How Remote Work Will Influence GHG Emissions: A National Analysis of the Relationship of the Impact of COVID-19 on Remote Work, Commuting, Residential Location, and Greenhouse Gas Emission Reduction

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Research Report

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Executive Summary

The COVID-19 deeply unsettled the US economy and how people work. For the first time, many workers did not commute to their regular workplace and instead worked remotely, if they could still work. Three years after the pronouncement of the pandemic in March 2020, the World Health Organization announced that the pandemic status of COVID-19 was rescinded. With the end of the pandemic, people's work habit returned to a more stable arrangement. For many workers, this meant continuing to work remotely at least some of the time. The increased share of workers who appear to be able to work remotely permanently has opened opportunities for more flexible residential arrangements. Some people live and work on different sides of the country and many who only commute once or twice per week moved to locations far from their employment. These changes have repercussions on people's commuting habits and the emissions associated with driving to work.

This report focuses on the joint effect of driving to work less often but from potentially farther away. The balance of these two factors can lead to reduced overall driving and emissions (reduction in days commuting outweigh the increase in the distance driven each day) or an increase in emissions if the increased distance more than makes up for the fewer days people drive. The ambiguity relates mostly to hybrid workers for whom commuting is still a requirement at least once a week. People working remotely full time can eliminate commuting completely. Therefore, to shed light on the aggregate effect of switching to hybrid and full-time remote work, we surveyed a representative national sample of people on their work arrangement, their move history, and the location of their home and work. The main results are:

An evolving work arrangement

The share of remote workers doubled from before March 2020 to September 2023. Post-COVID-19, there were approximately an equal share of people working remotely full time and working under a hybrid arrangement. The number of days hybrid workers commuted to work was evenly distributed, but two in five hybrid workers commuted to their place of work more often than their employer required them to. In contrast, few people reported working remotely more than their employer permitted. The share of remote workers has remained stable since 2023 according to the Bureau of Labor Statistics. Respondents appear confident that this stability will persist. Nearly 49% of respondents anticipated an increase or expect to maintain the same amount of remote work next year. Approximately 5% of respondents anticipated a reduction in the amount of work they performed remotely. Another 10% expressed uncertainty about the future of their work arrangement. Uncertainty was more prevalent among hybrid workers than it was among in-person and full-time remote workers.

Uneven access to remote work

Disparities across industries in the level of remote work they can accommodate are well documented. We use the rich demographic data the survey collected to examine who can remote work and to establish a robust estimate of how different demographics affect the likelihood that someone can work remotely at all. The demographic analysis serves two main purposes. First, it shows that most of the difference in ability to work remotely comes from differences between industries. Second, other demographic factors like race and ethnicity, gender, and age fail to significantly affect the ability to remote work, suggesting that there are no systematic disparities in being able to work remotely within industries. Education level is the only other factor that has a significant effect. In short, people in professional and office-centered jobs are more likely to be able to work remotely and those with college degrees within those industries are the most likely to work remotely.

Did remote workers move to remote places?

People moving out of cities was one of the recurring stories during the pandemic. While we do not focus on where people moved, we find that the average migration rate in our sample was in line with national averages, but that hybrid and remote workers were about 30% more likely to have moved than in-person workers. Those who switched work arrangements (in any direction) were almost twice as likely to move than those who did not. While most moves were short distance (about 10 miles, and 22 miles for remote workers), at least 25% of hybrid workers moved >190 miles away and remote workers >360 miles away. Despite remote workers' flexibility to move farther (thanks to being free from the demands of daily commuting), the distance between most remote workers' place of residence and work was not very different than in-person workers. It is only among a subgroup of remote workers for whom move distance is significantly greater. Statistical analyses show that hybrid workers balance commute distance and the number of days they must drive. The fewer days people have to commute, the farther they are likely to live from their place of employment.

An uncertain balance for emissions

The long-term effects of the increased reliance on remote work on greenhouse gas (GHG) emissions will depend on many possible changes. We focused on three primary interrelated factors: vehicle efficiency, frequency of commuting, and distance of commuting. Our findings indicate that reducing the number of days people commute has the most significant impact on emissions, and this effect is not offset when people increase the distance they drive substantially. In contrast to the anecdotal evidence that people moved to remote places and drove increasing distances to work, we show that distances between jobs and home increased only moderately for most people, regardless of work arrangements. While some uncertainty remains as to the net balance of emissions in the post-COVID era, our results suggest that hybrid work can significantly contribute to reductions in emissions.

Chapter 1: Introduction

1.1 Background

The COVID-19 pandemic saw one of the most significant changes in work and commute patterns ever experienced. Telecommuting, or remote working, experienced large increases, stemming from the desire to prevent infection in-person. Pre-pandemic, the share of telecommuters remained persistently low, ranging from 4% in 2006 to 6% of employed people working from home full time in 2019 according to the Census American Community Survey. The Bureau of Labor Statistics (BLS) put the figure higher at 9% in February 2020.[1] No matter the data source, the spread of COVID-19 in early 2020 led to a dramatic increase in remote working that has not been entirely reversed. Although many employees were required to return to the office starting in 2023, the U.S. Household Pulse Survey[2], as of September 2023, reported that 26% of adults in the U.S. still substituted some or all of their typical in-person work for telework.

Hybrid working schedules could become the "new norm", enabling and prompting telecommuters to move farther away from job centers as they substitute what was previously a greater commute frequency (e.g., each weekday) for lower commute frequency and greater commute distance. Evidence of increased housing demand in rural areas and smaller metros is consistent with workers moving away from job centers (Arend et al., 2023). If work is hybrid, with persons working at home and in an office, vehicle miles traveled could increase or decrease depending on the balance of longer distances between home and office, lower frequency commuting, and the possibility that persons might substitute other non-work driving for free time that results from less commuting. No empirical studies have examined the joint impact of changes in working-from-home, jobs-housing re-location and the associated environmental impacts in the post-pandemic era.

This project analyzes how changes in commuting behavior following COVID-19 have altered the spatial relationship between homes and workplaces. It aims to offer the best estimate currently available regarding the impact of remote work on greenhouse gas emissions, helping transit and planning agencies in modeling air quality and traffic congestion.

Throughout the paper we use the COVID-19 pandemic as a reference period. The pandemic disrupted economies worldwide and led to the rapid adoption of remote working for millions. We use March 2020, when most U.S. states instituted physical distancing mandates that shut down most workplaces, as the beginning of the pandemic's effect on work arrangements and refer to the time before as *pre-COVID*. The survey we use as the primary

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[1] The share of telecommuters varies with sources because of differences in definition and methodology. In this report we aim to use consistent points of reference and will use the Bureau of Labor Statistics figure because it separates full-time and part-time remote workers. Please see BLS article for detail: https://www.bls.gov/opub/mlr/2022/article/telework-during-the-covid-19-pandemic.htm

[2] U.S. Household Pulse Survey database: https://www.census.gov/programs-surveys/household-pulse-survey.html

source of data was fielded in September 2023 and the questions asked survey respondents about their current situation and, occasionally, the pre-COVID time period. The World Health Organization declared the end of the COVID-19 pandemic in May 2023, so we refer to the time period at the time of the survey as *post-COVID*.

1.2 Research Purpose

This project evaluates the spatial adaptation linked to remote working, how jobs-housing locations changed (i.e., by persons moving their residence or job location), and how the resulting configuration affected greenhouse gas (GHG) emissions in the post-pandemic era. We used a nationally representative survey that included retrospective and prospective questions asking respondents about the history of their work location and the most recent move over the last two years, their current residential location and commute patterns, and anticipated remote work and moves in the near future. While it will likely take years for the repercussions of the pandemic to play out in the housing and labor market, the survey in September 2023 was fielded at a time when trends in work arrangements had stabilized and the housing market had significantly slowed down due to higher mortgage rates. The survey, therefore, fills an important gap for research and policymaking. By using some prospective questions about anticipated behavior, we also get insights into possible future evolutions of remote work and commuting behavior.

The project aims to answer three sets of questions:

1. During the pandemic, did workers who can work remotely move more frequently? Were they more likely to move farther away from job centers? For workers who work hybrid, as the frequency of in-person workdays increases, are persons more likely to live closer to job centers?
2. What factors affect the relationship between home location and work location for remote workers? Does the relationship vary by demographic and industry composition?
3. Does working remotely lead to less driving and a reduction of greenhouse gas emissions compared with other work arrangements, including hybrid in-person/remote models? Are reductions in driving higher for people who work full-time remotely? How does driving and related GHG emissions for hybrid in-person/remote workers compare with driving and GHG emissions for persons who work fully in-person?

Additionally, we used retrospective and prospective questions to query past and anticipated moves, to assess if current patterns will persist or if, for example, remote workers are returning to the office.

1.3 Contribution and Significance

This project is one of the first to provide an early look at the impact of working-from-home during a time when the initial COVID shock has passed, but when work and residential location relationships are still in flux and likely adjusting. We understand that the long-run equilibrium might not yet be evident, but the initial shock has passed and by 2023 most workers had settled into a more permanent work arrangement as evidenced by the stability of the BLS monthly tracking of remote working rates.[3] This report contributes insight into how people balanced the number of times they commute to work, how far they commute, and how the vehicle they drive impacts commute-related GHG emissions.

Metropolitan planning organizations such as the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG) are already anticipating that remote work will reduce commute-based GHG emissions, and they are incorporating that into their plans to meet state mandated GHG emission targets and federally mandated air quality targets (True North Research, 2021). Yet, existing data and models give limited insight into the COVID-induced remote work phenomenon. Our survey provides better evidence on the magnitude of changing remote work patterns on GHG emissions and on the circumstances under which hybrid working, specifically, can contribute to increased emissions.

We estimate whether remote or hybrid workers actually generate lower GHG emissions on average than in-person workers. The results could offer the best estimate currently available regarding the impact of remote work on greenhouse gas emissions, helping transit and planning agencies in modeling air quality and traffic congestion.

[3] Labor Force Statistics from the Current Population Survey. Telework or work at home for pay: https://www.bls.gov/cps/telework.htm. Share of persons who telework to some extent across various months is as follows: September 2023: 19.8%; May 2023: 18.9%; January 2023: 19.4%; October 2022: 17.9%

Chapter 2: Literature Review

The often-used term these days, work-from-home, is one of the forms of telecommuting. The concept of telecommuting was first formed by Nilles in 1973 and has been a field of interest for transportation researchers since then. Telecommuting is used to describe working outside of the workplace during standard work times (Ory and Mokhtarian, 2006; Bailey and Kurland 2002). Other terminologies include telework, remote work, distance work, e-work, flexplace, and electronic cottage (Teo and Lim 1998). Telecommuting has been considered as a potential mechanism to alleviate traffic congestion, reduce emissions, improve air quality, and create environmental benefits in our cities (Hopkins and McKay, 2019; Nguyen, 2021). However, some scholars argued that these forecasts could be overly optimistic (Gold, 1991).

Prior to COVID-19, the share of telecommuters remained persistently low in the U.S. According to the ACS[4], from 1997 to 2010, the number of people working at least one day a week from home increased only 2.5 percentage points, from 7 % to 9.5%. Zhu et al. (2018) also claimed that only about 9% of the working population in the U.S. worked from home more than once a week (Zhu et al., 2018). The spread of COVID-19 to California in early 2020 led to a series of policies such as social distancing, partial lockdown, and quarantine to curb the spread of the disease, which reduced travel during the pandemic. Working from home was widely implemented during the pandemic to protect employees' health while continuing with economic activities (World Health Organization, 2020).

The pandemic increased remote working, with the daily work-from-home rate going from 8% in February 2020 to 35% in May 2020 (Brynjolfsson et al., 2020). Brynjolfsson et al. (2020) conducted two waves of surveys in April and May 2020 using Google Consumer Surveys (GCS) to ask whether people have started work-from-home in the past 4 weeks. They found that workers who were white, young, highly educated, high income, employed in information work (management, professional and related occupations), or parents were more likely to switch to work-from-home. These groups were also less likely to have been laid off or furloughed.

2.1 Attitude Towards Remote Working

As the United States navigates our post-pandemic recovery, urban planners and policymakers have wondered whether work patterns and the nature of urban centers will revert to the pre-COVID conditions, or whether there will be a permanent transformation. In one view, work-from-home will receive a permanent boost post-COVID, because firms already

[4] No Commute? Americans Who Work at Home: https://www.census.gov/newsroom/blogs/random-samplings/2012/10/no-commute-americans-who-work-at-home.html#:~:text=During%20a%20typical%20week%20in,employed%20people%20to%209.5%20percent

paid the fixed costs of learning how to make remote working functional and productive during the crisis. In this view, COVID-19 provided an environment to force firms to solve a coordination issue that they used to ignore (Bartik et al., 2020).

Baert et al. (2020) found that 63% of respondents out of a 14,000 worker survey hoped for more teleworking in the future. Bartik et al. (2020) provided results from firm surveys of both small and large businesses on the expectations about the persistence of remote working after the COVID-19 pandemic. These two surveys in Bartik et al. (2020) cover 1,770 leaders of small business from the Alignable Network and 70 business economists at larger firms from the National Association of Business Economists (NABE). The results indicated that the level of work-from-home varied across industries and was most common in industries with better educated and better-paid workers. The results from both surveys showed that more than one-third of the respondents believed that work-from-home will remain more common at their company after COVID-19 ends. Davis, Ghent, and Gregory (2021) used an equilibrium model to estimate work-from-home. The simulation data include occupational shares, wages, household locations, and frequency of work-from-home by location. They ascertained that the elasticity of substitution between in-person work and remote work has shifted in favor of remote work.

2.2 Remote Working and Commute

When workers become more able to work remotely, the new flexibility to avoid commuting can affect workers' residential location choice (Liu and Su, 2021). The standard urban model (Alonso, 1964; Muth, 1969; Mills, 1967) predicts that households will trade long commutes for lower land prices (and hence lower housing prices) on the urban fringe. Similarly, Kain (1961) posits that households trade-off commute costs for residential site costs (as cited in Brueckner, 1987). Decades of urban economics research have verified those predicted patterns (see, e.g., Mills and Tan, 1980, for an early example). The standard urban model leads to predictions that persons will consume lower-cost housing far from the urban core and in effect trade longer commutes for more land or, on a per-unit basis, lower-cost housing.

Telecommuting, by altering commute costs, can change residential location choices and equilibrium land uses in ways that can be predicted by the standard urban model. Ory and Mokhtarian (2006) in their empirical study examined the impacts of telecommuting on residential location and urban form and found that telecommuting could increase the decentralization of a city compared with a non-telecommuting baseline. Some researchers (Janelle, 1986; Graham and Marvin, 1996) believed that telecommuting could prompt individuals to move farther away from their jobs to cheaper or higher quality residential locations, generating longer commutes and leading to a net increase in vehicle miles traveled (VMT) if telecommuters still go to a workplace on some days. Following this logic, although telecommuting leads to longer one-way commutes, some other researchers found that, due to lower trip frequency, the average commute distance was still shorter than for non-telecommuters (Mokhtarian et al., 2004; Golob,2002). Mokhtarian (1998) and Hamer et al. (1991) also found a net reduction in VMT by telecommuters on days they telecommute.

The traditional approach to evaluating transportation systems focuses on automobile traffic flow and congestion reduction. However, there's a noticeable shift underway. In response to the pressing need to combat climate change and reducing greenhouse gas (GHG) emissions, many cities, regions, and states are reassessing their priorities. Instead of solely focusing on metrics that measure congestion, there is a growing emphasis on reducing the overall amount of driving (Obeid et al., 2022; Brownstone, 2008).

One key component of reducing greenhouse gas (GHG) emissions is the reduction of Vehicle Miles Traveled (VMT). VMT quantifies the total distance traveled by vehicles within a specific area over a set period. By targeting reductions in VMT, communities aim to achieve not only a decrease in GHG emissions but also a range of additional benefits (Fang and Volker, 2017). Reducing VMT can lead to decreases in other harmful air pollutants, mitigate water pollution, reduce wildlife mortality from vehicle collisions, and alleviate traffic congestion (Ewing et. Al., 2016; Kazancoglu and Ozbiltekin-Pala, 2021). Moreover, cutting VMT can contribute to improvements in public safety and health outcomes by lowering the risk of accidents and exposure to pollutants (Shin, 2020). Additionally, there are potential economic benefits, including savings in infrastructure costs, healthcare expenses, and productivity gains associated with reduced congestion and travel time (Fang and Volker, 2017).

2.3 Remote Working and Migration

A collection of research papers has developed spatial equilibrium models to analyze the repercussions of the widespread adoption of working-from-home. Liu and Su (2021) are among the first to examine the effect of COVID-19 on housing demand at the neighborhood level. They found that the pandemic reduced housing demand in central cities and higher density neighborhoods. This result is driven by 1) the diminished demand for living close to jobs that are highly telework-compatible, and 2) the drop in visits to services and amenities during the pandemic, both of which lower the value of living closer to amenity-rich locations. Delventhal, Kwon, and Parkhomenko (2021) conducted a spatial equilibrium model and found that job opportunities continue to concentrate in city centers even as residents increasingly choose to relocate away from urban areas. Behrens, Kichko, and Thisse (2021) developed a general equilibrium model to study how intensities of remote working affect the efficiency of firms. They discovered a decline in the demand for office space alongside a surge in the demand for residential living space. Mondragon and Wieland (2022) also used a spatial equilibrium model to argue that remote working has contributed to an increased demand for housing, and its post-pandemic surge has been responsible for half of the house price growth witnessed from 2019 to 2022.

