Catching Cab - An Act of Fear or Compulsion? Empirical Study based on Online APP Cabs in India during COVID-19 Pandemic

By Mukta Mukherjee[*] & Arunesh Ray[±]

The COVID-19 pandemic brought about a significant transformation in our daily commute from public transport to either personal transport or private cabs. The economic status of commuters determines whether switching from public to private mode of transport is a feasible option. This study explores the reasons behind the surge in online cab fares. The two probable reasons are the COVID-19 pandemic and public transport shortage. Additionally, the effects of weekends, dual shifts and infrastructure blockage were controlled. The results indicate that the surge in cab fares is driven by the inadequate public transport in relation to the number of commuters. The dual shifts of jobs are effective in transferring transport demand from peak to slack period. However, infrastructure blockage diminishes the effectiveness of dual shifts of jobs in transferring transport demands. The findings add to the existing literature by emphasizing the relevance of public transport for the lower income category in developing countries.

Keywords: *social distancing, technology, COVID-19, transport, online cab service, dual shifts*

Introduction

The WHO declared COVID-19 as a pandemic on June 11, 2021 after it affected 151 countries across the world. India stands in second position (44 million) after USA (104 million) in the total number of COVID- 19 patients affected as on January 30, 2023.[1] Most of the countries in the world including France, Germany, USA, China and India imposed a nationwide lockdown to contain the spread of the pandemic. Perceived risk from COVID-19 has caused many behavioral changes in the transport sector. In contrast to the developed countries context where most of the commuters reduced the travelling amount drastically, the developing countries context, due to lack of inadequate infrastructure and nature of the jobs, forced majority of the commuters to travel to sustain their livelihood despite the fear of contracting the virus (Paul et al. 2022). According to the Asian Development Bank Report (2020), most of the developing countries have only 15-20 percent jobs that can be conducted remotely, which forces majority of the people to travel. Besides reducing the frequency and length of travel, COVID-19 has induced a major change in the travel modes of the

[*]Assistant Professor, Department of Economics, Alliance University, Bangalore, India.
[±]Postgraduate Student, Global Risk Management Institute, India.
[1]Worldometer: https://www.worldometers.info/coronavirus/.

commuters from public to private transport (Beck et al. 2021, Kim et al. 2021, Abdullah et al. 2020). Surprisingly, a countrywide analysis by Asian Development Bank revealed that commuters in India commuters preferred public transport to driving in the COVID-19 recovery period (Asian Development Bank Report 2020). According to Road Transport Year Book (2018), in India, out of every 1000 persons, only 23have cars and 128 have bikes. The commuter's income plays an important role in switching from public to private transport.

Empirically, it has been observed that only the higher income group is successful in switching from public to private transport, whereas the lower income group still depends on public transport. Meena (2020) in a survey on the impact of COVID-19 on travel pattern in India found that only the higher income group (average monthly income of more than Rs. 1 lakh) would switch to cars and the lower income group (less than average monthly income of Rs. 50,000) are still dependent on public transport in the post-lockdown period. Captive commuters who do not have the choice of switching to private mode would continue to use public transport after the lockdown. This finding holds good empirically for commuters with lower income in developed countries as well. Kim et al. (2021), in their study on South Korea found affluent commuters are reducing their use of buses and switching to cars after COVID-19, however, those with lower income are still dependent on public transport. Further, as per a survey conducted in China, the propensity to switch from public transport to car is higher for the higher income groups (Asian Development Bank Report 2020). Although the impact of COVID-19 on modes of transport, travel patterns and trips has been widely studied, research has not focused on lower-income groups that are compelled to use public transport, to the best of our knowledge. This study aims to address the gap in literature.

