NBER Grant Proposal Economics of Transportation in the 21st Century:

Remote Work and Urban Transportation in the United States

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Work from home is a crucial legacy of the Covid pandemic. In the U.S., the share of work days performed at home rose from about 5% prior to the pandemic to more than 60% during the lockdowns of Spring 2020. This share has not fallen below 30% and no longer displays a substantial downward trend as of the end of 2022. (Barrero, Bloom, and Davis, 2021/2023). A key motivation behind working from home is to save on commuting costs (e.g. Duranton and Handbury, 2023). In aggregate, such a reduction in commutes has the potential to reduce traffic congestion, raise travel speed, and reduce greenhouse gas emissions associated with personal transportation. On the other hand, better driving conditions may attract other travelers and offset the initial speed gain, a phenomenon known as induced demand (Duranton and Turner, 2011). Overall, evidence is scarce on how the rise in remote work affects demand for transportation services.

Research Questions

In this research project, we harness a new panel of urban transportation data to investigate the impact of remote work on urban transportation in the United States. This investigation, in turn, will enhance our understanding of fundamental relationships in transportation economics. We propose to answer three main questions. First, how have travel speeds and congestion changed in American cities since before the Covid pandemic, and what are the main correlates of these changes? We think this broad description of recent mobility changes is of general interest. Second, have cities with higher work from home propensity experienced a larger reduction in traffic speed and congestion? Third, how did work from home affect the number of travelers, and how did total travel in turn affect travel speed? The relationship between total distance traveled and travel speed is known as the congestion elasticity and its size is the subject of much debate (see e.g. Akbar and Duranton, 2022, Kreindler, 2023, for recent advances). The rise in work from home at the onset of the pandemic offers a series of unique natural experiments to learn about this relationship. Specifically, as we will discuss in greater detail below, we can use cities' *a priori* work-from-home propensity as an instrumental variable for traffic volume. In addition, we will provide evidence on several other questions of interest:

- What areas of cities have seen the largest changes in speed and congestion since the rise in work from home? Are central business districts most affected?

- Did the rise in work from home disrupt familiar temporal traffic patterns? How have the onset and duration of peak hours changed since 2019? Did Mondays and Fridays, anecdotally the most popular remote work days, see the largest decreases in congestion?
- How did the frequency and availability of transit change since 2019? Which cities have seen the largest declines in service?
- How do recent changes in transportation outcomes in the United States compare to those in other countries around the world in which we collected similar data?
- In cities with the fastest rise in work from home, what kind of trips are substituted for work trips i.e., where does induced demand come from?
- How did the pandemic affect roadway provision in cities?

Interest to US Department of Transportation

These questions have important policy implications for the US Department of Transportation. First, work from home is a large change in the labor market that directly affects people's propensity to commute, as well as their use of urban infrastructure and demand for floorspace at home and at work. Urban transportation systems are designed to carry certain peak loads of traffic, and fundamental disruptions in traffic patterns can inform decisions on where and how much infrastructure to provide. For instance, central business districts have large buildings and massive transportation infrastructure that accommodate large weekday peak use. Are central business districts oversized given the declining number of commuters?

Second, being stuck in traffic is often cited as one of people's least pleasant daily activities, and traffic is credited as a major contributor to greenhouse gas emissions and pollution. It is therefore important to document whether work from home reduces traffic, or whether induced demand annihilates these gains.

Finally, the pandemic generated a series of unique natural experiments leading to large disruptions in vehicle miles traveled. These disruptions, such as lockdowns, can be exploited to estimate some fundamental quantities in urban and transportation economics. For instance, Duranton and Puga (2022) show that the congestion elasticity is of considerable importance to understand patterns of urban development, which in turn have economically significant effects on aggregate output levels.