Couture et al. (2021) analyzed cell-phone data and identified a significant outflow of individuals from New York City. Meanwhile, Haslag and Weagley (2021) utilized cross-state moving data from a moving company to observe a trend where predominantly high-income individuals were relocating to smaller, more cost-effective cities. Ozimek (2020) conducted a survey that revealed a notable increase in planned relocations, with over half of the respondents expressing a desire for more affordable housing due to the rise in remote work. Furthermore, Ozimek (2022) used survey data to highlight a substantial number of people moving beyond commuting distances and indicated that many more relocations are anticipated in the future.

Ramani and Bloom (2022) shed light on this issue, revealing a shift in real estate demand. This shift is evident in both rents and property prices, as persons move away from major city centers and toward less densely populated areas on the outskirts of cities. This phenomenon has been observed broadly but is more pronounced in larger cities. Both people and businesses have been relocating from major metropolitan areas to smaller cities and rural regions. One possible explanation for this trend is the greater flexibility of housing supply in less densely populated regions, which helps stabilize property prices even with changing population patterns. Ramani and Bloom (2022) discuss the significant differences in rent and home price growth as well as population and business migration patterns between central business districts (CBDs) in the largest 12 US metropolitan areas and less densely populated areas during the COVID-19 pandemic. Rent growth and home price growth in CBDs lagged behind the less dense areas by around 15 to 20 percentage points compared to the growth observed in the least dense 50% of zip codes, after adjusting for pre-pandemic trends. Additionally, migration patterns, based on USPS data, revealed that CBDs experienced net population and business outflows, while less dense areas gained a small percentage of their pre-pandemic population and businesses.

Chapter 3: Research Design and Data

Large-scale, publicly available datasets are unsuitable to study the impact of changing work arrangements because they do not allow for the linking of individual records that enable the kind of before-and-after comparisons required for this research. In the absence of a suitable dataset, we developed a survey instrument that the firm IPSOS fielded in September 2023 using their nationally representative KnowledgePanel® panel of respondents. This section provides an overview of the research design and specifics about the survey.

3.1 Research Design

The primary purpose of this research was to examine two main changes that would directly affect how people commute: whether they moved to a new location (and whether they concurrently changed jobs), and whether they were able to work remotely (part- or full-time). All survey respondents were adults (18 years old or older) working full-time at the time of the survey.

We aimed to collect 2,000 responses from a nationally representative sample that provide a sample of at least 500 responses in each of the outlined dimensions shown in Table 3.1.1. The 2x2 matrix divides the survey sample into workers who are able to work remotely or not, and for each type of worker, whether they moved after the Covid outbreak (March 2020) or not. These dimensions were used as selection devices so that respondents that did not fit into one of the matrix cells (or that fit into a cell for which we had already collected enough data) were excluded from answering further questions. We collected a total number of 2,214 responses, with each category meeting the target of 500 responses. This survey has been approved by the Institutional Review Board at the University of Southern California (Study ID: UP-23-00703).

Table 3.1.1 Unweighted responses by working arrangements and moving status

Type	Moved at least once after covid	Did not move after covid	Total
Able to work remotely	535	528	1,063
Not able to work remotely	527	534	1,061
Total	1,062	1,062	2,124

The survey collected information about how changes in work arrangements were associated with where people live and their daily routine. (Details of the survey questions are available in Appendix A.) The survey questions focused on three topics. The first set of questions gathered information about residential characteristics and their move history. We asked respondents about their current and past home zip codes, whether they moved, how many times they moved, when their last move occurred, why they moved, and how far they moved.

The second set of questions focused on work arrangement and changes in employment. We asked respondents' current and past job zip codes, how long have they worked for their current employer, whether they changed jobs after March 2020, how many times they changed jobs, why they changed jobs, how many days in a week they worked remotely before and after the start of the pandemic, and which day(s) of the week they typically work remotely.

The last set of questions focused on commute behavior, including information about the main vehicle respondents used. Questions covered the respondents' commute mode, whether it changed after covid, vehicle make/model/year, and the frequency of driving to non-commute related activities.

The questions provide a rich, but complex, picture of people's trajectories from March 2020 to late 2023. We processed respondent's responses to categorize people and create a simpler set of parameters to summarize data. Using respondents' work arrangements pre- and post-COVID, work arrangements are classified into three types:

- Remote: Workers who work fully remote for 5 or more days per week.
- Hybrid: Workers who commute to work in-person at least once a week, but no more than four days a week.
- In-person: Workers who work fully in-person for 5 or more days per week.

In addition to categorizing respondents, we used information about their zip code(s) of residence and work to calculate the distance they moved and the distance between their home and place of work pre- and post-pandemic. For all distance calculations, we were constrained to using the zip code information. Zip codes, because they are used for the purpose of mail delivery and can change inconsistently, are not set geographic areas the way other administrative units like counties and cities are. However, the US Census Bureau developed the Zip Code Tabulation Area (ZCTA) to approximate the boundaries of postal zip codes and to allow researchers to match zip code information with consistent geographic boundaries and census data.

We match respondents' zip code information to the ZCTA and use the geographic center of each ZCTA to calculate distance between locations. In cases where the respondents moved within the same zip code or lives and works in the same zip code, we are unable to calculate a distance and assign a value of zero.

There are limitations to this method. First, zip codes vary in size, so distances between the centers of any two zip codes are less likely to be actual commute distances in rural and suburban areas where zip codes tend to be large. The net error from this, though, will balance under- and over-estimations of distance because we use the geographic centroid of ZCTA's for all calculations. Second, because we have no information about respondents' locations other than their zip code of residence, any moves within the same zip code are coded as a 0-mile move, leading to an underestimate of the mean move distance. Close to one in ten movers changed residence within the same zip code.[5] Third, when respondents work and live in the same zip code, this is again coded as zero miles, also leading to potential undercounting of home-work distances.

3.2 Sample Definition and Field Period

The survey was conducted using KnowledgePanel®, the largest online panel in the United States, which employs probability-based sampling methods to recruit a representative sample of adults in the country. IPSOS invited one adult per household from a representative sample of households to participate in the survey. Selected panel members received an email invitation to complete the survey at their earliest convenience, with the subject and body of the email invitation provided in Appendix A.

IPSOS translated the original English-language survey into Spanish and made both languages available to respondents. (The survey instruments in both languages are available in Appendix A). We piloted the survey internally with a sample of convenience to refine the instrument and gauge survey length before sharing the survey with IPSOS for their own pre-test (see Table 3.2.1 for sample details). The finalized survey was fielded to the full panel in late September 2023 and reached the target number of responses in each of the cells for our matrix (Table 3.1.1) in October 2023. The median completion time for the main survey was 6 minutes. Respondents were unable to complete the survey more than once and qualified respondents were entered into the KnowledgePanel® sweepstakes upon completion.

Table 3.2.1 shows the timeline of the survey. We pretested the survey in August 2023 and fielded the main survey from September 22 to October 12, 2023. The Completion rate for the main survey is 63%. This number indicates the percentage of individuals who finished answering all the questions in the survey out of the total number of invited participants. The qualification rate, at 18%, is the percentage of completed surveys that met specific eligibility criteria. The lower qualification rate can be attributed to the need for a larger number of completed surveys to achieve the targeted 500 responses for each subcategory outlined in Table 3.1.1. The sample is nationally representative and includes respondents from most areas of the United States. The map (Figure 3.2.1) shows the current home locations of survey respondent.

[5] The share of very local moves (within the same zip code) is in line with other research based on zip code moves using a larger dataset in California (Boarnet et al., 2023)

Table 3.2.1. Completion and qualification rates of the survey

	Field Start	Field End	N Fielded	N Completed	Completion Rate	N Qualified	Qualification Rate
Pretest	8/9/2023	8/14/2023	200	102	51%	40	39%
Main	9/22/2023	10/12/2023	19,000	12,011	63%	2,124	18%

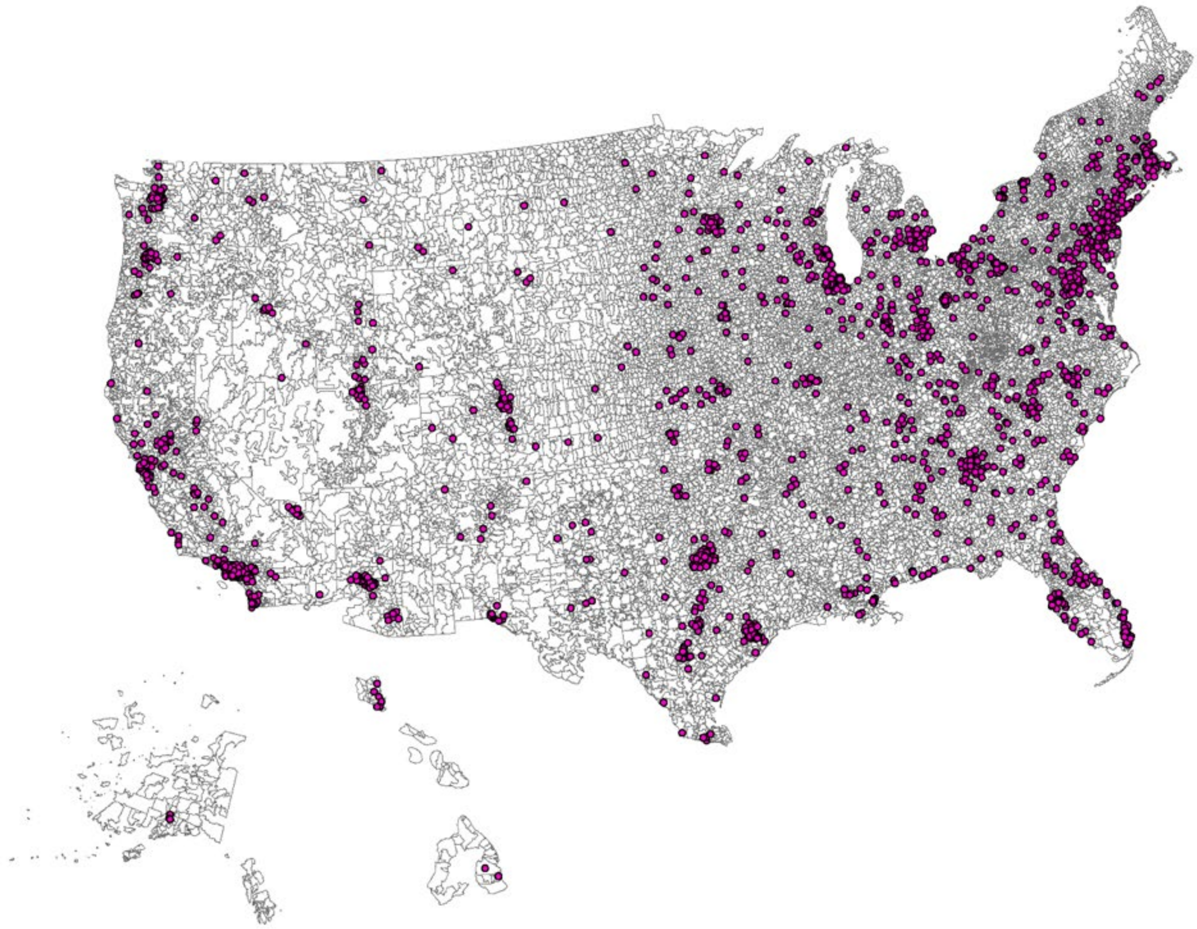


Figure 3.2.1. Current home location of survey respondents

3.3 Survey Methodology

We summarize key elements of the survey methodology based on the IPSOS KnowledgePandel Book.[6]

The KnowledgePanel® draws from a sample of 60,000 respondents to field nationally representative research surveys. Panel members are selected randomly through probability-based sampling. After accepting the panel invitation, participants complete a brief demographic survey. The information collected in this survey records demographic characteristics for all panel members. As a result, in our main survey, we don't need to ask extra demographic questions since we received the full set of demographic data for each respondent from IPSOS.

IPSOS provides sample weights based on the geographic distribution of demographic information from national surveys such as the Current Population Survey and American Community Survey (see Appendix B for more details on benchmarking). However, studies like this one generally require a specific subset based on a set of criteria that compromise the representative nature of the sample. The difference between the completion and qualification rate in Table 3.2.1 illustrates some deviation from the original pool of respondents. IPSOS provides a second set of weights specific to our survey to ensure the results are still nationally representative. The probability-proportional-to-size (PPS) procedure yields demographically balanced and representative samples that match the weighing obtained for the full panel. Table 3.2.2 shows the 4x4 matrix containing weighted responses for our screening questions: 1) Are you currently able to work remotely? and 2) Have you permanently changed residence since the pandemic began (March 2020)?

Table 3.2.2. Weighted shares (weighted responses divided by 2,124 total respondents)

Able to remote work?	Did you move at least once since March 2020?		
	Yes	No	Total
Yes	14%	35%	49%
No	12%	39%	51%
Total	26%	74%	100% (2,124)

While IPSOS uses a rigorous method to reach respondents and weight the responses, there are certain limitations that survey cannot avoid. Errors from respondents' answers (failure to recall an answer precisely, conscious or unconscious distortion of an answer, and lying are all possibilities) and limits in the ability to reach all relevant population means that no survey is perfect.

[6] For detailed methodology, please refer to: https://www.ipsos.com/sites/default/files/KnowledgePanel_Book.pdf

Chapter 4: Results

Our analysis aims to shed light on how people adapted their daily driving habits after the onset of the pandemic and following the normalization of remote work. People who switched to working remotely eliminated work-related traveling entirely, but many people switched to hybrid work arrangements and continued to commute at least once a week. The goal of the analysis is, in part, to disentangle the tradeoff between emission reduction from commuting to work less frequently and the increased driving distance due to living farther away from their work location (presumably because they commute less often). Vehicle emissions is the third element muddling this relationship. Someone traveling farther but using a clean-fuel car will have less impact than someone who continues to commute shorter distances alone in a highly-polluting vehicle.

We approach this by first looking at who works remotely full-time, part-time, or not at all, as well as how they get to work. We then use the results of the demographic analysis to test hypotheses relating to each aspect of the issue: how far people moved, how much longer is their commute, and, given the vehicle they use, did the balance of moving farther from work and driving less often to work result in a reduction of weekly GHG emissions for the average person?

Throughout this chapter, we report results that have been weighted and are derived from specific questions. All tables and analyses presented in Chapter 4 have been weighted to align with the national population benchmark shown in Appendix B. For the exact wording of questions, please refer to Appendix A for the complete questionnaire. Summary tables reference the corresponding question numbers in the notes.

4.1 Work arrangement preferences

In this section, we examine the shifts in work arrangements before and after the COVID-19 pandemic, as well as workers' preferences regarding their work settings. Our survey uses both retrospective and prospective questions to gather information on past and anticipated future work arrangements. This helps us determine whether current trends are expected to continue or if there are indications suggesting possible changes in the future, for example, remote workers planning to return to in-person work.

We first focus on the three types of work arrangements we defined:

- Remote: Workers who work fully remote for 5 or more days per week.
- Hybrid: Workers who commute to work in-person at least once a week, but no more than four days a week.
- In-person: Workers who work fully in-person for 5 or more days per week.

The total number of respondents is 2,124. Due to missing responses, the total valid responses for each analysis may vary slightly. For work arrangements, there are 2,105 responses for pre-COVID and 2,114 for post-COVID. The composition of workers across various work arrangements changed between the pre-COVID and post-COVID periods. For example, hybrid workers from the pre-COVID era may not be the same individuals observed in the post-COVID period. Some may have changed jobs and become either post-COVID in-person or remote workers.

Table 4.1.1 indicates that the proportion of remote workers nearly doubled compared to pre-COVID, from 11.6% to 22.6%, with hybrid workers showing a similar trend. The figures are higher than those reported by the Bureau of Labor Statistics[7] (19.8% of all workers involved teleworking at least some of the time, that is, hybrid or fully remote, in September 2023). Discrepancies of this magnitude are to be expected considering that the share reporting remote work arrangements is sensitive to sampling, survey design, and wording of the questions. In late 2020, researchers found a similar difference between their survey and BLS numbers (Brynjolfsson et al., 2020; Brynjolfsson et al., 2023). The proportion of in-person workers in our survey consequently decreased by about 20 percentage points, from 76.3% to 56.6%, from pre- to post-COVID.

Table 4.1.1. Share of different types of work arrangements from pre-COVID to post-COVID

Work Arrangement	Pre-COVID		Post-COVID	
	Freq.	Percent	Freq.	Percent
Remote	244	11.6%	478	22.6%
Hybrid	256	12.1%	440	20.8%
In-person	1,605	76.3%	1,196	56.6%
Total	2,105	100%	2,114	100%

*Source: survey Question: Q4_2, Q6_2

Table 4.1.2 shows the shift in work styles moving away from in-person arrangements. While 71% of in-person workers remained in-person, 17% switched to working hybrid, and 11% switched to working fully remotely. Of those working under a hybrid arrangement, a third switched to being remote full time, and most remote workers before the pandemic were still remote in 2023.

