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Exploring essential travel during COVID-19 quarantine: Evidence from China

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ABSTRACT

The COVID-19 has created significant impacts on the economy and individual life around the world. Various countries and cities have adopted corresponding control measures to reduce transport activities and maintain social distance to combat the spread of COVID-19. In the circumstances, residents only maintained essential travel to ensure a normal and fundamental life. In order to explore the impacts of the epidemic and control measures on individually essential travel, we have collected 513 questionnaires between February and March 2020 in China to investigate the various characteristics of essential travel. Using a multivariate logistic regression model, we examine the major factors that potentially impact the mode choices of essential travel. Results show that various socioeconomic, transport supply, health concern and travel purpose have significantly influenced travel mode choices of essential travel. The concept of essential travel will, in the era of port-pandemic, have profound implications on transportation policy making, especially on how to improve the fundamental welfare of the disadvantaged population.

1. Introduction

Since late January 2020, the majority of people in China had stayed at home for months to help contain the spread of the coronavirus. “Essential” had become a heated topic; relevant key words ranged from medical essentials such as face masks to home essentials like food (e.g. Centers for Disease Control and Prevention, 2020). When many stores, firms, public facilities got closed during the pandemic, people had largely reduced their daily transport activities and maintained only essential travel (Wilder-Smith et al., 2020). This extreme case of society-wide quarantine had provided a good opportunity to study essential travel to access food, jobs, pharmacy, and so forth.

A careful examination of essential travel can help policy makers better develop transport policies both during the pandemic and in the post COVID-19 world. What is the frequency of essential travel by a household and how does it differ from travel before the pandemic? What are the purposes of essential travel? What are the major transport modes used in essential travel? What factors can affect such travel mode choices? Do pandemic control policies matter in the dynamics? These are all important questions whose answers can inform us about the nature of essential travel. Some of them have recently been among the most debated ones in the field of transport policy. For instance, transport planners have been concerned over the increase in private auto use due to the threats of coronavirus transmission (Douglas et al., 2020). It would be necessary to explore the mechanism of such tendency using empirical data.

According to the literature, residents in lower socioeconomic status are more likely to suffer from limited access to essential goods and services due to inequity in household mobility (Welch, 2013; Pereira et al., 2017; Laker, 2020). The existing studies have nonetheless failed to offer adequate evidence on the general patterns of essential travel, which is difficult to directly observe in normal times (Jain and Guiver, 2001). Therefore, in this article, we will examine the major characteristics and explore the mode choices of essential travel using survey data collected during the pandemic. With a better understanding of essential travel, transport planners could more accurately estimate demand for essential travel and provide people improved access to essential goods and services. In particular, when the world finally witnesses an end of the COVID-19 epidemic, the empirical evidence would help cities promote transport equity and achieve sustainable development.

This article will start with a careful literature review on how the public health events like the COVID-19 pandemic affect individual travel, and how essential travel has been defined and studied using empirical evidence. We describe the research approach and data sources

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in the following section and present results from empirical analysis afterwards. According to what we find regarding essential travel, we discuss how policy making can be improved to better accommodate the basic needs of citizens for accessing various socioeconomic opportunities, not only during public health crises, but also in the post-pandemic world where essential travel is the baseline of livelihood.

2. Literature review

2.1. Impacts of COVID-19 on individual travel

The spreading of COVID-19 has generated dramatic impacts on individual travel, ranging from air flights to city buses, in both urban centers and rural areas. Due to the risks of catching the deadly disease, people have become much more cautious about traveling, especially via public transport vehicles where adequate social distancing could sometimes be difficult (Carlisle, 2020). To help contain the COVID-19 pandemic, governments have developed policies to restrict personal travel (De Vos, 2020). For instance, the State of California adopted an executive order and a public health order to direct “all residents to stay home except to go to an essential job or to shop for essential needs” on March 19, 2020 (California State Government, 2020). In China, the National Health Commission and Chinese Center for Disease Control and Prevention (2020) provided a comprehensive guide on how to protect oneself from getting infected; reducing non-essential travel is a key recommendation in the guide. Under the various pandemic control policies, the demand for individual travel has dropped substantially during the last few months.

