to move out are not teleworking currently, they need to start teleworking to continue their current job remotely. This is complimentary to their desire to start teleworking. On the other hand, people who want to extend teleworking are already working remotely in different frequencies. Therefore, it is intuitive that they have less motivation to leave the city than the people who are not teleworking at all.

Discussion and conclusion

This study investigates the changes in preference for teleworking frequency in the post-pandemic era. A survey of 301 respondents in New York City, USA, reveals the preferred teleworking frequency and before-pandemic teleworking frequency. From their choices, we split the respondents into three categories: previous teleworkers who do not want to increase their teleworking frequency, previous teleworker who want to increase their frequency (i.e., extended teleworker), and previous non-teleworker who wants to start teleworking (i.e., prospective teleworker) as the city reopens. A multinomial logit model is used to predict these categories with the help of several sociodemographic, household, geographic, travel behavioral, and attitudinal characteristics of the respondents.

The major findings are outlined below:

a The model suggests that the preference for teleworking diminishes with age in a non-linear fashion. Hispanic people are less likely to start/extend telework in the post-pandemic world than non-Hispanic people. Black people have the most probability of starting teleworking than other races while other people have more likelihood of extending their current teleworking frequency than Black people. Females are more likely to start teleworking than males while less likely to extend their current frequency.

b People with a child under five in households are more likely to start teleworking while they are less likely to start it if they have a child under 12 years old. Intuitively, people without any vehicle in households are more likely to start teleworking.

c For the prospective teleworkers, the number of work-related trips in a week does not affect them much. However, people who make at least one work trip have a higher probability of starting teleworking than extending it. The probability of starting teleworking does not change much with the number of trip days while the probability of extending the current frequency diminishes linearly with their work-trip frequency. People who use public transport for food and groceries have the highest probability of starting teleworking but the lowest probability of extending teleworking among the other mode users for grocery trips.

d When looking at the home location, we found that people who live in the Bronx or outside of the city have the highest probability of starting teleworking but the lowest probability of extending teleworking among people from other areas.

e From analyzing the three factor scores, we found that people who have more pro-street and pro-out-migration attitudes, are more interested in starting or extending teleworking. However, pro-safety people are less likely to start or extend teleworking.

Our findings are in line with the other published works. In examinations of the pandemic's impact on people's daily activities and travel habits, sociodemographic aspects are considered by scholars. The average age group who is likely to move towards telework is 35–44 in our study which is also found by other research work in North America and the European continent [28–30]. We found that people with a child under five years are forward to starting teleworking while people with a child under 12 years are not. This finding aligns with a similar notion that having younger children (e.g., pre-schooler) increases the likelihood of teleworking for greater family responsibility while for parents of school-aged children, there are parental responsibilities like picking up from school that can be connected with their commuting and reduce the incentive of starting teleworking [21]. Previous research found that automobile users are less likely to telecommute than public transport users [49,50]. We advance this understanding by adding that this relationship holds in New York City for newly starting teleworking while for the existing teleworkers, increasing frequency is less attractive to transit users than private vehicle users. During the pandemic, there were indications that females in the United States were more prone than males to avoid public spaces and remain at home [55]. Females stated that the danger of catching COVID-19 at work or school was larger [6]. Our model similarly finds that females are more interested to start teleworking compared to males. Beck et al. [56] evaluated the impact of socioeconomic characteristics such as age, gender, occupation, and household income on teleworking activities at the onset of the COVID-19 outbreak in Australia. Their findings revealed that those with higher earnings were more likely to engage in teleworking, whereas low-income people were more likely to engage in outside-the-home work activities. Our findings similarly suggest that most of the high-income groups are more likely to extend their current teleworking frequency than low-income groups., With that, we also found that in New York City, low-income groups are slightly more inclined to start teleworking after the pandemic than high-income groups.

Our findings are important for formulating sustainable policies in the future. To determine the sector and target group of post-pandemic accessibility-related investments, it's crucial to stay informed about the demography of future teleworkers. This information is also helpful to calculate the changes in travel demand in different Traffic Analysis Zones and use these calculations for long-term planning considering human migration and residential self-selection. This study will assist the discussion on sustainable transportation policy and energy efficiency due to the reduced travel demand in cities. Further, identification of the mode choice of the new teleworkers can be helpful for many cities to forecast their future mode-share.

This research has several limitations to acknowledge. First, the work trip length could play an important role in determining who is going to extend/start teleworking and who is not. Unfortunately, this information is not available in the current survey questionnaire. Second, it's possible that the effect of spatial autocorrelation is present in our result. Locational data of the respondents, which is not available, would help us determine if there is any autocorrelation in the responses. Nonetheless, we have tried to address this issue at our best capacity by incorporating the boroughs as dummy variables into our model. Third, the reason behind the increase/decrease/start of teleworking is not stated by the respondents. The desire to telework or to increase the frequency largely depends on the worker's occupations and the nature of the firms which are missing in the survey database. Although we tried to overcome this issue by incorporating income and business areas (i.e., boroughs) into the model, we believe that explicit inclusion of this information will help

future models to disentangle the causal relationship. Fourth, the sample size of the survey is not too large. Further, to conduct this analysis on teleworkers, we had to remove two-thirds of the respondents from the main survey sample. Therefore, we would like to encourage the readers to be cautious with the findings and validate them with other studies. Given the fact that NYC is a large city with highly heterogeneous social classes, future studies should employ a bigger dataset to reach a more credible conclusion.