[7] Labor Force Statistics from the Current Population Survey, Telework or work at home for pay: https://www.bls.gov/cps/telework.htm

Table 4.1.2. Shift in work arrangement from pre-COVID to post-COVID

Work Arrangement		Post-COVID			
		Remote	Hybrid	In-person	Total
Pre-COVID	Remote	9%	1%	1%	12%
	Hybrid	4%	6%	1%	12%
	In-person	9%	13%	54%	76%
	Total	22%	21%	57%	2,097 (100%)

*Source: survey Question: Q4_2, Q6_2

Worker preferences do not always align with the employers' remote work policy. Some people may prefer to work in the office more often while others favor a greater share of remote work. Table 4.1.3 shows that most workers choose the maximum number of remote work days allowed by their employers, with few exceeding these limits (see percentages along the main diagonal and cells to the right of the diagonal). Among hybrid workers who are allowed to work remotely 1 to 3 days, 7% to 13% reported working more days remotely than allowed. In contrast, two in five hybrid workers who are allowed 1 to 3 days of working remotely commute to their workplace more days than they are required. The share of individuals working in-person more regularly than required by their employer decreases to 30% for those working remotely 4 days a week. Even among those permitted to work remotely five days a week, 14% of these remote workers still go into a physical work location to some extent. These results highlight the distinction between the ability to work remotely and the reality of working remotely, which vary depending on individual and workplace characteristics. We explore this further in section 4.2.

Table 4.1.3. Current work arrangement preference - interior rows sum to 100%

Remote work days		Days actually working remotely						
		0	1	2	3	4	5 and up	Share of Total
Days allowed to work remotely	0**	98%	0.3%	0.1%	0%	0%	1%	1,098 (52%)
	1**	44%	50%	3%	1%	1%	2%	101 (5%)
	2	19%	19%	51%	8%	1%	2%	170 (8%)
	3	6%	11%	15%	54%	8%	5%	138 (7%)
	4	4%	2%	8%	13%	73%	0%	78 (4%)
	5 and up	5%	1%	1%	2%	5%	86%	523 (25%)
Share of Total		1,195 (57%)	109 (5%)	128 (6%)	106 (5%)	95 (5%)	475 (23%)	2,108 (100%)

*Source: survey Question: Q4_1, Q4-2

**Not all interior rows sum to 100% due to rounding

The significant share of respondents who worked in person more days than they needed may reflect a preference for in-person work or tacit understanding within their workplace that the employers favor in-person presence. Although most workers anticipate maintaining their current work arrangement, Table 4.1.4 shows that hybrid workers are more likely to report anticipating working in-person within a year when compared to remote workers.

Among hybrid workers, 20% indicate they expect to reduce or eliminate remote work for the coming year, whereas for remote workers, the corresponding share is only 10%. There is little uncertainty across all work arrangements. Only 11% of respondents stated that that they were unsure how their work arrangement would change in the future. Four out of five respondents working full-time remotely or in person stated that they expected to maintain this work arrangement one year later.

Table 4.1.4. Anticipated future work arrangement

Future work arrangement	Current remote working status			Total
	Remote	Hybrid	In-person	
Same amount of remote work	79%	63%	3%	33%
Begin or increase remote work	1%	7%	3%	4%
Reduce remote work	4%	13%	1%	4%
No remote work	6%	7%	80%	48%
Unsure / Don't know	9%	9%	13%	11%
Total	478 (100%)	440 (100%)	1,190 (100%)	2,108 (100%)

*Source: survey Question: Q4_2, Q9

4.2 Remote Workers' Demographics and Vehicle Type

Table 4.1.3 indicated that the ability to work remotely and its actual implementation may vary. This could be influenced by factors such as individual and employer characteristics. The ability to work remotely depends largely on the type of work people do, which is, in turn, highly correlated with people's demographic characteristics (Brynjolfsson et al., 2020; Wang et al., 2023). Understanding this association is crucial for addressing the intertwined relationship between remote working and migration, commuting, and environmental impacts. Demographics also affect the types of vehicle people drive, another critical factor in understanding commuting behavior and its environmental impacts. This section examines how respondents' demographic characteristics affect their likelihood of working remotely and the kind of vehicles they use when commuting by car.

Remote work Ability

Our survey asked respondents two separate questions: (1) whether their *employer allowed them to work remotely* and also (2) whether they *actually worked remotely*. Previous research has shown, however, that the ability to work remotely was greatly influenced by the type of industry in which one works, the role on the job, and the demographics of those doing the job (Brynjolfsson et al., 2020; Wang et al., 2023) and Table 4.1.3 showed that ability to work remotely is not the same as actually working remotely, especially when examining the number of days working in person. We use a statistical model to create an index that summarizes respondents' ability to work remotely as a way to condense many variables into a single value that represents the how likely someone is to be able to work remotely. We do so in two steps. First, we condense the 25 industry groupings provided by IPSOS into a categorical variable – *industry potential* - of whether the industry has positive, negative, or neutral impact on the ability to work remotely (see equation 1 and table 4.2.1 below). Second, we use a multivariate logit model to examine the dependent variable, which is from survey question 1: Are you currently able to work remotely? (Yes, any days=1, no=0), with independent variables including industry potential and worker demographics (also provided by IPSOS). We then obtain the predicted value conditional on the independent variables for *predicted remote work ability.* These *predicted values of remote work ability* serve as the control variable for all subsequent regression analyses in the remainder of this chapter.

The effect of occupation type on the potential to work remotely has been documented in prior literature (Dingel and Neiman, 2020). The IPSOS respondent demographic information lists 35 industry types. Given this variable's importance and to make the analysis more tractable, we estimate the impact of industry type on the self-reported ability to work remotely using the regression model in equation 1.

Equation 1:

$$Remote\ work\ ability\ (1,0) = f(industry\ type)$$

The definition of each variable is listed below:

- Remote work ability: Yes=1, No=0
- Industry type, 35 dummy variables, each 0,1 for working in these industries: Management (omitted); Business and Financial Operations; Computer and Mathematical; Architecture and Engineering; Life, Physical, and Social Sciences; Community and Social Services; Legal; Teacher, except college and university; Teacher, college and university; Other professional; Medical Doctor (such as physician, surgeon, dentist, veterinarian); Other Health Care Practitioner (such as nurse, pharmacist, chiropractor, dietician); Health Technologist or Technician (such as paramedic, lab technician); Health Care Support (such as nursing aide, orderly, dental assistant); Protective Service (such as firefighter, law enforcement worker); Food Preparation and Serving; Building and Grounds Cleaning and Maintenance; Personal Care and Service; Sales Representative; Retail Sales; Other Sales; Office and Administrative Support; Farming, Forestry, and Fishing; Construction and Extraction; Installation, Maintenance, and Repair; Precision Production (such as machinist, welder, baker, printer, tailor); Transportation and Material Moving; Armed Services; Other (Please specify); Business Operations (including Marketing); Financial Operations or Financial Services (including Financial Advisor, Broker); Education, Training, and Library; Arts, Design, Entertainment, Sports, and Media; Health Diagnosing or Treating Practitioner (such as physician, nurse, dentist, veterinarian, pharmacist); Sales

Table 4.2.1 provides results of this regression (equation 1) and is organized based on the significance level, sign, and magnitude of the coefficient for each occupation. Table 4.2.1 shows the regression coefficients, sorted into groups of positive and statistically significant, insignificant, and negative and statistically significant. We use those groupings to form the categories of positive, neutral, and negative industry potential for remote work.

Consistent with previous research (e.g., Bartik et al. 2020), our analysis confirms that workers in office and desk-based roles are associated with a higher likelihood of being able to work remotely, while those in service-related jobs and manual labor are more likely to have a negative association with remote work. Using these findings, we reclassify the detailed industries into three groups predicting remote work ability and call this new variable *industry potential*: those with positive potential, those with negative potential, and those with neutral potential for remote work.

Table 4.2.1. Regression results between remote work ability and industry types (Dependent variable: Remote work ability)

Industry potential for remote work	Detail occupation	Coef.
Positive potential	Computer and Mathematical	0.355***
	Business Operations (including Marketing)	0.343***
	Legal	0.249**
	Architecture and Engineering	0.246***
	Life, Physical, and Social Sciences	0.17**
	Financial Operations or Financial Services	0.17**
	Arts, Design, Entertainment, Sports, and Media	0.14*
Neutral potential	Sales	0.075
	Armed Services	0.047
	Office and Administrative Support	0.036
	Community and Social Services	-0.02
Negative potential	Other (Please specify)	-0.087*
	Education, Training, and Library	-0.17**
	Building and Grounds Cleaning and Maintenance	-0.197**
	Health Care Support	-0.214***
	Personal Care and Service	-0.252***
	Food Preparation and Serving	-0.291***
	Health Diagnosing or Treating Practitioner	-0.291***
	Health Technologist or Technician	-0.305***
	Transportation and Material Moving	-0.328***
	Installation, Maintenance, and Repair	-0.384***
	Precision Production	-0.42***
	Construction and Extraction	-0.461***
	Protective Service	-0.484***
	Farming, Forestry, and Fishing	-0.523***
_cons		0.523

* p<0.05 ** p<0.01 *** p<0.001

The second step in creating an index for remote work ability is to model a composite variable – *predicted remote work ability* – that amalgamates demographic factors and industry potential into a single numerical value representing the ability to work remotely. We do this by regressing individual survey respondents' answers to the question about whether they can work remotely (survey question 1: Are you currently able to work remotely? Yes, any days=1, No=0) on a set of demographic characteristics and industry potential variable from Table 4.2.1. We then run the logit regression shown in Equation 2 and get predicted values of remote work ability for each survey respondent based on their respective demographic characteristics, which we will use as a control variable in later regression analyses.

Equation 2:

$$Remote\ work\ ability = f\begin{pmatrix} income, education, housing\ tenure, age, gender, \\ race\ or\ ethnicity, industry\ potential\ for\ remote\ work \end{pmatrix}$$

The definition of each variable is listed below:

- Remote work ability: Yes=1, No=0 (omitted)
- Income dummy variables (0,1) in three categories for: Less than $50,000 (omitted), $50,000 to $99,999, $100,000 or more
- Education dummy variables (0,1) in three categories for: High school diploma or below (omitted), bachelor's degree or Some college or Associate's degree, and Master's degree or higher
- Housing tenure dummy variables (0,1): Owned or being bought by you or someone in your household (omitted) and rented for cash or occupied without payment of cash rent
- Age dummy variables (0,1) in four categories: 18-29 (omitted), 30-44, 45-59, and 60+
- Gender dummy variables (0,1): Male (omitted), female
- Race/ethnicity dummy variables (0,1) in five categories: White (omitted), Black, Hispanic, Other, and 2+ Races
- Industry potential dummy variables (0,1) in three categories: Neutral remote work potential (omitted), positive remote work potential, negative remote work potential

Table 4.2.2 shows the result of the remote work ability estimation in equation 2 that combines the demographic variables with the industry potential variable derived above in table 4.2.1. We found that education level and industry potential have the most significant impact on remote work ability. Remote workers tend to have higher education levels and work in professional industries that typically involve more office and desk work. Those with graduate degrees in particular had higher ability to work remote. Renting one's home was also slightly more correlated with the ability to work remotely compared to owning a home. Several demographic variables that the literature and/or popular perception previously considered important for remote work were not statistically significant in this model: notably, income, age, race/ethnicity, and gender had no correlation with the ability to work remotely, likely because those factors are working through the industry potential. Similarly, estimating the model (Equation 2) with a control for geographic region did not materially change the results. A likely explanation for the lack of significant coefficients associated with demographic factors is that they were already accounted for by the industry potential variable. However, we still believe these variables should be included in the model for theoretical reasons. For subsequent regression analyses in this report, we use the *predicted value of remote work ability* from this statistical model. The predicted value represents a continuous measure incorporating demographic and industry characteristics, in contrast to the binary indicator solely based on whether people responded to the survey question saying they can remote work.

Table 4.2.2. Regression Results of remote work ability

<table>
<tr><td colspan="2">Dependent Variable</td><td>Are you currently able to work remotely (1,0)</td></tr>
<tr><td>Category</td><td>Variable</td><td>(1)</td></tr>
<tr><td rowspan="2">Income
(Omitted: <$50,000)</td><td>$50,000 to $99,999</td><td>-0.158</td></tr>
<tr><td>> $100,000</td><td>0.337</td></tr>
<tr><td rowspan="2">Education
(Omitted: High school diploma or below)</td><td>Bachelor's / some college / Associate's</td><td>0.431**</td></tr>
<tr><td>Master's or higher</td><td>0.773***</td></tr>
<tr><td>Housing tenure (Omitted: Owned)</td><td>Rented</td><td>0.320*</td></tr>
<tr><td rowspan="3">Age
(Omitted: 18-29)</td><td>30-44</td><td>0.313</td></tr>
<tr><td>45-59</td><td>0.235</td></tr>
<tr><td>60+</td><td>0.216</td></tr>
<tr><td>Gender (Omitted: Male)</td><td>Female</td><td>0.073</td></tr>
<tr><td rowspan="4">Ethnicity
(Omitted: White)</td><td>Black</td><td>0.159</td></tr>
<tr><td>Other</td><td>0.383</td></tr>
<tr><td>Hispanic</td><td>0.387*</td></tr>
<tr><td>2+ Races</td><td>0.099</td></tr>
<tr><td rowspan="2">Industry potential for remote work
(Omitted: no significant potential)</td><td>Negative potential</td><td>-1.126***</td></tr>
<tr><td>Positive potential</td><td>1.077***</td></tr>
<tr><td colspan="2">Constant</td><td>-0.779**</td></tr>
<tr><td colspan="2">Observations</td><td>2120</td></tr>
</table>

* p<0.05 ** p<0.01 *** p<0.001

Vehicle choice and work arrangement

This project primarily examines how remote work influences commuting behavior and, consequently, how that affects greenhouse gas (GHG) emissions. A key component of greenhouse gas emissions from commuting is the type of vehicle used by the commuter. Like remote work ability, vehicle choice is often associated with socioeconomic status.

Our survey asked respondents to report the make, model, and year of their primary commute vehicle if they commuted by car. For those who commuted primarily by another mode (e.g., public transit), we asked which vehicle was most commonly available to them in their household, if they were to commute by car. About three quarters of respondents (1,629) commuted by car or owned a car and reported information on their vehicle. We identify typical greenhouse gas (GHG) emissions for each vehicle by cross-referencing respondents' self-reported vehicle details (vehicle's make, model, and year) with the associated CO_2 tailpipe emissions (measured in grams per mile, gpm) reported in EPA's Fuel Economy Guide database for 2023.[8] Table 4.2.3 reports the mean and quartiles of GHG emissions in CO_2 tailpipe grams per mile (gpm). There are no discernable differences between remote and in-person workers in terms of average vehicle efficiency choices. The main difference between the two categories is in the upper end (90th percentile) of the distribution (the top 10% of most polluting vehicles), where in-person workers tend to drive higher-emissions vehicles. Hybrid workers stand out as driving lower-emissions vehicles, about 8% lower on average, a difference that holds across the distribution.

Table 4.2.3. GHG emission of owned vehicles by work arrangement

Work arrangement	CO_2 tailpipe (gpm)				
	mean	25%	50%	75%	90%
Remote	394	324	389	465	509
Hybrid	365	309	359	433	481
In-person	393	318	384	462	543

* Vehicle CO_2 tailpipe (gpm) source: EPA Fuel Economy Guide 2023, https://www.fueleconomy.gov/feg/download.shtml
*Source: survey Question: Q4_2, Q7_2

For purposes of descriptive data analysis we reclassified vehicle GHG emissions into three levels: high, medium, and low to better understand the relationship between workers and their vehicle. We use the 2024 GHG rating provided by the EPA (refer to Appendix C1 for classification) to categorize each vehicle according to its actual CO_2 tailpipe emissions obtained from EPA's Greenhouse Gas Rating.[9] Based on the result presented in table 4.2.4, compared to the overall distribution, we found that: Hybrid workers have the highest share (10%) of low GHG emission vehicles and lowest share of high GHG emission vehicles (7%). Fully in-person workers have the highest share (14%) of high GHG emission vehicles and lowest share (5%) of low GHG emission vehicles. Fully remote workers have a distribution of high, medium, and low emission vehicles similar to the overall distribution.

[8] Data is available for download from the EPA here: https://www.fueleconomy.gov/feg/download.shtml
[9] Data can be downloaded here: https://www.epa.gov/greenvehicles/greenhouse-gas-rating

Table 4.2.4. GHG emission ranking of owned vehicles by work arrangement

Our GHG Category	EPA Rating	CO_2 (g/mile)	Remote	Hybrid	In-person	Total
High GHG emission	1-3	> 509	11%	7%	14%	12%
Medium GHG emission	4-6	266-508	82%	83%	81%	82%
Low GHG emission	7-10	0-265	7%	10%	5%	7%
Total			126 (100%)	404 (100%)	1,099 (100%)	1,629 (100%)

*Please refer to Appendix C1 for GHG emission category and detail EPA rating. Data can be downloaded here: https://www.epa.gov/greenvehicles/greenhouse-gas-rating
*Source: survey Question: Q4_2, Q7_2

Considering the demographics of remote workers, which typically include individuals with higher income, higher education levels, and employment in professional industries that offer more flexibility for remote work, we hypothesize that workers who work remotely are more likely to own lower emission vehicles, while in-person workers are more likely to own higher emission vehicles. In other words, high emission vehicle owners may be more likely to commute, while lower emission vehicle owners may be more likely to work remotely. We use the following equations (3-6) to test the hypotheses. Equations 3 and 4 use Ability to remote work (from survey question 1: are you currently able to work remotely?) as the dependent variable whereas equations 5-6 use the number of actual reported commute days as an alternate measurement.