The existing research has mainly explored the impacts on transportation modes and means during the pandemic. These results had contributed to limited understanding of transport policy making by local authorities, especially from the perspective of service provision to different groups of population. For instance, the air travel industry had observed a major negative impact of the pandemic on air passenger demand in Europe (-88.0%), Asia (-60.0%) and America (-59.4%) (Gallo and Font, 2020). With regard to urban public transit, studies reported that transit demand declines over 75% sharply in major cities like Washington and New York in the early days of the pandemic (Moovit, 2020). However, research has also found some “positive” impacts of the COVID-19 epidemic on individual travel, such as shortening travel time of public transit and reducing accidents (Gallo and Font, 2020). According to recent studies, non-motorized travel modes have become more popular, especially among low-income families (Bonacorsì et al., 2020).

In fact, the SARS in 2003 had resulted in unprecedented impact on people’s daily travel in China and generated similar discussion on mode choices. People reduced their exposure to the virus by avoiding going outside and using public transportation systems (Wen et al., 2005). Studies also examined the association of each reported SARS case with outside and using public transportation systems (Wen et al., 2005). Authors have been implemented to enforce social distancing and reduce personal interactions (De Vos, 2020). While essential travel has been defined during the COVID-19, the characteristics of such travel during the coronavirus epidemic are still unknown and its impacts on people’s lives in the difficult times need to be further studied.

2.2. Essential travel: definition and evidence

The “stay home” order in many cities and countries does not rule out all travel, as people have to access essentials including food, medical supplies and so forth. The definition of essential travel varies in the policies, orders, and guides. Taking the guide by the U.S. Centers for Disease Control and Prevention as an example, the organization suggested grocery shopping, take-out, banking, and getting gas, among others, belong to essential travel that is fundamental to daily life (U.S. Centers for Disease Control and Prevention, 2020). The State of California (2020) defined “essential jobs” as permitted ones during the “stay home” order but did not specify the “essential needs” in permitted local shopping. In general, the definition of essential travel can vary widely across different cultures and contexts. For instance, getting gas may be highly essential to people in the U.S. where automobile is a critical part in everyday life, but it could be much less fundamental in dense cities in China or Singapore.

Before the pandemic in 2019–2020, previous studies had discussed the characteristics of essential travel and employed the concept to evaluate whether transport planning accommodates travel demand, promotes equity and optimizes the efficiency of resource allocation (Krumdieck et al., 2010a; Laube et al., 2007). However, the way of splitting travel into three categories (essential travel, necessary travel, optional travel) largely depended on arbitrary experience. Krumdieck et al. (2010a) defined essential travel as travel that contributes to people’s health, work, income and other basic needs. Relevant concepts include necessary travel and optional travel (Gordon et al., 1998). Demonstrated the non-essential individual travel is about 30% of their total trips using National Personal Transportation Study (NPTS) of 1977 and 1983–1984 (Krumdieck et al., 2010b). Split trials with the purposes into three categories: 50% as essential, 20% as necessary and 10% as optional.

After the outbreak of the COVID-19, some researchers conducted quantitative studies to evaluate the impacts of non-essential travel on disease spreading. For instance (Sharkey and Wood, 2020), estimated a difference-in-difference model combining the travel activity data and health outcomes, and pointed out 1% decrease in non-essential travel would reduce 6.4% new cases in average (Sears et al., 2020). Reported similar conclusion and demonstrated the decrease in non-essential travel would bring economic benefits and relieve the pressure on local hospital system. However, those studies did not carefully distinguish essential travel from non-essential travel using empirical data, and therefore could not provide adequate implications on how to accommodate essential travel demand from the public. While essential travel has been redefined during the COVID-19, the characteristics of such travel during the coronavirus epidemic are still unknown and its impacts on people’s lives in the difficult times need to be further studied.