Data

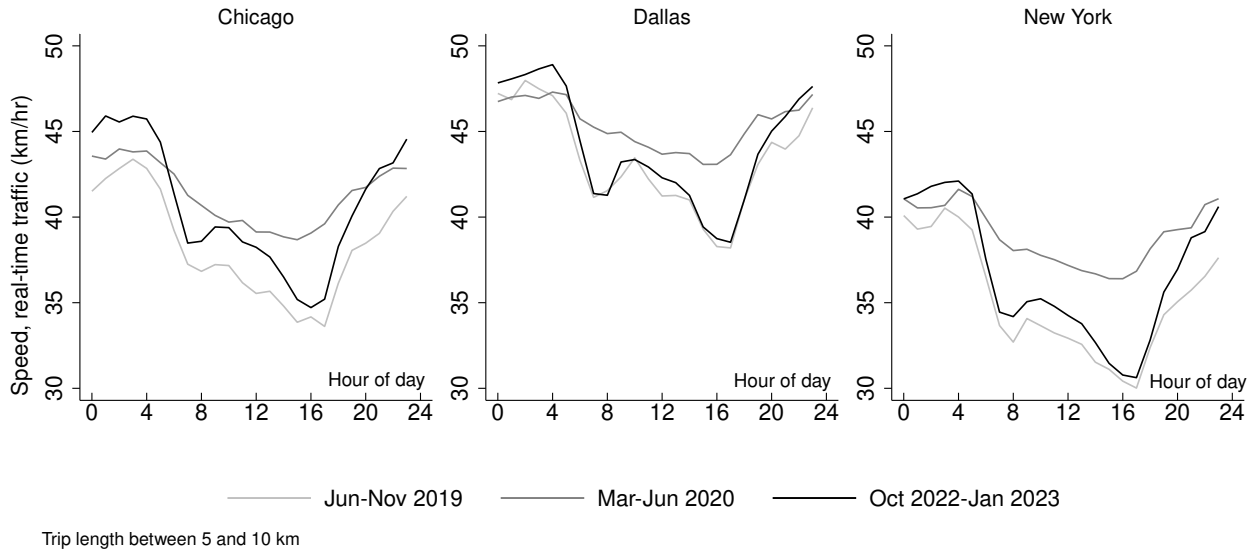
Our project combines detailed panel data on urban travel speed with data on propensity to travel to different destination types from Google Mobility, and data on propensity to work from home from various sources.

In Akbar, Couture, Duranton, and Storeygard (2023*a*,*b*), we have collected data about urban travel speeds and congestion in the Summer and Fall of 2019 using trips simulated on Google Maps. These data for simulated trip instances allowed us to estimate indices of travel speed and congestion in large U.S. cities prior to the pandemic. We resumed these queries in March 2020 at the onset of the pandemic, and have collected data continuously ever since. Overall, we currently (as of February 2023) have data for 166,502,796 instances of 2,174,984 trips (origin-destination pairs) in 139 large U.S. cities over a nearly four year period.

Using the confidential geographic information of the 2017 National Household Travel Survey (NHTS), we have also mapped 460,425 actual trips from NHTS interviewees, which we have queried repeatedly on Google Maps in the Summer and Fall of 2019 and queried repeatedly again after March 2020. In total, we have another 241,409,220 trip instances in 275 U.S. metropolitan areas for which, importantly, we know the initial trip purpose.

So far, we have verified that our data collection worked as expected. We have also generated preliminary results for eight large U.S. cities. Figure 1 below shows speeds by time of day for three of these cities over three periods: June to November 2019, March to June 2020, and October 2022 to January 2023. All three cities showed substantial increases in travel speeds in Spring 2020 when work from home was most prevalent, relative to Fall 2019. By Fall–Winter 2022–2023, speeds had returned to pre-pandemic levels in Dallas, while they remained substantially faster in Chicago, especially in the morning, and New York fell somewhere in between. Our data collection is rich enough to document other kinds of variation in travel patterns by day of week and area of the city, as well as over time, even on a daily basis in the largest cities, and other more difficult-to-measure outcomes of interest like travel time reliability.

Figure 1: Travel speed throughout the day in three U.S. cities



For traffic volume, we will rely on Google's Global Mobility Reports. They report indices of "visits" by "type" of destination (workplaces, residential, retail, parks, transit stations, etc.) at the county level between February 2020 and October 2022. As we understand, the "visits" indices are close proxies for the number of trips relative to a baseline in February 2020.

Time-varying measures of remote work propensity are also available from employment platforms such as Linkedin, from surveys (Bartik *et al.*, 2020), including the SWAA administered by Nick Bloom and Steven Davis, the American Community Survey, and, with a coarser geography, the American Time Use Survey.