Equation 3:

$$Able\ to\ remote\ work\ (1{,}0) = f(vehicle\ GHG\ ranking)$$

Equation 4:

$$Able\ to\ remote\ work\ (1{,}0) = f(vehicle\ GHG\ ranking, controls)$$

Equation 5:

$$Commute\ Days_{2023} = f(vehicle\ GHG\ ranking)$$

Equation 6:

$$Commute\ Days_{2023} = f(vehicle\ GHG\ ranking, controls)$$

The definition of each variable is listed below:

- Able to remote work: Yes=1, No=0 (omitted)
- Vehicle GHG Ranking= Low (0-265 CO_2 g/mile), medium (266-508 CO_2 g/mile) (omitted), high (>508 CO_2 g/mile)
- Commute days 2023 = Days of commute per week in 2023
- Controls: *predicted remote work ability*, regions (Northeast (omitted), Midwest, South, West)

The regression results (table 4.2.5) from equation 3 show that when compared to workers owning medium GHG emission vehicles, those with low GHG emission vehicles are more likely (odds ratio +0.55) to remote work. In Equation 5, the results show that in comparison to workers with medium GHG emission vehicles, those with high GHG emission vehicles tend to have 0.29 more in-person workdays, while those with low GHG emission vehicles have 0.41 fewer in-person workdays. Models 4 and 6 include the controls (predicted remote work ability and region). Vehicle efficiency no longer achieves statistical significance with the addition of predicted remote work ability, implying a strong correlation between socioeconomic status and vehicle efficiency level. The stability in sign and magnitude of the efficiency variables point to these relationships likely being in the right direction.

Table 4.2.5. Regression results of vehicle GHG emissions

Dependent Variable		Able to remote work (1,0)	Able to remote work (1,0)	Commute days 2023	Commute days 2023
Category	Variable	(3)	(4)	(5)	(6)
GHG emission rank (Omitted: Medium GHG emission)	High GHG emission	0.000	0.000	0.293*	0.136
	Low GHG emission	0.546*	0.336	-0.414*	-0.241
Predicted remote work ability			0.975***		-0.500***
Region (Omitted: Northeast)	Midwest		-0.177		0.054
	South		-0.046		0.144
	West		0.164		-0.027
Constant		-0.393***	-0.349*	4.012	3.900***
Observations		1630	1627	1629	1626
R-squared				0.008	0.116
Adjusted R-squared				0.006	0.112

* p<0.05 ** p<0.01 *** p<0.001

4.3 Migration and Remote Work

Migration was frequently in the news as the COVID-19 pandemic unfurled, especially as it pertained to the increase in flexible work arrangements. The results in Table 4.3.1 suggests that a little over a quarter of respondents migrated (changed their home location) in the period between March 2020 and September 2023. Among those who moved, 70% of respondents moved once, 23% moved twice, and only 7% moved more than twice. Hybrid and remote workers were more likely to move than in-person workers.

According to the Current Population Survey, about 8-9% of Americans moved annually (CPS, 2023), while the Public Use Microdata Sample (PUMS) reports a 14% annual move rate during this time period (Kerns D’Amore 2023). Once we divide the 26% of respondents who reported moving between March 2020 and September 2023 by the 3.5 years covered by the time period covered in the survey question, yield a 7.4% move rate. This estimate is in line in line with the national average, especially considering that some moved more than once.

Table 4.3.1. Moving status by current work arrangement.

Moving status since COVID-19 began (March 2020)	Remote	Hybrid	In-person	Total
Moved	29%	30%	23%	26%
Did not move	71%	70%	77%	74%
Total	478 (100%)	440 (100%)	1,196 (100%)	2,114 (100%)

*Source: survey Question: Q2, Q2_1, Q4_2

Respondents who changed their work arrangement from pre-COVID to post-COVID were more likely to move (Table 4.3.2). Previously remote employees who switched to in-person work were almost twice as likely to move as those who stayed remote. While relatively uncommon, hybrid workers who went remote and in-person workers who went remote or hybrid were much more likely to move (nearly double) than their counterparts with less flexible arrangements.

Table 4.3.2. Moving status by change in work arrangement from pre-COVID to post-COVID

Change in work arrangement		Moved	Did not move	Total	
Pre-COVID	Post-COVID			#	Share
Remote	Remote	20%	80%	189	9%
	Hybrid	43%	57%	31	1%
	In-person	41%	59%	24	1%
Hybrid	Remote	33%	67%	89	4%
	Hybrid	25%	75%	136	7%
	In-person	37%	63%	28	1%
In-person	Remote	37%	63%	192	9%
	Hybrid	31%	69%	270	13%
	In-person	23%	77%	1,139	54%
Share of Total		26%	74%	2,097	100%

*Source: survey Question: Q2, Q2_1, Q4_2, Q6_2

The survey asked respondents to report current home and work zip codes and previous home and work zip codes. We then measured the distance between the center of their home zip code before and after moving to approximate move distance. Table 4.3.3. shows that the median in-person and hybrid mover moved a distance of about 10 miles, while the median remote mover moved more than 22 miles. Most movers did not move far, but 1 in 10 hybrid movers moved at least 698 miles, and 10% of remote movers moved over 1200 miles. Generally, at least 25% of hybrid and remote movers moved 191 and 364 miles away, which is well beyond their current metropolitan area; and in many cases likely across state lines. This suggests a much larger set of move locations from which to choose compared to in-person workers and makes commuting on a regular basis and by car an unlikely option for a significant share of workers.

Table 4.3.3. Moving distance (mile) by current work arrangement

Current work arrangement	Mean	25%	50%	75%	90%
Remote	330	4.98	22.3	364.22	1205.27
Hybrid	207	3.16	10.16	191.71	698.06
In-person	166	0	9.56	46.53	667.22

*Source: survey Question: Q1a, Q2a, Q4_2

Table 4.3.4 shows the results of respondents' likelihood of moving in the next year. 13% indicated that they anticipated moving in the next year, slightly above the average annual move rate of 8-9% for this period. Table 4.3.5 shows the result of moving plan by work arrangement and house ownership. Renters were more likely to anticipate moving than homeowners, in line with national trends between these two groups. In-person workers were least likely to anticipate moving, followed by remote workers. Hybrid renters were the group most likely to anticipate moving.

Table 4.3.4. Future moving plan by work arrangement

Anticipated Future Move Status	Remote	Hybrid	In-person	Share of Total
Move	15%	13%	13%	280 (13%)
No move	85%	87%	87%	1,828 (87%)
Share of Total	478 (100%)	440 (100%)	1,190 (100%)	2,108 (100%)

*Source: survey Question: Q2, Q4_2

Table 4.3.5. Future moving plan by work arrangement and housing tenure

Anticipated Future Move Status	Remote		Hybrid		In-person		Share of Total
	Owner	Renter	Owner	Renter	Owner	Renter	
Move	9%	31%	7%	37%	7%	26%	13%
No move	91%	69%	93%	63%	93%	74%	87%
Total	331 (100%)	148 (100%)	338 (100%)	97 (100%)	813 (100%)	381 (100%)	2,108 (100%)

*Source: survey Question: Q2, Q4_2

4.4 Distance between work and home

Using current and past home and job locations, we calculated a measure for respondents' commute distance based on the distance between the zip codes in which people reside and work. For people living and working in the same zip code, that distance is zero (see Chapter 3). Remote workers do not commute, but their distance to where they would otherwise go to work is indicative of their decision regarding where to live.

The increase in average distance points to such a separation of residential and work location (Table 4.4.1 and Table 4.4.2). Table 4.4.1 presents distance statistics between home and job for all survey respondents. In Table 4.4.2, results are shown after excluding the outliers—non-remote workers (hybrid or in-person) with distances exceeding 300 miles between their home and job. These outliers represent the top 1 percentile. The lack of change in the distance distribution at different percentiles compared to the large increase in mean suggest that a small subset of hybrid and remote workers moved to locations very far from their employers. These outliers may involve in-person and hybrid workers who commute by air to another state once a week, then travel to their job by car on a daily basis. Therefore, either the distance or the number of people living far increased enough in that subset to skew the average. The percentile presented in Tables 4.4.1 and 4.4.2 refers to the percentile of different groups of workers, either before or after the COVID-19 pandemic. We use results that exclude outliers from Table 4.4.2 in the following explanation.

Greater distances would be consistent with a view of remote workers as completely spatially divorced from where they work. In stark contrast to this view, however, most remote workers live and work in the same zip code. It's important to remember that the groups of remote, hybrid, and in-person workers pre-COVID and post-COVID are not identical. For the quarter of remote workers who lived the farthest from their place of work, persons increased the distance to their work location by 9 miles relative to pre-Covid from 9.9 to 18.9 miles; the 10% of remote workers who live the farthest increased their home-to-work distance by 1.5 times, suggesting a trend where post-COVID remote workers are more inclined to relocate to locations farther away from their jobs compared to their pre-COVID counterparts.

Post-COVID Hybrid and in-person workers had lower magnitude changes in home-to-job distance relative to remote workers. Median distance between home and job increased by 1.1 miles for hybrid workers and decreased by 0.2 miles for in-person workers (Table 4.4.2). However, hybrid workers at the 90^{th}, 95^{th}, and 99^{th} percentile of pre-Covid distance increased their home-to-job distance (which we as shorthand we call commute distance) by 1.8, 7, and 80 miles respectively. In-person workers did not have the same effect: in fact, the 99^{th} percentile of in-person workers decreased their home-to-job distance (i.e., commute) by 60 miles. Given the difference in composition of workers across work arrangements pre- and post-COVID, one possible explanation for the large decrease could be that many in-person workers residing far from their workplace switched to some form of remote work.

Table 4.4.1. Home-to-job distance (miles) by work arrangements

Percentiles	Remote		Hybrid		In-person	
	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID
mean	58.35	100.58	36.40	24.81	25.64	21.68
25%	0	0	0	3.8	0	0
50%	0	0	7.67	8.58	6.45	6.14
75%	9.933	18.84	16.85	16.98	14.26	14.01
90%	74.97	197.68	27.36	30.14	26.47	23.75
95%	296.53	548.30	49.14	59.77	46.11	33.32
99%	1440.14	2020.84	1137.88	500.19	609.32	552.07
Total workers	208	456	239	413	1,477	1,084

*Source: survey Question: Q1a, Q2a, Q4_2
Sample size: pre-Covid (1,924), post-Covid (1,953)

Table 4.4.2. Home-to-job distance (miles) by work arrangements excluding outliers (non-remote workers with home-to-job distance >= 300 miles)

Percentiles	Remote		Hybrid		In-person	
	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID
mean	58.35	100.58	12.43	14.78	10.93	9.46
25%	0	0	0	3.73	0	0
50%	0	0	7.41	8.54	6.21	6.07
75%	9.933	18.84	15.34	16.70	13.59	13.59
90%	74.97	197.68	25.36	27.15	23.69	22.75
95%	296.53	548.30	33.72	40.71	35.47	31.21
99%	1440.14	2020.84	105.32	185.31	111.46	58.8
Total workers	208	456	233	406	1,432	1,067

*Source: survey Question: Q1a, Q2a, Q4_2
Sample size: pre-Covid (1,873), post-Covid (1,929)

We next conduct a regression analysis to statistically test the association between work arrangement and the change in distance between home and job, controlling also for the predicted remote work ability and geographic region (Equation 7). We hypothesize that, compared to pre-COVID, remote and hybrid workers are more likely to live farther away from their workplace post-COVID. The change in distance could come from a change in residence (a move) a change in job, or a change in the location of employment. The test focuses on any change to reflect people’s choice with regards to their location, whether in-person workers are more likely to live closer to the job after the pandemic than remote and hybrid workers.

Equation 7:
$$\Delta\ HomeJob\ Distance =\ f(work\ arrangements_{2023}, controls\ )$$

The definition of each variable is listed below:

- Δ HomeJob Distance= Change in distance between home and workplace from pre-COVID (before March 2020) to post-COVID (September, 2023)
- Work arrangements 2023 = Remote, Hybrid, in-person (omitted)
- Controls: *predicted remote work ability*, regions (Northeast (omitted), Midwest, South, West)

We conduct another regression analysis (equation 8) to test whether more commuting days are associated with shorter distances between workers' home and job locations to further delve into differences between different hybrid work arrangements. We use the following equations to test the hypothesis:

Equation 8:
$$HomeJob\ Distance_{2023} = f(days\ of\ \ commute_{2023}, controls)$$

The definition of each variable is listed below:

- HomeJob Distance 2023 = Distance between home and workplace in post-COVID (September, 2023)
- Commute days 2023 = Days of commute per week in 2023
- Controls: *predicted remote work ability*, regions (Northeast (omitted), Midwest, South, West)

Table 4.4.3 shows the regression results for both models. Model 7 indicates that post-COVID remote workers increased the distance from their job by 29 more miles compared to Post-COVID in-person workers. The hybrid worker coefficient was not statistically significant. The hybrid category includes people who commute nearly every day and those who commute once a week, which may muddle the results. Model 8 shows that an additional day of in-person work (commute) is associated with a reduction (-12 miles) in the distance between their home and the workplace post-COVID. This result helps explain why the difference in Model 7 between in-person and hybrid workers was not significant. Workers trade-off greater distances from their job for lower numbers of days they must commute.

Table 4.4.3. Regression results of home-job distance

Dependent Variable		Change in HomeJob Distance	Post-COVID HomeJob Distance (2023)
Category	Variable	(7)	(8)
Work arrangement 2023 (Omitted: in-person)	Remote	28.984*	
	Hybrid	-19.577	
Commute days per week in 2023			-12.059***
Predicted remote work ability		6.153	7.902
Region (Omitted: Northeast)	Midwest	17.947	22.623
	South	6.391	32.729*
	West	17.317	41.644**
Constant		-4.531	53.429***
Observations		1901	1950
R-squared		0.007	0.027
Adjusted R-squared		0.003	0.024

* p<0.05 ** p<0.01 *** p<0.001

Among respondents who commuted, the vast majority (~85%) drove alone. Walking / biking was the next most common, followed by transit, and then carpooling (Table 4.4.4). These shares are roughly in line with national statistics from ACS 2022 5-year estimates (U.S. Census Bureau, 2022); our survey has fewer carpoolers but slightly more walkers / bikers and those who drive alone. When asked whether they switched commute mode, including remote work options, compared to pre-COVID, 20% of respondents indicated that they changed commute modes (Appendix Table C4). The most common switch was from driving alone to working remote (1/3 of all mode switchers). There was little difference in commute mode and change thereof by work arrangements (omitted here for brevity, please refer to Appendix C6 for detail).

Table 4.4.4. Commute mode from pre-COVID to post-COVID

commute mode	Pre-COVID	Post-COVID
Walking / biking	5%	4%
Car, single occupant (only yourself)	84%	87%
Car, multiple occupants (a carpool)	4%	4%
Ride share (Uber, Lyft), taxi, or vanpool	1%	1%
Bus	2%	2%
Train	3%	2%
Other (Please specify):	1%	1%
Total	1,738 (100%)	1,636 (100%)

*The difference in the total is caused by non-responses in the survey.
*Note, table 4.4.4 excludes fully remote workers since they do not have a commute mode
*Source: survey Question: Q7, Q7-1_1

4.5 Environmental impact of Remote work

In this section, we look at how the changes in commute distance outlined in the previous section (daily and on a weekly basis, i.e., the sum of all commutes both ways) affected greenhouse gas emissions associated with each work arrangement. We analyze driving and related GHG emissions for hybrid in-person/remote workers compared with driving and GHG emissions for persons who work in-person full time.

We found a 20% reduction in weekday commute trips (Table 4.5.1, for the aggregated, weighted data) compared to pre-COVID levels, along with a 3% decrease in weekly greenhouse gas (GHG) emissions (Figure 4.5.1). This suggests that much of the decrease in commute trips was offset by longer commutes. Moreover, there is nearly a doubling in the number of remote and hybrid workers post-COVID, and hybrid workers in post-COVID are more likely to remote work for more days than pre-COVID hybrid workers (Appendix C9). The greatest reduction in overall commute GHG emissions comes from the larger number of people who work full-time remotely and, therefore, do not commute. Hybrid workers show the least reduction in GHG emissions, likely due to living farther away from their workplace (see Table 4.4.3) and generating longer one-way commutes on the days they do commute. In-person workers' commute GHG emissions remained stable from pre-COVID to post-COVID periods.