2.3. Travel mode choice of essential travel

It can be expected that people will travel less and may change their choices of modes in essential travel. According to Troko et al. (2011), people might avoid public transport to keep social distancing. Under the circumstances of virus spreading, different pandemic control policies have been implemented to enforce social distancing and reduce personal interactions (De Vos, 2020). Examples include regulations on bus services and road traffic, as well as lockdowns of public places. As a result, reduced accessibility to activities such as transportation, maintenance (e.g. grocery store, pharmacy) and leisure might lead to changes in essential travel mode choices. Previous studies have pointed that a decrease in accessibility may lead to an increase in car driving (Handy et al., 2005; Cao et al., 2007). There has been limited research on the factors affecting travel mode choice of essential travel. Thus, we turn to the literature of travel mode choice in general to get some insights on this topic.

At macro level, regional characteristics can affect travelers’ mode choice (Schwanen and Mokhtarian, 2007). For example, some studies have suggested that the travelers in areas with higher levels of economic development (Wang and Zhang, 2011; Li et al., 2005), higher population densities (Cho, 2013) and larger urban size (Dargay and Hanly, 2004;
such as leisure. Second, essential travel demand is less related to per
essential travel is less frequent and less subject to non-essential purposes
essential travel is different from normal travel in a few dimensions. First,
and car usage (De Palma and Rochat, 2000; Chen et al., 2008).
In general, in spite of the enormous research exploring the travel
mode choices, how those choices may be subject to the various con-
straints during the pandemic, and how traditional factors play a role in
the dynamics have not been adequately studied in the literature yet.

3. Research approach and data

Based on a careful review of the literature, we hypothesize that
essential travel is different from normal travel in a few dimensions. First,
esential travel is less frequent and less subject to non-essential purposes
such as leisure. Second, essential travel demand is less related to per-
sonal preferences and socioeconomic attributes, or in other words, to
people in different socioeconomic status, essential travel demand is
similar. Third, essential travel can vary across neighborhoods with
different local access to essential goods and services. To evaluate these
hypotheses, we use various statistical tests on empirical data, which will
be described below.

In addition, we further develop a multinomial logistic regression
model to examine the major factors that potentially impact the mode
choices of essential travel. We focus on households in different urban
contexts and examine the following sets of independent variables in the
model: 1) city characteristics including size, economic level, and in
particular, intensity of the COVID-19 spreading in each city; 2) pandemic
control policies including transportation and non-
transportation ones; 3) neighborhood characteristics, such as relative
location in the city, access to transportation infrastructure, and access to
essential goods and services; 4) household characteristics, including
household size, and shopping patterns. The dependent variable is the
primary transport mode the respondent chose to use during the COVID-
19 quarantine. Options of mode choices include private car, public
transit modes including bus and rail, semi-public transit modes
including ride-hailing and taxi, and nonmotorized modes including
walking and biking. The share of using public transit or semi-public
transit mode is no more than 4% and it would be difficult to systemat-
ically observe the variations in either mode, therefore we choose to
combine them as one group. In the model, we select nonmotorized
modes as the reference group, and examine whether people favor private
car or public/semi-public transit relative to nonmotorized modes during
the pandemic. According to recent studies, people are concerned about
the risks of getting infected with the coronavirus during taking public
and semi-public transit modes (Troko et al., 2011; De Vos, 2020). We
would like to test this hypothesis using the empirical data.

We select households in China as our observations for the following
reasons. First, most Chinese cities had implemented relatively stringent
quarantine measures so that the majority of people chose to make
essential travel only. As many cities around the world failed to contain
the spreading of the disease through strict quarantine, the practices in
Chinese cities had contributed to a valuable dataset for examining the
tavel demand almost exclusively dedicated to essential purposes. Sec-
ond, Chinese cities had been affected by the COVID-19 epidemic to
widely different degrees, although most cities had adopted very similar
quarantine guidance. Such variations can offer us a great opportunity to
observe the patterns of essential travel in different urban contexts.

Third, many Chinese cities offer citizens multiple transport modes
including bus, taxi, ride hailing, and so on. The diverse collection of
transport modes would be an important prerequisite for effectively
examining how people make mode choices in essential travel.