Future modelers can work on a smaller set of predictors revealed in our study and go into detail with their interaction effect and non-linear effects after accounting for spatial heterogeneity. This work expands the current body of knowledge by identifying the social groups where the changes in travel behavior, related energy consumption, and travel demand are expected to take place. Targeted improvement in workplace management and technology can help employees to shift to telework, get reduced exposure to the negative externalities of commuting, and enjoy both health safety and work efficiency. By addressing these issues, future studies would bolster the understanding regarding social justice involved with the scope of teleworking to pave the way for a sustainable economy and society.

Declaration of Competing Interest

There is no conflict of interest to declare.

Appendix

Table A1.

Table A1
Multinomial Logit model result (Dependent variable: Type of Teleworker; base category: No increase).

	Extended teleworker				Prospective teleworker			
Predictor Variables	Coeff.	Std. error	Odds Ratio	P-value	Coeff.	Std. error	Odds Ratio	P-value
Intercept	0.997	0.040	2.710	<0.001	3.634	0.039	37.879	<0.001
Household income								
under $24,999	Base							
$25,000-$49,999	−3.182	0.023	0.042	<0.001	−1.485	0.021	0.227	<0.001
$50,000-$74,999	3.127	0.022	22.795	<0.001	1.374	0.022	3.950	<0.001
$75,000-$99,999	0.715	0.020	2.044	<0.001	0.237	0.017	1.267	<0.001
$100,000-$199,999	2.516	0.017	12.379	<0.001	1.506	0.017	4.508	<0.001
$200,000 or more	2.682	0.020	14.620	<0.001	1.149	0.020	3.156	<0.001
Gender								
Female	Base							
Male	0.794	0.012	2.212	<0.001	0.045	0.012	1.046	<0.001
Ethnicity								
Hispanic	Base							
Not Hispanic	2.124	0.014	8.367	<0.001	1.985	0.013	7.278	<0.001
Race								
Asian	Base							
Black	4.010	0.025	55.159	<0.001	5.318	0.024	203.996	<0.001
Other	7.900	0.031	2698.391	<0.001	5.260	0.030	192.569	<0.001
White	3.120	0.013	22.639	<0.001	1.905	0.013	6.717	<0.001
child 5 years (in HH)								
No	Base							
Yes	−2.581	0.018	0.076	<0.001	−0.788	0.016	0.455	<0.001
child 12 years (in HH)								
No								
Yes	0.535	0.013	1.707	<0.001	0.908	0.013	2.479	<0.001
age class	−1.439	0.005	0.237	<0.001	−1.088	0.005	0.337	<0.001
Grocery mode								
Home delivery	Base							
Non-motorized transports	0.046	0.016	1.047	0.003	−0.461	0.016	0.630	<0.001
Motorized private vehicle	0.377	0.017	1.458	<0.001	0.817	0.017	2.264	<0.001
Public transport	1.148	0.043	3.152	<0.001	5.543	0.038	255.527	<0.001
HH vehicle								
no vehicle	Base							
one vehicle	−0.099	0.015	0.906	<0.001	−1.547	0.015	0.213	<0.001
Workday								
no work trip	Base							
1 to 3 days	−1.253	0.013	0.286	<0.001	−0.863	0.013	0.422	<0.001
4 day or more	−3.230	0.017	0.040	<0.001	−0.499	0.014	0.607	<0.001
Home location								
Bronx	Base							
Brooklyn	4.648	0.023	104.351	<0.001	1.514	0.019	4.547	<0.001
Manhattan	3.814	0.024	45.349	<0.001	0.751	0.019	2.119	<0.001
Outside	7.011	0.041	1108.246	<0.001	6.546	0.038	696.626	<0.001
Queens	4.368	0.022	78.924	<0.001	1.558	0.017	4.747	<0.001
Staten_Island	6.040	0.036	420.076	<0.001	3.961	0.034	52.487	<0.001
Factor 1: pro street activity	0.203	0.008	1.226	<0.001	0.558	0.008	1.748	<0.001
Factor 2: pro safety	−0.946	0.006	0.388	<0.001	−1.899	0.007	0.150	<0.001
Factor 3: pro out-migration	−0.584	0.007	0.558	<0.001	0.349	0.007	1.418	<0.001
Model Diagnostic								
Log likelihood (null model)	−1,519,009							
Log likelihood (full model)	−735,795.74							
Pseudo rho square	0.516							

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