Table 4.5.1. Total daily commute trips, weighted and aggregated daily for pre- and post-COVID

Time Period	Monday	Tuesday	Wednesday	Thursday	Friday	Total
Pre-COVID	3,595	3,624	3,607	3,612	3,542	17,980
Post-COVID	2,899	3,036	3,004	3,021	2,795	14,755
Difference	-19%	-16%	-17%	-16%	-21%	-18%

*Source: survey Question: Q4_2_1, Q6_2_1, Q7, Q7_1_1

GHG emissions typically refer to the total emissions of all greenhouse gases. However, according to the EPA[10], when referring to vehicle GHG emissions, most cases focus primarily on CO_2 emissions, as CO_2 is the most prevalent greenhouse gas emitted by vehicles and is often used as a proxy for overall GHG emissions from vehicles. We calculate daily round-trip commute GHG emissions per vehicle using equation 9:

Equation 9:

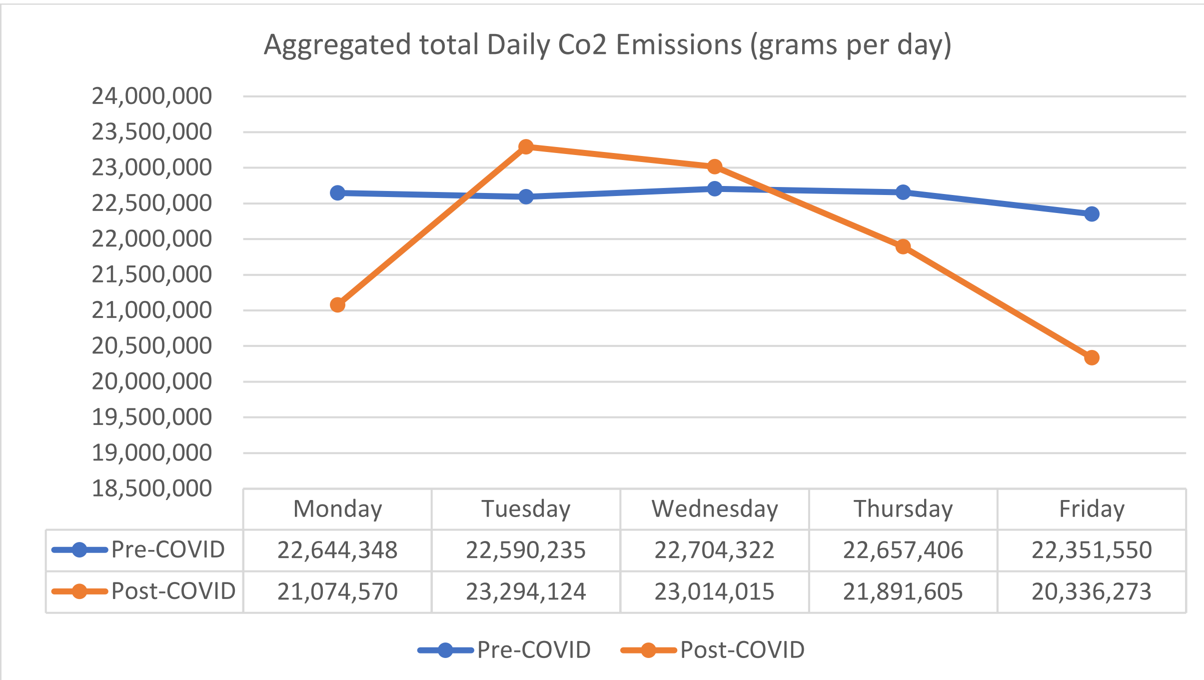
$$Daily\ commute\ CO_2\ emission\ per\ vehicle = CO_2\ tailpipe\frac{grams}{mile} * HomeJob\ distance * 2$$

[10] Vehicle Greenhouse Gas Emissions: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

Daily commute and GHG emissions

We use Equation 9 to estimate the daily commute CO_2 emission in grams for each individual in our sample, both pre- and post-COVID. Then, we calculate the aggregate daily greenhouse gas (GHG) emissions for the entire sample based on respondents' information about which day of the week that they usually commute.

The results in Table 4.5.1 show the largest reduction in total commute traffic occurred on Friday (-21%) and Monday (-19%), while the smallest reduction was observed on Tuesday (-16%), Wednesday (-17%), and Thursday (-16%). Total commute GHG emissions saw the most significant reductions on Monday (-7%) and Friday (-9%), followed by Thursday (-3%), compared to the pre-COVID period.



	Monday	Tuesday	Wednesday	Thursday	Friday
Pre-COVID	22,644,348	22,590,235	22,704,322	22,657,406	22,351,550
Post-COVID	21,074,570	23,294,124	23,014,015	21,891,605	20,336,273

Figure 4.5.1. Total daily commute GHG Emissions (CO_2 grams per mile) by day of week

Our survey findings suggest that hybrid workers are more likely to commute on Tuesday, Wednesday, and Thursday, shedding some light on the post-COVID results for those days in Figure 4.5.1. Despite the overall lower weekly commute greenhouse gas (GHG) emissions across all work arrangements, hybrid workers living farther away from their workplace may cause longer one-way commutes, potentially leading to higher daily total GHG emissions on these midweek days.

Personal weekly commute GHG emissions by work arrangement

After considering the broader context at the aggregated level, we next focus on weekly CO_2 emissions per person. We compute weekly CO_2 emissions per person by considering the number of car occupants and remote working days, using the following equation.

Equation 10:

$$Weekly\ CO_2\ emission\ per\ person = \frac{(\ CO_2\ tailpipe\ gpm *\ homejob\ distance * 2 * commute\ days)}{number\ of\ vehicle\ occupants}$$

Table 4.5.2 shows total weekly vehicle miles traveled (VMT) by work arrangement. It's important to keep in mind that the groups of remote, hybrid, and in-person workers pre-COVID and post-COVID are not the same. We found that the weekly VMT of in-person workers is higher than hybrid workers, which is due in part to in-person workers' additional days of commuting. However, when comparing the change in weekly VMT from pre-COVID to post-COVID periods, we found that both groups increased mean VMT. However, this was driven largely by VMT increases in the 99^{th} percentile of commuters by VMT. The median in-person worker had no VMT increase. The median hybrid workers increased VMT by about 8 miles.

Table 4.5.2. Total weekly commute VMT by work arrangement, in total weekly miles, excluding outliers (non-remote workers with home-to-job distance >= 300 miles)[11]

Work arrangement	Remote		Hybrid		In-person	
	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID
Mean	0	0	73.64	129.6	110.9	164.8
25%	0	0	13.1	14.8	0	0
50%	0	0	37.0	44.7	65.4	65.5
75%	0	0	101.2	92.5	141.5	142.6
90%	0	0	180.2	182.8	233.0	234.1
95%	0	0	288.7	288.6	337.1	328.4
99%	0	0	436.1	2,000.8	1000.4	1120.5
Total workers	226	468	152	341	1,191	981

*Source: survey Question: Q1a, Q2a, Q4_2

Sample size: pre-Covid (1,569), post-Covid (1,790)

Table 4.5.3 presents the weekly commute greenhouse gas (GHG) emissions by work arrangement during the pre- and post-COVID periods. GHG emissions are the combination of VMT and vehicle-specific emissions. For this analysis, we assume that people did not change

[11] See Appendix Table D9 for total weekly commute VMT by work arrangement without excluding outliers

vehicles pre- to post-COVID.[12] The table compares the total emissions for each group. Same as previous analysis, some individuals are in different groups pre- and post-COVID (i.e., some persons changed in-person/hybrid/remote work status; see Table 4.1.2) and, therefore, the difference in emissions can be the results of changes in behavior for people who did not change work arrangement and the inclusion of new people (in the case of hybrid workers) or loss of people (for in-person workers) that have different driving habits.

In line with average VMT increases in Table 4.5.2 above, average GHG emissions increased (Table 4.5.4) for both hybrid and in-person workers. These appear largely driven by extreme outliers toward the top of the distribution. For all percentiles, hybrid workers generated substantially less GHG than in-person workers. Although post-COVID hybrid workers tend to relocate farther from their job (as shown in Table 4.4.2), they, on average, commute fewer days, which offsets the longer one-way commute distance.

Table 4.5.3. Total weekly commute GHG Emissions by work arrangement, excluding outliers (non-remote workers with home-to-job distance >= 300 miles)[13]

Work arrangement	Remote		Hybrid		In-person	
	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID
Mean	0	0	27,949	50,393	42,614	65,850
25%	0	0	3,916	4,802	0	0
50%	0	0	16,962	15,136	24,408	25,338
75%	0	0	36,630	34,957	51,503	54,341
90%	0	0	66,710	68,616	96,477	96,225
95%	0	0	97,920	100,005	142,637	139,195
99%	0	0	178,480	790,301	398,084	398,419
Total workers	226	468	123	335	1,090	956

*Source: survey Question: Q1a, Q2a, Q4_2, Q7_2
Sample size: pre-Covid (1,439), post-Covid (1,759)

Commute distance, migration, and emissions

Remote work promises large reductions in commute-related emissions. While industry projections expect remote work to remain an important work arrangement, hybrid may become relatively more common (e.g., McKinsey Global Institute 2023; Haan 2023). As such, there is ambiguity as to whether hybrid work will lead to decreases in emissions because the reduction in driving that comes from cutting the number of commute days can be offset by the increasing

[12] We did not ask about changes in vehicles in the questionnaire, but car sales were generally much lower in 2020 and 2021 and average fuel efficiency of the car fleet from 2020 to 2023 did not improve enough to make a marked difference for the overall fleet. https://www.bts.gov/content/average-fuel-efficiency-us-light-duty-vehicles
[13] See Appendix Table D10 for total weekly commute VMT by work arrangement without excluding outliers

distance people drive to get to work. This section focuses on disentangling the relationship between work arrangement, migration decisions, and emissions through statistical analysis.

We test the hypothesis that more commute days are associated with higher weekly greenhouse gas emissions. We estimate this relationship directly pre- and post-COVID (equation 11; models 9 and 10). We also estimate the difference in weekly commute GHG emissions among the three types of work arrangement, since the relationship between commute days and weekly GHG emissions may not be linear (equation 12, models 11 and 12). To examine whether post-COVID hybrid workers are more likely to generate higher weekly commute GHG emissions than pre-COVID hybrid workers, we analyze the relationship between the change in weekly commute GHG emissions and the change in commute days from pre to post-COVID periods (Equation 13, models 13 and 14). The equations used are as follows:

<u>Equation 11 (Model 9 and 10):</u>

$$\boldsymbol{Weekly\ GHG\ emission\ per\ person_t = f(commute\ days_t, controls)}$$

<u>Equation 12 (Model 11 and 12):</u>

$$\boldsymbol{Weekly\ GHG\ emission\ per\ person_t = f(work\ arrangments_t, controls)}$$

<u>Equation 13:</u>

$$\boldsymbol{\Delta Weekly\ GHG\ emission\ per\ person = f(\Delta commute\ days, controls)}$$

The definition of each variable is listed below:

- t= post-COVID (2023), pre-COVID (2020)
- Commute days = Days of commute per week
- Weekly GHG emission per person= tailpipe CO_2 grams per person per week
- Δ Weekly GHG emission per person= change in tailpipe CO_2 grams per person per week from pre-COVID (before March, 2020) to post-COVID (September, 2023)
- Work arrangements 2023 = Remote, Hybrid, in-person (omitted)
- Controls: predicted remote work ability, regions (Northeast (omitted), Midwest, South, West)

Model 9 (Table 4.5.4) indicates that an additional day of commuting in the post-COVID period is associated with an increase of 7,895 weekly round-trip commute GHG emissions (CO_2 in grams), while in the pre-COVID period, the increase is 8,749 (CO_2 in grams) (Model 10).

Model 11 shows that in the post-COVID period, compared to remote workers, hybrid workers produce 28,039 more weekly commute GHG emissions, and fully in-person workers produce 40,146 more weekly commute CO_2 emissions. Moreover, an additional mile increase in home-job-distance in post-COVID, there is an associated increase of 16.7 grams of CO_2 emissions, controlling for other characteristics, controlling for other characteristics.

The result of the pre-COVID period in model 12 shows a greater difference between hybrid and in-person workers. Hybrid workers produced, ceteris paribus, 32,814 more weekly GHG emissions than remote workers, while in-person workers produced 49,018 more in the pre-COVID time period. For home-job-distance, an additional mile increase pre-COVID is associated with an increase of 115 grams of CO_2 emissions.

Model 13 indicates that compared to pre-COVID commute days, an additional day of commuting in the post-COVID period is associated with an increase of 9,200 weekly commute GHG emissions. Model 14 shows that compared to pre-COVID home-to-job distance, an additional mile between home and job in post-COVID period is associated with an increase of 66 weekly commute GHG (CO_2) emissions.

A few key takeaways from these model results. First, per capita weekly GHG emissions decreased relative to pre-Covid. Second, in-person workers have higher weekly GHG emissions than hybrid workers who in turn have higher weekly GHG emission than remote workers.

Migration and commute GHG emissions

The foregoing analysis showed that adding days of commutes adds substantially to GHG emissions (Model 13). This is to be expected. Given a fixed commuted distance, driving that distance more days will increase the worker's emissions. The next set of models turn to the effect of changes in the distance between residential and work location. We hypothesize that compared to their pre-COVID home-to-job distance; workers who move farther from their workplace generate more weekly commute GHG emissions. We used the following equation to statistically test this relationship:

<u>Equation 14:</u>

$$\Delta Weekly\ GHG\ emission\ per\ person = f(\Delta HomeJob\ Distance, controls)$$

The definition of each variable is listed below:

- Δ Weekly GHG emission per person= change in tailpipe CO_2 grams/mile per person per week from pre-COVID (before March, 2020) to post-COVID (September, 2023)
- Δ HomeJob Distance= change in distance between home and workplace from pre-COVID (before March 2020) to post-COVID (September, 2023)
- Controls: $Remote\ \widehat{work}\ Ability$, regions (Northeast (omitted), Midwest, South, West)

The results in table 4.5.4 model 14 show that a one-mile increase in the distance from home to workplace compared to the pre-COVID home-to-job distance is associated with an increase in weekly CO_2 emissions (+66.7 grams) compared to the pre-COVID period. As with the change in number of days commuting, this increase is to be expected. The estimate, however, is skewed because it does not differentiate between types of workers. Remote workers who moved much farther from their workplace will have a large decrease in emissions if they were working in-person pre-COVID, or no change in emissions if there were already working remotely. We, therefore, expand on the model to examine the differences across work arrangements.

We use an interaction term to investigate how changes in home-job distance affect emissions for hybrid and in-person workers. The interaction term separates the effect of changes in home-job distance for hybrid and in-person workers and tells us if increases in distance are associated with greater emissions for each of the worker types. We use the following equation to answer this question:

Equation 15:

$$\begin{aligned}\Delta Weekly\ GHG\ emission\ per\ person \\ &= f(\Delta HomeJob\ Distance, work\ arrangement_{2023}, (\Delta HomeJob\ Distance \\ &* work\ arrangement_{2023}), Job\ change, moving\ status, Controls)\end{aligned}$$

The definition of each variable is listed below:

- Δ Weekly GHG emission per person= change in tailpipe CO_2 grams/mile per person per week from pre-COVID (before March, 2020) to post-COVID (September, 2023)
- Δ HomeJob Distance= change in distance between home and workplace from pre-COVID (before March 2020) to post-COVID (September, 2023)
- Work arrangements 2023 = Remote (omitted), Hybrid, in-person
- Job change= job changed after COVID (march, 2020): No (omitted), Yes
- Moving status = Moved after COVID (march,2020): No (omitted), Yes
- Controls: $Remote\ \widehat{work}\ Ability$, regions (Northeast (omitted), Midwest, South, West)

Model 15 in Table 4.5.4 indicates that, compared to post-COVID remote workers who experienced no change in weekly GHG emissions pre- and post- COVID (due to our definition of VMT for remote workers), hybrid workers in post-COVID period reduced weekly GHG emissions by 11,220 grams compared to the pre-COVID period. Conversely, in-person workers in post-COVID period increased weekly GHG emissions by 5,983 grams compared to the pre-COVID period.

Next, we examine the interaction between current work arrangement and changes in home-to-job distance. In the post-COVID period, compared to remote workers, for hybrid workers, each additional mile in distance between home and workplace, changed from pre-COVID to post-COVID, is associated with an increase of 698 in weekly GHG emissions per person. For in-person workers, the increase is 3,562.

Regression results from equation 9 to 15 confirm that fully remote workers tend to relocate farther from their workplaces and produce less GHG emissions as they no longer commute (if the worker status changed to remote), while GHG emissions for fully in-person workers remain relatively stable. Hybrid workers tend to move farther away from their workplace relative to in-person workers. However, their overall weekly emissions significantly drop due to the reduction in commute days, offsetting any increased distance between their home and job.

Table 4.5.4. Regression results of GHG emissions (without outliers: home-to-job distance >=300 for non remote workers)

Dependent Variable		Weekly CO_2 per person 2023	Weekly CO_2 per person 2020	Weekly CO_2 per person 2023	Weekly CO_2 per person 2020	Δ weekly CO_2 per person	Δ weekly CO_2 per person	Δ weekly CO_2 per person
Category	Variable	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Commute days	Commute days 2023	7895.423***						
	Commute days 2020		8749.013***					
	Δ Commute days					9199.633***		
HomeJob Distance	HomeJob Distance 2023			16.77373***				
	HomeJob Distance 2020				115.0457***			
	Δ HomeJob Distance						66.72752***	-4.998176
Work arrangement 2023 (Omitted: Remote)	Hybrid			28039.78***				-11220.03***
	In-person			40146.79***				5983.285***
Work arrangement 2020 (Omitted: Remote)	Hybrid				32814.44***			
	In-person				49018.91***			
Work Arrangement *Δ HomeJob Distance (Omitted: Remote)	Hybrid							697.9075***
	In-person							3562.659***
Job Change: Yes								61.62939
Moving status: Moved								2224.033
Predicted remote work ability		1735.019	3455.991	697.2536	2834.572	707.8239	-1651.371	300.1607
Region (Omitted: Northeast)	Midwest	29.24338	5367.172	-654.5274	4669.459	-4397.641	-4980.022	-2409.551
	South	1114.158	5519.595	775.0774	4204.788	-1667.337	-241.3287	-1757.146
	West	-2152.444	-903.0669	-3402.516	-2492.959	-826.4457	-2248.317	409.082
Constant		273.6008	-3890.297	-1392.669	-9536.828	853.7748	-2280.065	-5569.282
Observations		1,743	1,425	1,713	1,407	1,382	1,364	1,364
R-squared		0.1313	0.0522	0.1221	0.0763	0.0442	0.0172	0.7188
Adjusted R-squared		0.1288	0.0489	0.1185	0.0717	0.0408	0.0135	0.7165

Chapter 5: Conclusion

The transition towards remote working following the COVID-19 pandemic significantly reshaped commuting patterns and prompted discussions of the implications for reducing greenhouse gas (GHG) emissions. This project analyzes how changes in commuting behavior following COVID-19 have altered the spatial relationship between homes and workplaces. We investigate whether workers with remote work abilities tend to move farther away from their workplaces and how this affects their commuting behavior.