To empirically test the hypotheses above, we made a research plan
after the outbreak of the COVID-19 and designed a semi-structured
survey on travel behaviors during the quarantine. Given the quaran-
tine guidance, we had to rely on online surveys to avoid interpersonal
contacts. Between February 15 and March 2, we collected 608 responses
using an online survey platform. To avoid possible biases, we did not
rely on any survey promotion services which can direct the survey to
certain online communities and undermine the validity of the data
collection (Wright, 2005). As part of the survey is open-ended, answers
to some questions in the responses were missing. After removing those
incomplete records, 558 questionnaires were finally put into analysis.
When developing the multinomial logistic model, we excluded the
questionnaires with no specific modes of essential travel and included a
total of 513 observations in the final model estimation. As a discernible
proportion of the observations were located outside of the urbanized
area where a few variables were not applicable, we separately examined
two models using all observations and observations in urbanized areas
only. Results from two models were compared and discussed afterwards.

4. Results

4.1. Patterns of essential travel

As we indicated earlier, travel during the COVID-19 quarantine was
viewed as essential travel. We are interested in how essential travel is
different from daily travel before the pandemic and how that differences
vary across residential areas in and beyond cities. The descriptive sta-
tistics of the survey data indicate that the frequency of travel during the
quarantine was 8.01 per household per week (see Table 1). Relative to
other types of residential areas, households living in rural areas had less
taveled during the pandemic. As many families in the rural areas
in China are food self-sufficient, the demand for going shopping for food is
limited, especially when the pandemic made travel less efficient (see
Table 2).

The average number of weekly commuting trips dropped from 7.17
to 2.27. A household on average made 1.67 grocery trips per week
during the pandemic, compared to 4.12 before the pandemic. The

| Number of shopping trips per week before pandemic |
|-----------------------------------------------|
| Non-city Urban district | 4.12 | 4.17 | 4.06 | 3.97 | 3.90 |
| Town Rural |
| Overall travel frequency during pandemic (trips/week) |
| All |
| City Urban district | 8.01 | 7.87 | 8.28 | 9.68 | 7.33 |
| Suburban district |
| Non-city |

Table 1

Descriptive statistics of travel frequency among households surveyed.
number of trips to leisure activities such as dining fell substantially from 2.77 per week to only 0.23 per week. In this sense, the frequency of commuting trips, grocery trips, and leisure-oriented trips dropped by 68%, 59%, and 83% respectively. Thus, the travel demand in the quarantine period was more subject to grocery shopping and commuting rather than leisure activities. In general, the tendency of decreasing travel frequency does not vary significantly across households in different residential types—urban districts, suburban districts, town, and rural. But travel by rural households was apparently more limited during quarantine; when public transit services were suspended and personal transportation was largely constrained, accessing socioeconomic activities became more difficult in low-density rural areas.

According to the survey results, 66% of the cities where respondents lived cancelled or largely shrunk their bus services, and 40% of them controlled the traffic on surface roads, for instance, through closing highway ramps. At community level, 84% of the residential communities under studied chose to monitor body temperature before entering, 87% of them prohibited any outside vehicles from visiting the communities. 44% of the communities even set limits on the daily frequency of getting in and out. In this way, these pandemic control measures can greatly affect the willingness and cost of travel.

64% of the households chose private car to make essential travel during the pandemic. 21% chose nonmotorized modes including walking and bicycling. 2.7% relied on public transit plus walking. 3.6% selected semi-public transit modes including taxi and ride hailing. In urban cores, higher shares of respondents chose car, public transit and semi-public transit modes as essential travel modes, while less people walk or bike. In suburbs, people relied more on public transit and nonmotorized modes but much less on car and semi-public transit modes. Outside of the cities, public transit and semi-public transit were seldom selected as the major modes in essential travel; those using nonmotorized modes accounted for 28% and 38% of respondents in towns and rural areas respectively.

4.2. Factors in the mode choice of essential travel

Table 3 displays the descriptive statistics of variables included in the econometric models below. Relative to all respondents, respondents in cities live in large communities, have better access to bus services, larger household sizes, and more frequently go to places for employment and shopping.