To build exogenous predictors of the work from home propensity by city, we will assemble a variety of sources, given measurement challenges. First, Dingel and Neiman (2020) developed an index of the share of jobs that can be done from home, based on occupation and sector of employment. Using U.S. Census data about sectoral and occupational employment in cities,

we can construct a predictor of work from home for each city. Alternatively, time-varying measures of remote work propensity are also available from employment platforms such as Linkedin, from surveys (Bartik *et al.*, 2020) and from the American Community Survey.

We have also collected additional data on roads from OpenStreetMap, as well as a census of establishment locations and categories from Google Places. We will use the Google Places data to get estimates of the industry mix for any geography. In particular, our establishment data will allow us to measure the density of retail, restaurants, and white collar workplaces along each trip. Finally, we plan to assemble data about mandated lockdowns, closures of workplaces, and possibly, the spread of covid cases. After a preliminary exploration, we understand such data to be broadly available.

Methods

Using these data, we can document the evolution of travel speed patterns across U.S. cities at a granular level, through time and within cities, since 2019.

Our Google Maps data collection provides the dependent variable (traffic speed) to estimate the impact of work from home on travel outcomes and answer our second question. Regressing an index of (log) travel speed for a city on a measure of work from home requires some care, given the potential for simultaneity bias. For our third question, we can estimate the congestion elasticity by regressing an index of (log) travel speed for a city on an index of (log) numbers of trips. This (closely related) regression is subject to similar identification concerns.

A first version of the simultaneity bias is that bad travel conditions may deter travelers. For instance, roadwork on a major arterial road may induce some residents to stay home. Akbar and Duranton (2022) discuss this problem in detail and various solutions to circumvent it. We suggest two novel instruments to predict changes in number of travelers in each city, which are appropriate for our context and may not be otherwise correlated with travel speeds. Our first instrument exploits the many natural experiments in traffic reduction spurred by the pandemic, such as mandated lockdowns, school and workplace closures, cancellation of events, etc. These decisions were arguably not influenced by the state of traffic. Detailed data about institutional Covid responses are available from Mathieu *et al.* (2022). Second, we can use the Dingel-Nieman index of jobs that can be done from home as an instrument that predicts actual propensity to work from home and to commute or not. Such a predictor, based on occupational and sectoral employment, is plausibly uncorrelated with local traffic conditions (after conditioning out characteristics that determine slow traffic in the cross-section of cities).

Another form of simultaneity may occur because of (roadway) supply responses by cities. At the height of the pandemic, many cities reduced the roadway made available to motorized vehicles to create bike lanes, outside spaces for restaurants to expand, etc. We may fail to observe a reduction in congestion despite a drop in the number of travelers, if roadway capacity was simultaneously reduced. We can condition out these supply changes directly. For our recent work (Akbar *et al.*, 2023*a*,*b*), we have fully processed the 2019 road layers of OpenStreetMap to measure the characteristics of the road network in all the cities in our sample. Duplicating this procedure for subsequent time periods and tracking differences over time should be straightforward. Research on the accuracy of OpenStreetMap is optimistic about the data quality and how roadway changes get reported (Senaratne et al., 2017). Documenting these changes in roadway provision is also of independent interest and to be discussed in our descriptive work.

Research Team

The proposed team is well-suited to carry out this research. We have been working together using a related methodology to study urban transportation outcomes in world cities for the past six years. Notably we have extensively vetted the accuracy of Google Maps data in measuring travel outcomes in (Akbar *et al.*, 2023*a*,*b*). Couture and Duranton have used the 2009 NHTS extensively to study U.S. cities, most notably in Couture, Duranton, and Turner (2018), which uses related methods but without the Google Maps data. Our methodologies are thus highly refined and can be easily applied to the new data, which are of the same structure as those we have already used. Finally, Shreya Dutt has been working with us since early last summer as a research assistant.

Conflicts of interest

We, Prottoy A. Akbar, Victor Couture, Shreya Dutt, Gilles Duranton, and Adam Storeygard, each declare that we have no relevant or material financial interests that relate to the research described in this proposal.

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