We developed and field a survey in September 2023, using IPSOS' KnowledgePanel to gather a nationally representative sample of adults (18 years old or older) living in the U.S. and working full-time at the time of the survey. A total of 2,124 responses were collected among four types of workers: individuals with the ability to work from home and those without, further divided by whether they relocated following the Covid outbreak and whether their commuting and driving habits changed. This survey data serves a crucial role in filling gaps in previous work and offers a better understanding of the spatial and environmental implications of remote work. Our analysis aims to offer the best estimate currently available regarding the impact of remote work on commute patterns and associated greenhouse gas emissions, helping transit and planning agencies in modeling air quality and traffic congestion.

Our findings highlight shifting work arrangements, characterized by a notable increase in remote work since the pandemic's onset. Seventy-one percent of pre-covid in-person workers remained in-person in post-covid period, 17% switched to working hybrid, and 11% switched to working fully remotely. Of those working under a hybrid arrangement, a third switched to being remote full time, and most remote workers before the pandemic were still remote in 2023. While uncertainties persist regarding future work arrangements, most survey respondents expect their work relationships to remain the same going forward. However, disparities in remote work ability across industries are evident, with professions emphasizing office settings and those requiring higher educational qualifications being more conducive to remote work.

Regarding residential relocations, remote and hybrid workers demonstrate a higher likelihood of relocation. A quarter of survey respondents reported moving at least once since March 2020. Hybrid and remote workers were about 7 percentage points more likely to have moved than in-person workers. In-person workers who switch to remote or hybrid work arrangements were almost twice as likely to move than those who did not. While most moves were short distance (about 10 miles, and 22 miles for remote workers), at least 25% of hybrid workers moved >190 miles away and, among remote workers, >360 miles away.

The average distance between home and work has shifted notably across different work arrangements. For remote workers, it increased from 58.6 to 100.5 miles, while for hybrid workers, it decreased from 36.4 to 24.8 miles. Similarly, in-person workers experienced a decline, from 25.6 miles to 21.6 miles. While most remote workers live and work in the same zip code, a quarter of remote workers who lived the farthest from their place of work, increased the distance to their work location by 9 miles (from 9.9 to 18.9 miles). The top 10% of remote workers who live the farthest increased from 74.9 to 197.7 miles. The median commute distance for in-person workers was 6.5 miles and decreased by about 0.4 miles post-COVID. For hybrid workers, this was 7.7 miles, but increased to 8.6 miles post-COVID. From the regression results, we also found that remote workers increased the distance from their job by 29 more miles compared to in-person workers and an additional day of in-person work (commute) is associated with a reduction (-12 miles) in the distance between their home and the workplace in post-COVID.

In terms of emissions, reduced commuting frequency is associated with reduced weekly commute GHG, this effect is not offset by the increases in commute distance. We found that the weekly VMT of in-person workers is higher than hybrid workers, which is mainly due to in-person workers' additional days of commuting. When comparing the change in weekly VMT from pre-COVID to post-COVID periods, we found an increase in the average weekly VMT for both in-person workers (111 to 165 miles) and hybrid workers (74 to 130 miles). Similarly, the weekly commute GHG emissions for in-person workers increased, from 42,614 to 65,850. Results also show that hybrid workers generated higher weekly commute GHG emissions in post-COVID period compared to pre-COVID period, but there is a compositional change in hybrid worker status pre- and post-COVID. The average went up from 27,949 tailpipe gram to 50,393 tailpipe gram.

The choices regarding vehicle efficiency and commute distance among hybrid workers remain unclear. Individuals who work remotely for fewer days per week may opt to continue using older and less fuel-efficient vehicles. Since they still tend to relocate farther away from their workplace, this choice could result in increased emissions on those particular days.

While uncertainties persist regarding the overall impact of remote work on emissions in the post-COVID era, our findings underscore the potential significance of these arrangements in reducing driving activities and associated emissions. Continued research and ongoing monitoring of hybrid workers' behavior will be crucial to fully understand and optimize the environmental implications of evolving work patterns.

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Appendix

Appendix A. Survey Questionnaire

Final Programmed English Main Survey Questionnaire

Study Information

Note: The study information below should be completed for all projects. Copy/paste the table into the internal project kickoff meeting invitation so all teams have it for reference.

Client	University of Southern California
Project Name	Work from Home Survey
Account Executive	Sergei Rodkin
Project Manager	An Liu
Ipsos Job Number	23-018040-01
SNO(s)	25579 - Pretest
LOI	10 minutes
Type of Study	Ad-hoc, one shot
Field Start Date (tentative is fine)	
Field End Date (tentative is fine)	
Teams Involved	Enter all teams who will touch the project (e.g., Scripting, DP, Coding, IIS, Panel Relations)
DP Team Scope	
Kickoff Meeting Date (tentative is fine)	
Comments	

Sample Variables

- KP standard demographics
- Xspanish
- Xacslang
- Xzip

Quota Description

	Recent movers moved after Covid-19 (March 2020)	Non recent movers Did not move after Covid-19 (March 2020)
Telework (any days)	500 completes (if Q1=1 and Q2=1)	500 completes (if Q1=1 and Q2=2)
Full time in person	500 completes (if Q1=2 and Q2=1)	500 completes (if Q1=2 and Q2=2)

Main Questionnaire (including screener, if applicable)

Programming Notes:

- *Code all refusals as -1.*
- *Use default instruction text for each question type unless otherwise specified.*
- *Do not prompt on all questions. (Remove this instruction if sample is all opt-in, client list sample, or otherwise not KP.)*

Base: All respondents

Q0 [DISPLAY]

Dear Participants,

The expansion of remote working options has changed the way many people organize their daily activities. This survey will collect information about how this shift in work arrangements, whether you work remotely or not, has affected where you live and your daily routine. As expanded remote working becomes normalized, the consequences for how we plan cities, transportation, and access to services could be significant. The information we collect will help us inform policymakers and the public about the direction of these changes.

This survey is completely anonymous and should take no longer than 5-7 minutes to complete. If you are unable to answer a question, skip to the next question. In all questions, remote work refers to the ability to work outside your employer’s physical location where you would usually commute to.

Your participation is greatly appreciated and will make a significant contribution to our understanding of remote work, during a time when the initial Covid-19 shock has passed, but when work and residential location relationships are still in flux and likely adjusting. Thank you for your time and insights.

SCREENING QUESTIONS

Base: all respondents

[PPEMPLOY]

QEMPLOY [Q]

How many hours do you usually work for pay or profit per week? Please include hours you work for pay or profit at all your jobs if you have more than one job. If none, enter “0”. If less than an hour in a week, enter “1”.

— — —

SCRIPTER: min.=0, max.=168. Show label to right of box: Hours per week. Do not allow decimals. Prompt following nonresponse. Create data only variable.

IF QEMPLOY ≥ 35 PPEMPLOY = 1.

IF QEMPLOY ≤ 34 AND QEMPLOY ≥ 1 PPEMPLOY = 2.

IF QEMPLOY = 0 PPEMPLOY = 3.

Variable name: PPEMPLOY [S]

Variable Text: Current employment status

Response list:

1. Working full-time
2. Working part-time
3. Not working

Terminate if ppemploy=2 OR 3

Base: All respondents
Prompt twice if refused

Q1 [S]

Are you currently able to work remotely?

1. Yes (any days)
2. No

Base: All respondents
Prompt once if refused

Q2 [S]

Have you permanently changed residence since the pandemic began (March 2020)?

1. Yes
2. No

Programming instruction: terminate if refused after prompt

Base: Q2=1

Q2_1 [S]

How many times did you move since the pandemic began (March 2020)?

1. 1 time
2. 2 times
3. 3 times
4. 4 times
5. More than 4 times

Base: Q2=1

Q2_2 [DD]

When was your last move?

Month: [DropDown with Range January to December]

Year: [DropDown with Range 2020 to 2023]

Base: Q2=1

Q2_3 [S]

In your last move, how far did you move?

1. Less than 20 miles
2. Over 20 miles

Base: Q2=1

Q2_4 [S]

Were you able to work remotely before your last move?

1. Yes
2. No

Quota table: Please terminate if quota is full

	Recent movers moved after Covid-19 (March 2020)	Non recent movers Did not move after Covid-19 (March 2020)
Telework (any days)	500 completes (if Q1=1 and Q2=1)	500 completes (if Q1=1 and Q2=2)
Full time in person	500 completes (if Q1=2 and Q2=1)	500 completes (if Q1=2 and Q2=2)

Jobs-Housing Questions

Base: All respondents

Q1a [Number box]

What is your current home zip code:

Insert NUMBER BOX with Range [00000 to 99999]

Programming instruction:

If in-field and profile zip codes match or QZIP is refused, create dov_match=1

If in-field and profile zip codes do not match but in-field zip codes exist in look-up table, create dov_match=2

If in-field and profile zip codes do not match but in-field zip codes do not exist in look-up table, create dov_match=3

If in-field and profile zip codes match or QZIP is refused, create new geocode DOVs as follow:

- State (numeric) DOV = ppstaten
- Metropolitan status DOV = ppmsacat
- Census division DOV = re-code from ppstaten
- Census region DOV = re-code from ppstaten

If in-field and profile zip codes do not match but in-field zip codes exist in look-up table, set new geocode DOVs = geocode variables from the look-up table

- State (numeric) DOV = state (numeric code) from look-up
- Metropolitan status DOV = metropolitan status from look-up
- Census division DOV = re-code from state (numeric code) from look-up
- Census region DOV = re-code from state (numeric code) from look-up
-

Re-code ppreg4 from ppreg9 from state from look up table

ppreg9	ppreg4
1	1
2	1
3	2
4	2
5	3
6	3
7	3
8	4
9	4

Recode ppreg9 from state from look-up table

```
if  (state ge 11 and state le 16) ppreg9=1.
if  (state ge 21 and state le 23) ppreg9=2.
if  (state ge 31 and state le 35) ppreg9=3.
if  (state ge 41 and state le 47) ppreg9=4.
if  (state ge 51 and state le 59) ppreg9=5.
if  (state ge 61 and state le 64) ppreg9=6.
if  (state ge 71 and state le 74) ppreg9=7.
if  (state ge 81 and state le 88) ppreg9=8.
if  (state  ge 91 and state le 95) ppreg9=9.
```

-
-

If in-field and profile zip codes do not match and in-field zip codes do not exist in zip-level crosswalk -> use profile data for all geocode variables

- State (numeric) DOV = ppstaten
- Metropolitan status DOV = ppmsacat
- Census division DOV = re-code from ppstaten
- Census region DOV = re-code from ppstaten

Base: All respondents

Q2a [Number box]

What was your **home** zip code **before** the pandemic began (March 2020):

Insert NUMBER BOX with Range [00000 to 99999]

Base: Q2=1

Q2b [Ranking]

What are the top 3 reasons that motivated your move? *(Up to 3 reasons, Ranked 1, 2 and 3, with #1 being the top reason)*

Programming instruction: See this link - [Preview - Online Survey Software | Qualtrics Survey Solutions (ipsossay.com)](). This is the most natural way in Qualtrics for sorting/ranking statements based on the drag and drop functionality. Please only show 3 numbers and hide the others.

Scripter: Please allow respondents to select up to 3 responses

1. Able to work remotely
2. 12. Move closer to family
3. New job or job transfer
4. To look for work or lost job
5. To establish own household / Change in marital status
6. Wanted easier commute
7. Wanted newer / better / larger house or apartment
8. Wanted lower priced housing
9. Wanted better / safer neighborhood
10. Wanted better schools / environment for kids
11. Health related reasons
12. Other (Please specify): **[TEXTBOX]**

Please drag-and-drop your preferred rankings that motivated your move. (Ranked 1, 2, and 3, with #1 being the top reason).

Base: All respondents

Q2_2_1 [Number box]

How large is your current home? (Please provide your best estimate in square feet)

Insert NUMBER BOX (square feet)

Base: Q2=1

Q2_2_2 [Number box]

How large was your home before the pandemic began (March 2020)? (Please provide your best estimate in square feet)

Insert NUMBER BOX (square feet)

Base: All respondents

Q2_2_3 [S]

What is the total number of bedrooms in your **current** place of residence?

1. 0 bedrooms
2. 1 bedroom
3. 2 bedrooms
4. 3 bedrooms
5. 4 bedrooms
6. 5 or more bedrooms

Base: Q2=1

Q2_3_4 [S]

What is the total number of bedrooms in your **previous** place of residence before the pandemic began (March 2020)?

1. 0 bedrooms
2. 1 bedroom
3. 2 bedrooms
4. 3 bedrooms
5. 4 bedrooms
6. 5 or more bedrooms

Base: All respondents

Q3 [Number box]

What is your **current <u>job</u>** zip code: (either the location where you work in person or the location of the office where you would report to work if you primarily or always work remotely)

Insert NUMBER BOX with Range [00000 to 99999]

Base: All respondents

Q4 [S]

How long have you worked for your current employer?

1. Less than 1 year
2. 1 - 3 years
3. 3 - 5 years
4. 5 - 10 years
5. More than 10 years

Base: All respondents

Q4_1 [S]

How many days per week **<u>are you allowed</u>** to work remotely in your current job?

1. 0 days (Not allowed to work remotely)
2. 1 day
3. 2 days
4. 3 days
5. 4 days
6. 5 or more days (Fully remote)

Base: All respondents

Q4_2 [S]

How many days per week do you **<u>actually</u>** work remotely in your current job?

1. 0 days OR not allowed to work remotely
2. 1 day
3. 2 days
4. 3 days
5. 4 days
6. 5 or more days (Fully remote)

Base: if Q4_2=2-5

Q4_2_1 [MP]

On which day(s) of the week do you typically work remotely? (multiple choices)

1. Monday
2. Tuesday
3. Wednesday
4. Thursday
5. Friday
6. Varies from week to week [S]

Base: All respondents

Q5 [S]

Have you changed jobs since the pandemic began (March 2020)?

1. No. Same position, same employer.
2. Yes. Different position, same employer.
3. Yes. Similar position, different employer.
4. Yes. Different position, different employer.

Base: Q5=2,3,4

Q5_1 [S]

How many times did you change jobs since the pandemic began (March 2020)?

1. 1 time
2. 2 times
3. 3 times
4. 4 times
5. More than 4 times

Base: Q5=2,3,4
Q5_2 [DD]

When was the last time you changed jobs?

Month: [DropDown with Range January (1 ... December (12)]

Year: [DropDown with Range 2020 (1 ... 2023 (4)]

Base: Q5=2,3,4

Q5_3 [Ranking]

What are the top 3 reasons that motivated your job change? *(Up to 3 reasons, Ranked 1, 2 and 3, with #1 being the top reason)*

Programming instruction: See this link - [Preview - Online Survey Software | Qualtrics Survey Solutions (ipsossay.com)](). This is the most natural way in Qualtrics for sorting/ranking statements based on the drag and drop functionality. Please only show 3 numbers and hide the others.

Scripter: Please allow respondents to select up to 3 responses

1. Better pay / benefits
2. Better career opportunity
3. Ability to work remotely
4. Loss of previous job
5. Residence relocation
6. Easier commute
7. Other (Please specify): **[TEXTBOX]**

Q5_3_b Please drag-and-drop your preferred rankings that motivated your job change. (Ranked 1, 2, and 3, with #1 being the top reason).

Base: Q5=2,3,4

Q6 [Number box]

What zip code did you **work in** most often **before** the pandemic began (March 2020):
Insert NUMBER BOX with Range [00000 to 99999]

Base: all respondents

Q6_1 [S]

How many days per week **<u>were you allowed</u>** to work remotely in your job before March 2020?

1. 0 days (Not allowed to work remotely)
2. 1 day
3. 2 days
4. 3 days
5. 4 days
6. 5 or more days (Fully remote)

Base: all respondents
Q6_2 [S]

How many days per week did you **actually** work remotely in your job before March 2020?

1. 0 days OR not allowed to work remotely
2. 1 day
3. 2 days
4. 3 days
5. 4 days
6. 5 or more days (Fully remote)

Base: if Q6_2=2-5

Q6_2_1 [MP]

On which day(s) of the week did you typically work remotely before March 2020? (multiple choices)

1. Monday
2. Tuesday
3. Wednesday
4. Thursday
5. Friday
6. Varies from week to week [S]

Commute Questions

Base: Q4_2=1 to 5

Q7 [S]

On days you go to work (for your current job), you commute by:

1. Walking / biking
2. Car, by yourself
3. Car, with others (a carpool)
4. Ride share (Uber, Lyft), taxi, or vanpool
5. Bus
6. Train
7. Other (Please specify): **[TEXTBOX]**

Base: All respondents

Q7_1 [S]

Did your commute mode change, compared with pre-pandemic (before March 2020)?

1. Yes
2. No

Base: Q7-1=1

Q7_1_1 [S]

Pre-pandemic (before March 2020), on days you go to work, you commuted by:

1. Walking / biking
2. Car, single occupant (only yourself)
3. Car, multiple occupants (a carpool)
4. Ride share (Uber, Lyft), taxi, or vanpool
5. Bus
6. Train

Base: Q7=2 or Q7=3

Q7_2 [Drop down]

What is the car make/model/year you use for your current commute most often?

1. Make [Drop down]

2. Model [Drop down]

3. Year [Number box with range 1900 to 2023]

Base: Q7=3

Q7_3 [S]

How many people do you usually carpool with?

1. 1
2. 2
3. 3
4. 4
5. 5 or more

Base: Q7=1, 4, 5, 6

Q7_4 [S]

Is a car available to you (on typical circumstances for daily use, not just for commute)?

1. Yes
2. No

Base: Q7_4=1

Q7_4_1 [TEXTBOX, NUMBER BOX]

What is the car make/model/year for your daily use?