In the first model using all observations, we could see how people prefer car or public and semi-public transit modes relative to nonmotorized modes. Estimated coefficients indicate which factors can positively or negatively affect that preference among respondents in the survey. In richer cities, people prefer car use while in dense cities, public/semi-public transit modes are trendier. With regard to pandemic control policies, regulations on surface road transport would make car mode less competitive compared to nonmotorized modes, as expected. The impacts of road regulations appear to be more significant on transit modes (chi2 = 4.84 and prob > chi2 = 0.03). In a city with a higher number of coronavirus patients during the pandemic, people would choose nonmotorized modes rather than car or public/semi-public transit modes. Such preference is, however, not significantly different between the car and transit modes (chi2 = 0.83 and prob > chi2 = 0.36); in other words, although people seem to avoid buses, subways, etc. more than private vehicles when the risk of virus infection increases, that difference is not apparent.

If people live in a large community, they may find many groceries and service providers nearby and therefore can rely on walking or biking to access essential supplies. Convenient access to freeways can contribute to a higher probability of using car. Living in urban districts (rather than suburban ones) can increase the likelihood of using both car and transit modes.

Households with large sizes are likely to use private cars as well. Demand for regular commuting, proxied as the frequency of commuting per week, is positively associated with the relative odds of using car or public/semi-public transit modes vs. nonmotorized ones. Again, using car to commute is not statistically significant from using transit modes (chi2 = 1.63 and prob > chi2 = 0.20). Generally speaking, despite the relatively small number of observations, the overall fit of the model is acceptable and estimated coefficients are in line with reasonable expectations.

Using households in cities only, we developed another model whose results are shown in Table 5. In the context of cities, we were able to measure a few additional variables such as access to bus stops, local supply of daily essentials, and regulations on bus services during pandemic. As values of these variables were not comparable between communities.
### Table 4
Regression results of model using all observations.

| Relative to nonmotorized modes | Car | Public/Semi-public transit |
|-------------------------------|-----|----------------------------|
|                               | Coef. | S.E. | Coef. | S.E. |
| City level                    |       |     |       |     |
| GDP per capita                | 0.535*** | 0.324 | −0.173 | 0.685 |
| Population density            | 0.126 | 0.151 | 0.817*** | 0.317 |
| Regulations on road transport during pandemic | −0.460** | 0.209 | −1.812*** | 0.540 |
| Number of coronavirus patients | −0.043*** | 0.005 | −0.069*** | 0.027 |
| Community level               |       |     |       |     |
| Community size                | 0.145 | 0.119 | −0.937** | 0.299 |
| Access to freeway             | 1.318** | 0.675 | 1.272 | 0.855 |
| In urban districts            | 0.569** | 0.257 | 1.004* | 0.528 |
| Household level               |       |     |       |     |
| Household size                | 0.257*** | 0.093 | −0.133 | 0.178 |
| Frequency of commuting in household | 0.113*** | 0.038 | 0.191*** | 0.065 |
| Frequency of essential shopping in household | −0.042 | 0.079 | 0.111 | 0.108 |
| Constant                      | −7.664*** | 2.874 | −8.886* | 5.227 |
| Number of observations        | 513 |     |       |     |
| Pseudo R2                     | 0.133 |     |       |     |

Note: ***p < 0.01; **p < 0.1; *p < 0.5.