Hall et al. (2018), in their study on US metropolitan cities found that online cab services like UBER complemented the use of public transport by providing the fixed route of public transport more flexibility and increasing the use of public transport. Meena (2021) in a post-lockdown phase survey of Indian commuters found that 67 percent experienced more anxiety and stress while travelling by public transport due to fear of contracting the virus and feeling unsafe. Alternatively, for commuters who are not able to afford private vehicles but wiish to protect themselves from COVID-19, online cabs like UBER and OLA can become a viable option. Paul et al. (2022) found that the propensity of using on-demand services like UBER in Dhaka, Bangladesh, increased from 8 percentage to 11 percentage, due to COVID-19. This suggests that the demand for online cab services should increase, which would boost cab fares. However, commuters whose income has decreased as a result of the lockdown would attempt to minimize their expenditure cab services, which are more expensive than public transport, leading to a decrease in demand and online cab fare. The net effect would determine the effect of COVID-19 on online cab services and cab fares. This paper's contribution would be to evaluate the effect of public transport availability on the use of online cab services like OLA and UBER in pre- and post-lockdown periods. In this context, we examine how COVID-19altered the structure of online cab fare in Kolkata city, India.

Kolkata is one of the eight metro cities of India and the seventh biggest city of India in area and population. As per the 2011 census, the population of the city is 44 lakhs. However, the average annual salary is only Rs. 15 lakh in comparison to the other three metros (Delhi, Mumbai and Bengaluru), where the annual salary is at least Rs. 20 lakh (Hindustan Times 2023). Having lower income, most commuters depend on public transport rather than private individual transport. About 60 lakh commuters typically travel each day from both within and around the greater Kolkata area (Anandabazar Patrika 2020). These commuters mainly depend on public transport like buses, metros, and local trains for their commute. After lifting of the lockdown, in the initial period, the local trains and metros were not operating, due to which, commuters had to depend on buses for public transport. Further, private buses were not operating in the first few days from June 1-3, 2020. This created an additional public transport supply constraint for the low-income group, who had to commute to sustain their livelihood. The shortage of public transport would lead to rise in the demand for online cab-services and increased cab fares. However, this increase in demand for online cab-services would be purely due to supply constraint rather than commuter's behavioral change pattern for safe travel to avoid contracting SARS virus. In the former case, the increase in demand for online cab-services would be short-lived and reduce with adequate public transport, however in the latter, there would be a long-run impact on the demand for online cab-services.

In Kolkata city, as per the central government guidelines, a lockdown was imposed from March 25 to May 31, 2020. The study uses balanced panel data on daily app-based cab fare for different time zones before and after the lockdown. Using the fixed effect methodology, the study aims to segregate the effect of COVID-19 from public transport shortage on the online cab fare.

The purpose of the study is to analyze the effect of lockdown restriction and public transport supply constraint on app-based cabs fare. The entire study is divided as follows. The literature survey on online cab service is explained in the following section. Next, the model and explanatory variables adopted in the study are explained. The result and analysis are explained later. Finally comes the discussion and conclusion.

Literature Review

The online cab service and app-based cab service have recently garnered importance in the field of research (Luciano et al. 2023, Rizki et al. 2021). Cramer and Kruger (2016) have shown that app-based cab service like UBER is more efficient than a traditional yellow taxi in matching the commuters with the drivers, using their technology. Hence, they both reduce the search costs of both commuters for cabs and cab drivers for potential riders. Further, Hall et al. (2018) in their study of US metropolitan cities empirically validated that online cab services like UBER complemented the use of public transport by providing the fixed route of public transport more flexibility and increasing the use of public transport.

Literature on online application-based cabs have been broadly divided into two categories: analyzing either the customer experience, examining their business model or predicting the use of app-based cab services like OLA or UBER. A few studies (Nikam et al. 2020, Kalla and Purohit 2017) performed a detailed analysis of the business model employed, particularly by OLA. Alemi et al. (2018) determined the factors that influence the commuters to use online cab services like UBER. They found that the more educated and technology-driven millennial generation frequently use UBER. Further, accessibility of a location by automobiles plays an important factor in using online cab-service. Some empirical studies (Perea and Samarasinghe 2020, Khuong and Dai 2016, Soleh et al. 2018) evaluate the major factors that determine customer's satisfaction and customer loyalty for app-based cabs. Price of the app cab has been found to play a significant role on customer's satisfaction (Perea and Samarasinghe 2020, Khuong and Dai 2016, Soleh et al. 2018). A study on e-biking in Indonesia revealed that COVID-19 has made the condition of app-based drivers vulnerable (Rachmawati et al. 2021). There is no study to show the effect of public transport availability and dual shifts of jobs on app cab fare. The current study fills this gap in this literature by examining how public transport, government policies like dual shifts and infrastructure blockage impact online cab fare.