1. Make [Drop down]

2. Model [Drop down]

3. Year [Number box with range 1900 to 2023]

Base: All respondents

Q8_1 [S, Grid]

How often do you drive to the following locations, in comparison to before the pandemic (before March 2020)?

Statement in rows:

1. Driving for errands
2. Driving to the grocery store
3. Driving kids to school, activities, and events
4. Driving to recreational locations (beach, parks… etc.)
5. Driving to social events or activities

Answers in columns:

1. Much more often
2. Somewhat more often
3. About same
4. Somewhat less often
5. Much less often

Base: All respondents

Q8-2 [Grid, Accordion]

Did you drive **greater or lesser distance** to the following locations, in comparison to before the pandemic (before March 2020)?

Statement in rows:

1. Driving for errands
2. Driving to the grocery store
3. Driving kids to school, activities, and events
4. Driving to recreational locations (beach, parks… etc.)
5. Driving to social events or activities

Answers in columns:

1. Much farther
2. Somewhat farther
3. About same
4. Somewhat shorter
5. Much shorter

Base: All respondents

Q9 [S]

Do you anticipate working remotely **a year from now**?

1. Yes, I anticipate working remotely next year about the same amount as I work remotely now
2. Yes, I anticipate beginning or increasing remote work by next year.
3. Yes, but I anticipate reducing remote work by next year.
4. No, I anticipate not working remotely next year.
5. Unsure / Don't know

Base: Q9=2

Q9_1_1 [S]

Why do you anticipate increasing your remote work time by next year?

1. I anticipate changing jobs to one which allows greater flexibility.
2. My employer will allow remote work indefinitely going forward.
3. Other (Please specify): **[TEXTBOX]**

Base: Q9=3

Q9_1_2 [S]

Why do you anticipate reducing remote work by next year?

1. My employer will require more in-person/office work.
2. I prefer in-person/office work.
3. Other (Please specify): [Textbox]

Base: Q9=4

Q9_1_3 [S]

Why do you anticipate not working remotely next year?

1. I don't work remotely now.
2. My employer will require in-person/office work by next year.
3. I prefer in-person/office work.
4. Other (Please specify): **[TEXTBOX]**

Base: All respondents

Q9_2_1 [S]

Do you anticipate moving within the next year?

1. Yes
2. No

Base: Q9_2_1=1

Q9_2_2 [S]

Where do you plan to move in the coming months or year?

1. Place that is closer to the office
2. Place that is farther away from office
3. Other (Please specify): **[TEXTBOX]**

Final Programmed Spanish Main Survey Questionnaire

Study Information

Note: The study information below should be completed for all projects. Copy/paste the table into the internal project kickoff meeting invitation so all teams have it for reference.

Client	University of Southern California
Project Name	Work from Home Survey
Account Executive	Sergei Rodkin
Project Manager	An Liu
Ipsos Job Number	23-018040-01
SNO(s)	25579 - Pretest
LOI	10 minutes
Type of Study	Ad-hoc, one shot
Field Start Date (tentative is fine)	
Field End Date (tentative is fine)	
Teams Involved	Enter all teams who will touch the project (e.g., Scripting, DP, Coding, IIS, Panel Relations)
DP Team Scope	Enter DP requirements here (e.g., data clean, banner tables, client SPSS dataset, etc.)
Kickoff Meeting Date (tentative is fine)	Enter kickoff meeting date here
Comments	

Sample Variables

- KP standard demographics
- Xspanish
- Xacslang
- Xzip

Quota Description

	Recent movers moved after Covid-19 (March 2020)	Non recent movers Did not move after Covid-19 (March 2020)
Telework (any days)	500 completes (if Q1=1 and Q2=1)	500 completes (if Q1=1 and Q2=2)
Full time in person	500 completes (if Q1=2 and Q2=1)	500 completes (if Q1=2 and Q2=2)

Main Questionnaire (including screener, if applicable)

Programming Notes:

- *Code all refusals as -1.*
- *Use default instruction text for each question type unless otherwise specified.*
- *Do not prompt on all questions. (Remove this instruction if sample is all opt-in, client list sample, or otherwise not KP.)*

Base: All respondents

Q0 [DISPLAY]

Estimados participantes,

El aumento de opciones de trabajo remoto ha cambiado la forma en la que muchas personas organizan sus actividades cotidianas. Esta encuesta recopilará información sobre cómo este cambio en los preparativos laborales, ya sea que se trabaje de forma remota o no, ha afectado su lugar de residencia y su rutina diaria. A medida que se amplie y normalice la modalidad de trabajo remoto , las consecuencias en la forma en que planificamos ciudades, transporte y acceso a servicios podrían ser significativas. La información recopilada nos ayudará a informar a legisladores de políticas y al público sobre la dirección de estos cambios.

Esta encuesta es anónima y no debe tardar más de 5-7 minutos en completarse. Si usted no puede responder a una pregunta, por favor continue a la siguiente pregunta. En todas las preguntas de esta encuesta, se refiere a trabajo remoto a la capacidad de trabajar en una ubicación externa que no sea la ubicación física de su empleo, ubicación a la que normalmente se trasladaría oviajaría.

Se aprecia su participación en esta encuesta, su contribución será significativa para nuestra comprensión de trabajo rem durante un periodo en el que el shock inicial de Covid-19 ha pasado, pero en el cual las relaciones laborales y la ubicación residencial de empleados continua cambiando y es muy probablemente se ajusten. Gracias por su tiempo y su perspectiva sobre el tema.

SCREENING QUESTIONS

Base: all respondents

[PPEMPLOY]

QEMPLOY [Q]

¿Cuántas horas suele usted trabajar por un salario o ganancias obtenidas semanales? Por favor incluya las horas que trabaja usted por un salario o ganancias obtenidas en todos sus empleos si usted tiene más de un empleo. Si en estos momentos usted esta desempleado, introduzca "0". Si esta laborandomenos de una hora en una semana, ingrese "1".

_ _ _

SCRIPTER: min.=0, max.=168. Show label to right of box: Hours per week. Do not allow decimals. Prompt following nonresponse. Create data only variable.

IF QEMPLOY ≥ 35 PPEMPLOY = 1.

IF QEMPLOY ≤ 34 AND QEMPLOY ≥ 1 PPEMPLOY = 2.

IF QEMPLOY = 0 PPEMPLOY = 3.

Variable name: PPEMPLOY [S]

Variable Text: Current employment status

Response list:

1. Trabajando tiempo completo
2. Trabajando medio tiempo
3. No está trabajando o desempleado

Terminate if ppemploy=2 OR 3

Base: All respondents
Prompt twice if refused

Q1 [S]

¿Actualmente puede usted trabajar de forma remota ?

3. Sí (cualquier día de la semana)
4. No

Base: All respondents
Prompt once if refused

Q2 [S]

¿ Desde el comienzó de la pandemia (Marzo de 2020) usted cambio permanentemente de residencia?

1. Sí
2. No

Programming instruction: terminate if refused after prompt

Base: Q2=1

Q2_1 [S]

¿ Desde que comenzó la pandemia (Marzo de 2020) cuántas veces se ha mudado usted?

1. 1 vez
2. 2 veces
3. 3 veces
4. 4 veces
5. Más de 4 veces

Base: Q2=1

Q2_2 [DD]

¿Cuándo fue su última mudanza?

Mes: [DropDown with Range Enero to Diciembre]

Año: [DropDown with Range 2020 to 2023]

Base: Q2=1

Q2_3 [S]

En su última mudanza, ¿Cuál es la distancia que usted se mudó?

1. Menos de 20 millas
2. Más de 20 millas

Base: Q2=1

Q2_4 [S]

¿ Antes de su última mudanza pudo usted trabajar de forma remota?

1. Sí
2. No

Quota table: Please terminate if quota is full

	Recent movers moved after Covid-19 (March 2020)	Non recent movers Did not move after Covid-19 (March 2020)
Telework (any days)	500 completes (if Q1=1 and Q2=1)	500 completes (if Q1=1 and Q2=2)
Full time in person	500 completes (if Q1=2 and Q2=1)	500 completes (if Q1=2 and Q2=2)

Jobs-Housing Questions

Base: All respondents

Q1a [Number box]

¿Cuál es el código postal de su residencia o vivienda?

Insert NUMBER BOX with Range [00000 to 99999]

Programming instruction:

If in-field and profile zip codes match or QZIP is refused, create dov_match=1

If in-field and profile zip codes do not match but in-field zip codes exist in look-up table, create dov_match=2

If in-field and profile zip codes do not match but in-field zip codes do not exist in look-up table, create dov_match=3

If in-field and profile zip codes match or QZIP is refused, create new geocode DOVs as follow:

- State (numeric) DOV = ppstaten
- Metropolitan status DOV = ppmsacat
- Census division DOV = re-code from ppstaten
- Census region DOV = re-code from ppstaten

If in-field and profile zip codes do not match but in-field zip codes exist in look-up table, set new geocode DOVs = geocode variables from the look-up table

- State (numeric) DOV = state (numeric code) from look-up
- Metropolitan status DOV = metropolitan status from look-up
- Census division DOV = re-code from state (numeric code) from look-up
- Census region DOV = re-code from state (numeric code) from look-up
-

Re-code ppreg4 from ppreg9 from state from look up

table

ppreg9	ppreg4
1	1
2	1
3	2
4	2
5	3
6	3
7	3
8	4
9	4

Recode ppreg9 from state from look-up table

```
if  (state ge 11 and state le 16) ppreg9=1.
if  (state ge 21 and state le 23) ppreg9=2.
if  (state ge 31 and state le 35) ppreg9=3.
if  (state ge 41 and state le 47) ppreg9=4.
if  (state ge 51 and state le 59) ppreg9=5.
if  (state ge 61 and state le 64) ppreg9=6.
if  (state ge 71 and state le 74) ppreg9=7.
if  (state ge 81 and state le 88) ppreg9=8.
if  (state  ge 91 and state le 95) ppreg9=9.
```

If in-field and profile zip codes do not match and in-field zip codes do not exist in zip-level crosswalk -> use profile data for all geocode variables

- State (numeric) DOV = ppstaten
- Metropolitan status DOV = ppmsacat
- Census division DOV = re-code from ppstaten
- Census region DOV = re-code from ppstaten

Base: All respondents

Q2a [Number box]

¿Cuál era el código postal de su **<u>hogar o vivienda</u>** **antes** de que comenzara la pandemia (Marzo de 2020)?

Insert NUMBER BOX with Range [00000 to 99999]

Base: Q2=1

Q2b [Ranking]

¿Cuáles son las 3 razones principales que motivaron su ultima mudanza? *(Por favor enumere hasta 3 razones, Clasificando 1, 2 y 3, siendo #1 la razón principal)*

Programming instruction: See this link - Preview - Online Survey Software | Qualtrics Survey Solutions (ipsossay.com). This is the most natural way in Qualtrics for sorting/ranking statements based on the drag and drop functionality. Please only show 3 numbers and hide the others.

Scripter: Please allow respondents to select up to 3 responses

13. Poder trabajar de forma remota
14. 12. Mudarse para estar más cerca de la familia
15. Nuevo empleo o translado laboral
16. Para buscar empleo o por perdida de empleo
17. Para establecer su propio hogar /Cambio en su estado civil/marital
18. Quería acceso o unviaje más fácil
19. Quería una casa o un departamento nuevo/mejor/más grande
20. Quería una vivienda económicamente accesible o de mejor precio
21. Quería una mejor colonia más segura
22. Quería acceso a mejores escuelas/entorno para los niños
23. Razones relacionadas con problemas de la salud
24. Otra razón (Por favor especifique): **[TEXTBOX]**

Por favor arrastre y suelte sus clasificaciones preferidas que motivaron su mudanza. (Clasificando 1, 2 y 3, siendo #1 la razón principal).

Base: All respondents

Q2_2_1 [Number box]

¿Cuál es la extensión de su actual hogar? (Por favor proporcione una estimación en pies cuadrados)

Insert NUMBER BOX (pies cuadrados)

Base: Q2=1

Q2_2_2 [Number box]

¿Qué tan grande era su hogar antes de que comenzara la pandemia (Marzo de 2020)? (Por favor proporcione una estimación en pies cuadrados)

Insert NUMBER BOX (pies cuadrados)

Base: All respondents

Q2_2_3 [S]

¿ En su residencia **actual**, cuál es el número total de habitaciones?

1. 0 habitaciones
2. 1 habitación
3. 2 habitaciones
4. 3 habitaciones
5. 4 habitaciones
6. 5 o más habitaciones

Base: Q2=1

Q2_3_4 [S]

¿ Antes de que comenzara la pandemia (Marzo de 2020) en su lugar de residencia **anterior**, cuál era el número total de habitaciones?

1. 0 habitaciones
2. 1 habitación
3. 2 habitaciones
4. 3 habitaciones
5. 4 habitaciones
6. 5 o más habitaciones

Base: All respondents

Q3 [Number box]

¿Cuál es el código postal de su **actual empleo**? (Este puede ser la ubicación donde trabaja usted de modo presencial o la ubicación de la oficina donde se reportaría usted aa trabajar, si usted siempre trabaja de forma remota)

Insert NUMBER BOX with Range [00000 to 99999]

Base: All respondents

Q4 [S]

¿Cuánto tiempo ha trabajado para su actual empleo?

1. Menos de 1 año
2. De 1 a 3 años
3. De 3 a 5 años
4. De 5 a 10 años
5. Más de 10 años

Base: All respondents

Q4_1 [S]

¿ En su empleo actual cuántos días de la semana **se le permite** trabajar de forma remota?

1. 0 días (No le es permitido trabajar de forma remota)
2. 1 día
3. 2 días
4. 3 días
5. 4 días
6. 5 o más días (Tiempo completo de forma remota)

Base: All respondents

Q4_2 [S]

¿ **Actualmente** cuántos días a la semana trabaja ustedde forma remota en su actual empleo?

1. 0 días (No le es permitido trabajar de forma remota)
2. 1 día
3. 2 días
4. 3 días
5. 4 días
6. 5 o más días (Tiempo completo de forma remota)

Base: if Q4_2=2-5

Q4_2_1 [MP]

¿En qué día(s) de la semana suele usted trabajar de forma remota? (múltiples opciones)

1. Lunes
2. Martes
3. Miércoles
4. Jueves
5. Viernes
6. Varía de una semana a otra [S]

Base: All respondents

Q5 [S]

¿Ha cambiado usted de empleo desde que comenzó la pandemia (Marzo de 2020)?

5. No. Misma posición, misma compañía.
6. Sí. Una posición diferente, misma compañía .
7. Sí. Una posición similar, diferente compañía .
8. Sí. Diferente posición, diferente compañía .

Base: Q5=2,3,4

Q5_1 [S]

¿ Desde que comenzó la pandemia cuántas veces ha cambiado de empleo (Marzo de 2020)?

1. 1 vez
2. 2 veces
3. 3 veces
4. 4 veces
5. Más de 4 veces

Base: Q5=2,3,4
Q5_2 [DD]
¿Cuándo fue la última vez que cambió de empleo?

Mes: [DropDown with Range Enero (1 ... Diciembre (12)]

Año: [DropDown with Range 2020 (1 ... 2023 (4)]

Base: Q5=2,3,4

Q5_3 [Ranking]

¿Cuáles son las 3 razones principales que motivaron su cambio de empleo? *(Por favor enumere hasta 3 razones, Clasificando 1, 2 y 3, siendo #1 la razón principal)*

Programming instruction: See this link - [Preview - Online Survey Software | Qualtrics Survey Solutions (ipsossay.com)](). This is the most natural way in Qualtrics for sorting/ranking statements based on the drag and drop functionality. Please only show 3 numbers and hide the others.

Scripter: Please allow respondents to select up to 3 responses

1. Un mejor salario/beneficios
2. Una mejor oportunidad laboral
3. La posibilidad de trabajar de forma remota
4. Pérdida de su empleo anterior
5. La reubicación de su residencia
6. El traslado o viaje más fácil a su nuevo empleo
7. Otra razón (Por favor especifique): **[TEXTBOX]**

Q5_3_b Por favor arrastre y suelte sus clasificaciones preferidas que motivaron su cambio de empleo. (Clasificando 1, 2 y 3, siendo # 1 la razón principal).

Base: Q5=2,3,4

Q6 [Number box]

¿ **Antes** de que comenzara la pandemia (Marzo de 2020) en qué código postal **trabajó** usted con más frecuencia?

Insert NUMBER BOX with Range [00000 to 99999]

All respondents

Q6_1 [S]

¿ Antes de marzo de 2020 cuántos días a la semana **se le permitía** trabajar de forma remota en su empleo?

1. 0 días (No se le permitía trabajar de forma remota)
2. 1 día
3. 2 días
4. 3 días
5. 4 días
6. 5 o más días (Tiempo completo de forma remota)

All respondents

Q6_2 [S]
¿ Antes de marzo de 2020 cuántos días a la semana trabajaba **realmente** de forma remota en su trabajo?

1. 0 días (No se le permitió trabajar de forma remota)
2. 1 día
3. 2 días
4. 3 días
5. 4 días
6. 5 o más días (Tiempo completo de forma remota)

Base: if Q6_2=2-5

Q6_2_1 [MP]

¿Antes de marzo de 2020 en qué día(s) de la semana solía usted trabajar de forma remota? (múltiples opciones)

1. Lunes
2. Martes
3. Miércoles
4. Jueves
5. Viernes
6. Variaba de una semana a otra [S]

Commute Questions

Base: Q4_2=1 to 5

Q7 [S]

En su actual empleo, os días que usted va a trabajar, como se traslada o viaja usted? :

1. Caminando o en bicicleta
2. En coche, individualmente (usted solo/a)
3. En coche, con otros ocupantes (coche compartido o carpool)
4. En viaje compartido (Uber, Lyft), taxi o vanpool
5. En autobús
6. En tren
7. Otro modo de transporte (Por favor especifique): **[TEXTBOX]**

Base: All respondents

Q7_1 [S]

¿Cambió usted su modo de traslado o viaje en comparación con su modo de transporte antes de la pandemia (antes de Marzo de 2020)?