### Table 5
Regression results of model using observations in cities only.

| Relative to nonmotorized modes | Car | Public/Semi-public transit |
|-------------------------------|-----|----------------------------|
|                               | Coef. | S.E. | Coef. | S.E. |
| City level                    |       |     |       |     |
| GDP per capita                | 0.599 | 0.377 | −0.153 | 0.696 |
| Population density            | 0.123 | 0.180 | 0.812** | 0.352 |
| Regulations on road transport during pandemic | −0.532* | 0.282 | −1.715*** | 0.486 |
| Regulations on bus during pandemic | 0.198 | 0.359 | 0.151 | 0.525 |
| Number of coronavirus patients | −0.043*** | 0.006 | −0.063** | 0.027 |
| Community level               |       |     |       |     |
| Community size                | 0.161 | 0.135 | −1.209*** | 0.301 |
| Access to freeway             | 2.754** | 1.094 | 1.901 | 1.313 |
| Access to bus stop            | −0.050* | 0.027 | 0.023 | 0.041 |
| In urban districts            | 0.634** | 0.308 | 0.072 | 0.594 |
| Local supply of daily essentials during pandemic | 0.491* | 0.268 | 0.061 | 0.451 |
| Household level               |       |     |       |     |
| Household size                | 0.309*** | 0.113 | −0.030 | 0.190 |
| Frequency of commuting in household | 0.103*** | 0.039 | 0.193*** | 0.071 |
| Frequency of essential shopping in household | −0.038 | 0.089 | 0.121 | 0.112 |
| Constant                      | −8.956*** | 3.463 | −9.572* | 5.417 |
| Number of observations        | 444 |     |       |     |
| Pseudo R2                     | 0.136 |     |       |     |

Note: ***p < 0.01; **p < 0.1; *p < 0.5.

Essential travel is crucial to everyone who is exposed to shocks like the COVID-19 pandemic, but the existing literature has not adequately examined the concept, especially through empirical data analysis. The quarantine between February and March 2020 in Chinese cities offered a rare opportunity for identifying this important type of travel, summarizing its patterns, and investigating the factors in its mode choices. The findings have profound implications on how to understand essential travel and apply the concept to transport planning.

First, the empirical results display a real-world model of essential travel: commuting and shopping account for a significant proportion of daily trips, while leisure-oriented trips appear to be much less relevant. This composition pattern of travel during the quarantine period resonates with the hypothesis that such travel is attached to essential purposes including accessing jobs and earning income, and obtaining groceries and medical supplies. Leisure activities had been largely avoided as expected. Our findings therefore can help validate the definition of essential travel and calibrate the policies targeting equal access to essential needs.

Second, the mode choice in essential travel is of particular importance because it is closely linked to the actual capability of people for acquiring fundamental resources. The choice set of essential transport modes depends on the socioeconomic status, preferences, and many other attributes of a household. The COVID-19 quarantine, as a rare event with society-wide impacts, had systematically imposed risks and restrictions on using certain transport modes such as public transit and semi-public transit like ride-hailing. Public transit services are heavily subsidized by the government, and responsible for helping disadvantaged population access socioeconomic opportunities. During the public health crisis, people, especially those disadvantaged ones with no private cars could thus suffer from the dramatically decrease in mobility. Descriptive statistics above, which display a very limited share of public transit use in rural areas, well justify this hypothesis. In addition, results from the multinomial logistic models indicate that when people need to commute for jobs or buy daily essentials that are not available nearby, they would be inclined to use private cars instead of public transit. Such tendency is more related to mental and psychological readiness for taking buses or subways rather than physical restrictions or regulations on public transit services. In this sense, the COVID-19 pandemic may, to a large degree and in the long run, challenge the way choice riders perceive public transit services, and affect their actual mode choices. Considering the commonly-seen irreversible shift to private car use among choice riders, we need to carefully reevaluate the impacts of the pandemic on public transit market.

Third, results from the survey data also indicate certain groups of cities, towns and rural areas, we did not include them in the model above. Much of the results from the city-only model resonate with those in Table 4, while the addition of the new variables leads to some interesting findings. For instance, while access to bus stop is significantly associated with private vehicles use, restrictions on bus services during pandemic do not significantly affect the mode choices. Instead, travel purposes may be more influential in the changes in mode choices. When respondents find it difficult to access daily essentials in close vicinity of their communities, they may choose to drive their cars to make purchases instead of using public/semi-public transit or nonmotorized modes.

Figs. 1 and 2 display the changes in probability of using different travel modes when two variables of interest change from zero to one. Compared to a city with no regulations on surface road transportation, people in a city with those regulations would shift from car and public/semi-public transit modes to nonmotorized modes, holding all other variables at mean values. The probability of using public or semi-public transit modes decreases from 5% to 1.5%. Similarly, if people could not acquire daily essentials in close vicinity of their communities during pandemic, they would largely increase the use of private vehicles, and decrease using other modes. The probability of using car increase from 73% to 82%, while that of using transit decrease from 4.3% to 3.1%. Thus, the various socioeconomic, transport, and public health-related impacts of the COVID-19 pandemic have significantly influenced travel mode choices, and public/semi-public transit modes seem to be the most vulnerable modes among all options.
households may be more vulnerable to the shrink of the transport mode choice set. For instance, with limited access to public transportation infrastructure and low car ownership, rural families have to rely on nonmotorized modes such as bicycling and walking. Those families are thus likely to miss socioeconomic opportunities such as jobs.

Looking ahead, we believe the findings can have some useful policy
implications on accommodating demand for essential travel in the post-pandemic world. First of all, the public sector should pay more attention to essential travel in transportation planning and policy making. Travel is an indispensable part of daily life, while essential travel is more closely associated with the fundamental socioeconomic opportunities related to the survival and success of people and families. When the world is hit by public health events like the COVID-19 pandemic, travel activities are threatened. So to ensure essential travel would be a critical goal of the government to protect individual livelihood, economic sustainability, and social stability. For example, local governments in Chinese cities such as Wuhan chose to provide free bus and taxi services to people with especially needs or disabilities to help them access medical services. Although many cities have recovered or been recovering from the pandemic, they would still find it significant to create some emergency-response mechanisms that help improve the resilience of transport system in extreme situations. Similar practices have been found in Zhejiang and Henan, where newly adopted laws required that transportation means be provided to address the needs of special population groups during any public health emergency events. The concept of essential travel can help local authorities develop effective measures for ensuring such access at critical times.

In addition, the pandemic has been gradually changing travel behaviors and even the long-term preferences and prospects. Relative to private car, public transit is further losing its shares in the transport market. Considering the steady shrinking of its ridership during the last decade, policy makers may become more pessimistic about the future of public transit. In this sense, to improve service quality and address the concern of transit riders would be a reasonable alternative to restoring the vitality of public transit services, whose significance in promoting social welfare is outstanding and irreplaceable. A successful example in Chinese cities is to require health QR Code and conduct stringent sanitization on buses and subways. Such practices can greatly help remove the worry of exposing to coronavirus among passengers during taking the public transit.

Moreover, the concept of essential travel is important in understanding the needs of disadvantaged population who are most vulnerable to external shocks. Information on major purposes, mode choices, and influencing factors of essential travel can help policy makers develop strategies for improving the access to essential needs. For instance, local governments can organize community meetings in disadvantaged neighborhoods to acquire the information of frequency, purposes, and mode choices of essential travel. Based on the data, the governments can encourage public transit agencies to provide customized services to those neighborhoods as a means of enhancing local access to essential needs.

Although these results and policy implications are derived from data collected during the pandemic in China, the transferability to other similar contexts is credible. The empirical data was obtained from all sizes and types of cities in Chin and covered different urban/rural contexts including urban district, suburban district, town and rural area, each of which has unique characteristics of travel mobility. The urban area has complete road infrastructure and public transportation supply but the rural area is the opposite. We develop models on urban observations and all observations respectively to account for the effects of both contexts. Therefore, the results may be applied to different cities and urban contexts and can potentially help formulate policies per the discussion above.

Finally, we would like acknowledge some limitations in data collection and analysis in this article. Due to the various constraints on data collection during the quarantine, the data sample we obtained was not as large as expected, making some in-depth analysis difficult. The dataset did not contain variables like family income, as we did not have reliable approach to justify the values of such variables. With more detailed data, the models could be improved and show more interesting results. We hope the research done during this rare social event can serve as a foundation for future research on essential travel, and our findings can incentivize further efforts to investigate the significance of essential travel in human society.

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1 The health QR Code is a technological application that relies on mobile technology and big data and help curb the spread of the coronavirus. The automatically generated quick response codes, commonly abbreviated to QR codes, are assigned to citizens as an indicator of their health status (see Gan and Culver, 2020).
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