1. Sí
2. No

Base: Q7-1=1

Q7_1_1 [S]

Antes de la pandemia (antes de Marzo de 2020), los días que iba a trabajar, cual era su modo de transporte para llegar a su lugar de empleo?:

1. Caminando o en bicicleta
2. En coche, individualmente (usted solo/a)
3. En coche, con otros ocupantes (coche compartido o carpool)
4. En viaje compartido (Uber, Lyft), taxi o vanpool
5. En autobús
6. En tren
7. Otro modo de transporte (Por favor especifique): **[TEXTBOX]**

Base: Q7=2 or Q7=3

Q7_2 [Drop down]

¿Actualmente cuál es la marca/modelo/año del coche que usted utiliza con más frecuencia para su traslado o viaje ?

1. Marca [Drop down]

2. Modelo [Drop down]

3. Año [Number box with range 1900 to 2023]

Base: Q7=3

Q7_3 [S]

¿Con cuántas personas suele usted compartir su viaje en coche (carpool)?

1. 1 persona
2. 2 personas
3. 3 personas
4. 4 personas
5. 5 o más personas

Base: Q7=1, 4, 5, 6

Q7_4 [S]

¿Usted tiene disponibilidad de un automóvil (para uso diario, no solo para trasladarse o viajar a su trabajo)?

1. Sí
2. No

Base: Q7_4=1

Q7_4_1 [TEXTBOX, NUMBER BOX]

¿Para uso diario cuál es la marca/modelo/año del coche que usted utiliza?

1. Marca [Drop down]
2. Modelo [Drop down]
3. Año [Number box with range 1900 to 2023]

Base: All respondents

Q8_1 [S, Grid]

¿Con qué frecuencia conduce usted a alguno de los siguientes lugares, en comparación con la frecuencia que usted conducía a estos lugares antes de la pandemia (antes de Marzo de 2020)?

Statement in rows:

1. Conduce usted para hacer mandados
2. Conduce a la tienda de comestibles
3. Lleva usted a los niños a la escuela, actividades y eventos
4. Conduce usted a lugares recreativos (playa, parques... etc.)
5. Conduce usted a eventos o actividades sociales

Answers in columns:

1. Mucho más a menudo
2. Un poco más a menudo
3. Más o menos lo mismo
4. Un poco menos a menudo
5. Mucho menos a menudo

Base: All respondents

Q8-2 [Grid, Accordion]

¿Actualmente conduce usted una distancia más lejana o más cercana a alguno de los siguientes lugares, en comparación con la distancia que usted conducía antes de la pandemia (antes de Marzo de 2020)?

Statement in rows:

1. Conduce usted para hacer mandados
2. Conduce a la tienda de comestibles
3. Lleva usted a los niños a la escuela, actividades y eventos
4. Conduce usted a lugares recreativos (playa, parques... etc.)
5. Conduce usted a eventos o actividades sociales

Answers in columns:

1. Mucho más lejos
2. Un poco más lejos
3. Más o menos la misma distancia
4. Algo más cercano
5. Mucho más cercano

Base: All respondents

Q9 [S]

¿ **<u>Dentro de un año</u>** prevé usted trabajar de forma remota?

1. Sí, el próximo año anticipo que trabajare de forma remota aproximadamente la misma cantidad de tiempo que trabajo de forma remota actualmente.
2. Sí, anticipo que comenzara o aumentara mi trabajo remoto para el próximo año.
3. Sí, anticipo que se reducirá mi tiempo de trabajo remoto para el próximo año.
4. No, anticipo que no trabajare de forma remota el próximo año.
5. No estoy seguro/a. No lo sé

Base: Q9=2

Q9_1_1 [S]

¿Cuál es la razón por la cual usted anticipa que aumentara su tiempo de trabajo remoto para el próximo año?

1. Anticipo cambiar de trabajo a uno que permita una mayor flexibilidad.
2. En un futuro cercano mi empleo permitirá el trabajo remoto de forma indefinida .
3. Otra razón (Por favor especifique): **[TEXTBOX]**

Base: Q9=3

Q9_1_2 [S]

¿Por qué prevé usted que se reducira el tiempo de su trabajo remoto para el próximo año?

1. Mi actual empleo requerirá más trabajo en persona o en la oficina.
2. Prefiero el trabajo en persona o en la oficina.
3. Otra razón (Por favor especifique): **[TEXTBOX]**

Base: Q9=4

Q9_1_3 [S]

¿Por qué anticipa usted que no trabajara de forma remota el próximo año?

5. Actualmente no trabajo de forma remota.
6. Para el próximo año mi actual empleo requerirá más trabajo en persona o en la oficina.
7. Prefiero el trabajo en persona o en la oficina.
8. Otra razón (Por favor especifique): **[TEXTBOX]**

Base: All respondents

Q9_2_1 [S]

¿Anticipa usted mudarse dentro del próximo año?

1. Sí
2. No

Base: Q9_2_1=1

Q9_2_2 [S]

¿A dónde planea usted mudarse en los próximos meses o próximo año?

1. A un lugar que este más cerca de la oficina
2. A un lugar que está más lejos de la oficina
3. Otra razón (Por favor especifique): **[TEXTBOX]**

Appendix B. Weighting Benchmark Distributions

Below is the detailed weighting procedure quoted directly from IPSOS methodology documents (IPSOS, 2022).[14]

1. In the first step, design weights for KnowledgePanel (KP) assignees are computed to reflect their modeled selection probabilities.
2. The above design weights for respondents who reported working full-time are adjusted to align with the geodemographic distributions of the full-time employed population aged 18 and over using an iterative proportional fitting (raking) procedure. Geodemographic benchmarks are sourced from the 2023 March Supplement of the CPS, except for language dominance within Hispanics, which is sourced from the 2021 ACS. The dimensions used for weighting include:
    - Gender (Male/Female) by age (18–29, 30–44, 45–59, and 60+)
    - Race/Hispanic ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other or 2+ Races/Non-Hispanic, Hispanic)
    - Census Region (Northeast, Midwest, South, West) by Metropolitan Status (Metro, Non-Metro)
    - Education (Less than High School, High School, Some College, Bachelor and beyond)
    - Household income (under $10k, $10K to <$25k, $25K to <$50k, $50K to <$75k, $75K to <$100k, $100K to <$150k, and $150K+)
    - Language Dominance (non-Hispanic and English Dominant, Bilingual, and Spanish Dominant Hispanic) when survey is administered in both English and Spanish

    The resulting weights are trimmed and scaled to match the number of screened full-time employed respondents.

3. Next, all screened full-time employed respondents belonging to specific worker subgroups are isolated, and benchmarks for the respective populations are created using their screener weight. These benchmarks are used to weight the final qualified respondents.
    Four worker subgroups:
    - Telework - Recent movers
    - Telework - Non recent movers
    - Full time - Recent movers
    - Full time - Non recent movers

[14] A full and detailed overview of the IPSOS methodology is available at: https://www.ipsos.com/en-us/solutions/public-affairs/knowledgepanel, accessed 01/16/2024

4. In the final step, screener weights for final qualified respondents are raked to align with weighted geodemographic distributions of the full-time employed population aged 18 and over, ensuring that final qualified respondents within each subgroup are representative of their respective population, and the subgroups are weighted proportionally. The dimensions for weighting include:
    - Gender (Male, Female) by Telework (Yes, No) by Recent Mover (Yes, No)
    - Age (18-29, 30-44, 45-59, 60+) by Telework (Yes, No) by Recent Mover (Yes, No)
    - Race-Ethnicity (White/Non-Hispanic, Black/Non-Hispanic, Other or 2+/Non-Hispanic, Hispanic) by Telework (Yes, No) by Recent Mover (Yes, No)
    - Census Region (Northeast, Midwest, South, West) by Telework (Yes, No) by Recent Mover (Yes, No)
    - Metropolitan Status (Metro, Non-Metro) by Telework (Yes, No) by Recent Mover (Yes, No)
    - Education (Less than High School, High School, Some College, Bachelor or higher) by Telework (Yes, No) by Recent Mover (Yes, No) ** collapse LS/HS within Telework and Full time - Recent movers
    - Household Income (under $25K, $25K-$49,999, $50K-$74,999, $75K-$99,999, $100K-$149,999, $150K and over) by Telework (Yes, No) by Recent Mover (Yes, No) ** collapse under $50 K within Telework
    - Language Dominance (English Dominant or Spanish Dominant Hispanic, Bilingual Hispanic, Non-Hispanic) by Telework (Yes, No) by Recent Mover (Yes, No)

    The resulting weights are trimmed and scaled to align with the number of qualified respondents. Detailed information on the demographic distributions of the national benchmarks can be found in Appendix G.

The analysis presented from this point onward is based on weighted results. We use Analytic Weights for our analysis, where each observation is treated as the mean of a group corresponding to its assigned weight.

18+ full-time employed Population Benchmarks

Detailed weighting distribution quoted directly from IPSOS methodology (IPSOS, 2022).[15]

Table B1. Gender by Age Distribution

Gender by age	Frequency	Percent
18-29 Male	14,780,067	11.18
18-29 Female	11,777,123	8.91
30-44 Male	26,976,804	20.4
30-44 Female	21,099,799	15.96
45-59 Male	22,758,081	17.21
45-59 Female	18,362,394	13.89
60+ Male	9,569,033	7.24
60+ Female	6,885,083	5.21

Table B2. Race-Ethnicity Distribution

Race-Ethnicity	Frequency	Percent
White, Non-Hispanic	78,517,043	59.39
Black, Non-Hispanic	16,329,127	12.35
Other, Non-Hispanic	10,625,238	8.04
Hispanic	24,706,283	18.69
2+ Races, Non-Hispanic	2,030,694	1.54

Table B3. Education Distribution

Education	Frequency	Percent
Less than HS	7,820,383	5.92
HS	34,301,567	25.95
Some college	32,377,201	24.49
Bachelor or higher	57,709,234	43.65

Table B4. Income Distribution

Income	Frequency	Percent
Under $25,000	3,822,227	2.89
$25,000-$49,999	13,269,333	10.04
$50,000-$74,999	18,846,781	14.26
$75,000-$99,999	18,871,264	14.27
$100,000-$149,999	30,898,053	23.37
$150,000 and over	46,500,726	35.17

[15] A full and detailed overview of the IPSOS methodology is available at: https://www.ipsos.com/en-us/solutions/public-affairs/knowledgepanel, accessed 01/16/2024

Table B5. Language Dominance Distribution

Language Dominance	percent
English Dominant Hispanic	5.2
Bilingual Hispanic	10.41
Spanish Dominant Hispanic	3.08
Non-Hispanic	81.31

Appendix C. Detailed and additional summary data

Vehicle greenhouse gas emissions categories

Table C1. Vehicle GHG Category matching with original EPA Rating

Our GHG Category	EPA Rating	MPG (gas)	CO_2 (g/mile)
Low	10	>=92	0-97
	9	59-91	98-152
	8	43-58	153-209
	7	34-42	210-265
Medium	6	28-33	266-323
	5	22-27	324-413
	4	18-21	414-508
High	3	16-17	509-573
	2	14-15	574-658
	1	<=13	>=659

Data source: https://www.epa.gov/greenvehicles/greenhouse-gas-rating

Moving Frequency after COVID-19

Table C2. Moving Frequency after COVID outbreak in March 2020

Moving frequency	%
1 time	69%
2 times	23%
3 times	5%
4 times	2%
More than 4 times	1%
Total	550 (100%)

Table C3. Moving frequency by current work arrangement

Work arrangement	Move frequency			
	Mean	25%	50%	75%
Remote	1.42	1	1	2
Hybrid	1.36	1	1	2
In-person	1.37	1	1	2

Home-to-job Distance

Table C4. Home-to-job distance (miles) by change in work arrangements from pre-COVID to post-COVID

Change in work arrangement		mean	25%	50%	75%	90%
Pre-COVID	Post-COVID					
Remote	Remote	66.23	0.00	0.00	9.35	182.29
	Hybrid	99.35	0.00	6.07	18.42	276.46
	In-person	131.00	0.00	4.17	21.54	154.56
Hybrid	Remote	51.18	0.00	9.55	17.73	35.98
	Hybrid	25.53	4.23	7.88	15.34	31.35
	In-person	21.31	4.06	9.12	17.12	27.97
In-person	Remote	7.56	3.91	7.42	12.87	14.36
	Hybrid	54.70	0.00	5.92	16.95	32.98
	In-person	21.22	0.00	6.14	14.01	23.75

Detailed commute mode change from pre- to post- COVID

Table C5. Commute mode change from pre-COVID to post-COVID

Mode change	Freq.	Percent
No response	7	0.33%
Yes	436	20.52%
No	1,681	79.15%
Total	2,124	100%

Table C6. Commute mode and work arrangement from pre-COVID to post-COVID

commute mode	Pre-COVID		Post-COVID	
	Hybrid	In-person	Hybrid	In-person
Walking / biking	4%	5%	4%	4%
Car, single occupant (only yourself)	69%	86%	80%	89%
Car, multiple occupants (a carpool)	10%	3%	5%	3%
Ride share (Uber, Lyft), taxi, or vanpool	2%	0%	2%	0%
Bus	4%	2%	2%	2%
Train	10%	2%	6%	1%
Other (Please specify):	1%	1%	2%	1%
Total	204 (100%)	1,523(100%)	440 (100%)	1,196 (100%)

Table C7. Commute mode from pre-COVID to post-COVID

Commute mode		now								
		Fully Remote	Walking / biking	Car, single occupant	Car, multiple occupants	Ride share, taxi, or vanpool	Bus	Train	Other	Total
Pre-COVID	Fully Remote	5%	0%	5%	0%	0%	0%	0%	0%	11%
	Walking / biking	2%	0%	6%	0%	0%	0%	0%	1%	10%
	Car, single occupant	32%	3%	11%	4%	1%	1%	1%	0%	53%
	Car, multiple occupants	3%	0%	4%	1%	0%	0%	0%	0%	8%
	Ride share, taxi, or vanpool	0%	0%	1%	0%	0%	0%	0%	0%	1%
	Bus	2%	0%	3%	0%	0%	0%	0%	0%	7%
	Train	4%	1%	3%	0%	0%	2%	1%	0%	10%
	Total	48%	5%	33%	5%	1%	4%	3%	1%	100%

Commute days by work arrangements

Table C8. Days of commute by work arrangements from pre-COVID to post-COVID

Commute Days	Pre-COVID			Post-COVID		
	Remote	Hybrid	In-person	Remote	Hybrid	In-person
0	100%	0%	0%	100%	0%	0%
1-2	0%	34%	0%	0%	46%	0%
3-4	0%	66%	0%	0%	54%	0%
5	0%	0%	100%	0%	0%	100%
Total	244 (100%)	256 (100%)	1,605 (100%)	478 (100%)	440 (100%)	1,196 (100%)

GHG emissions and frequency of commuting

Table C9. GHG ranking by commute days

Work arrangement	Commute days	GHG Ranking			Total
		High GHG emission	Medium GHG emission	Low GHG emission	
Remote	0	11%	82%	7%	126 (100%)
Hybrid	1-2	7%	80%	13%	180 (100%)
	3-4	6%	85%	8%	224 (100%)
In-person	5	14%	81%	5%	1,099 (100%)
Total		12%	82%	7%	1,629 (100%)

Table C10. Home-to-Job distance by commute days

Work arrangement	Commute days	Mean	25%	50%	75%	90%
Remote	0	100.59	0.00	0.00	18.84	197.68
Hybrid	1-2	25.90	3.57	7.89	16.77	30.73
	3-4	23.87	4.06	8.74	17.15	27.97
In-person	5	21.68	0.00	6.14	14.02	23.75

VMT and GHG by Work Arrangement

Table C11. Total weekly commute VMT by work arrangement, in total weekly miles

Work arrangement	Remote		Hybrid		In-person	
	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID
Mean	0	0	103.2	138.1	239.8	185.7
25%	0	0	13.1	14.8	0	0
50%	0	0	39.3	44.7	66.9	67.0
75%	0	0	101.2	92.5	144.1	143.7
90%	0	0	181.9	182.8	252.4	237.5
95%	0	0	290.8	334.6	428.0	329.8
99%	0	0	540.7	2,000.8	5,878.9	4,403.8

*Source: survey Question: Q1a, Q2a, Q4_2

Sample size: pre-Covid (1,924), post-Covid (1,953)

Table C12. Total weekly commute GHG Emissions by work arrangement

Work arrangement	Remote		Hybrid		In-person	
	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID	Pre-COVID	Post-COVID
Mean	0	0	37,551	53,039	79,285	73,366
25%	0	0	3,916	4,692	0	0
50%	0	0	16,962	15,136	24,730	25,432
75%	0	0	37,497	34,957	53,403	54,637
90%	0	0	66,710	68,616	106,682	97,489
95%	0	0	97,920	100,005	155,225	150,189
99%	0	0	178,480	790,301	1,670,437	1,014,180

*Source: survey Question: Q1a, Q2a, Q4_2, Q7_2

Sample size: pre-Covid (1,924), post-Covid (1,953)