Methodology and Data

According to the demand-supply framework, the app cab fare in a locality for a particular time of the day depends on demand for cabs and availability of the online cabs there at that moment. Hence, during high demand for cabs compared to the availability of cabs, usually a peak price loading occurs, which drastically surges the cab fares compared to normal times (OLA 2022). During the pandemic, the Government of India announced a nationwide lockdown (restriction in movement and all forms of activity) from March 25 to May 30, 2020 to prevent rapid spread of COVID-19 among people. The restriction in movement issued by the government during lockdown and further the fear of spread of COVID-19 by contact led to social distancing and self-imposed confinement in houses. Even after the lifting of lockdown on May 30, 2020, the availability of both public transport and online cab services was significantly curtailed. On the other hand, the fear of contracting COVID-19 increased people's propensity to switch from public transport to online cab service. Both these factors would cause an increase in the demand for online cab service.

In addition to the online cab service, Kolkata also has the traditional yellow cab services. The localities will themselves play an important role as these yellow cabs will be competitors for online cab service and their availability in an area would affect the online cab fares, (Cramer and Kruger 2016). The zones for this study were restricted to regions where OLA and UBER service was available and could not be chosen randomly (Economic Times 2020). If we consider only cross-section, the analysis will suffer from cross-section bias, for example, the availability of yellow cab services would affect the extent of lockdown on both

transport and fares. Similarly, considering only time series data can incorporate time series bias. Gradually, exposure and familiarity to online cab service will enhance the usage of online cab service (Alemi et al. 2018). To remove both cross-section and time series bias, the study uses a fixed effect panel methodology (Baltagi 2005). The following fixed effect model tries to capture the essence of the previous discussion and removes the cross-section and time series bias:

$$(pit) = \alpha_0 + Number\ of\ Active\ Cases\ \beta_1 + Lockdown_{it}\beta_2 +$$
$$Number\ of\ Active\ Cases * Lockdown_{it}\ \beta_3 + Private\ Bus\ Operation\ \beta_4 +$$
$$\mu_i + \varphi_i\ (t) + \vartheta_{it};$$
$$i = Distance\ zone, t = Time\ of\ a\ day \qquad [1]$$

The dependent variable online cab fare $'pit'$ in a locality $'i'$ in any particular $'t'$ time of day would be dependent on many factors. The unobserved individual locality factors are captured by μ_i , $\varphi_i\ (t)$ captures the trend of cab fare and ϑ_{it} represent the random error term. Our primary interest lies in the coefficient of regression variable $'Number\ of\ Active\ COVID - 19\ Cases' * Lockdown,$ which represents change in in travel behavior pattern to maintain social distancing following the lockdown. With an increase in COVID-19 active cases following lockdown, is there rise in online demand for cab-services due to social distancing? The coefficient β_3 represents the online cab fare affected by COVID-19 cases in a particular locality since it is in a more restricted area with fewer transport options as opposed to a less restricted area with more options following lockdown. Our secondary concern is the coefficient β_4 effect of private bus operation dummy variable on cab fare. Hall et al. (2018) found that in the US metropolitan cities, the use of online cab services complemented the public transport services by increasing their usage. However, the lower income commuters would be mainly captive users, who are dependent on public transport as it is a cheaper mode of transport; hence public transport would act as a substitute for private cabs. Therefore, whether the majority of the commuters are captive users would determine the net effect and relationship of public transport as a complement or substitute for online cab-services. Additionally, we also explore the effect of dual shift for government employees and weekends on the cab fare. The dual shift of government employees would allocate demand between different times of the day and hence decrease pressure on demand for transport and reduce online cab services. Weekends would require only travelling for leisure, which would lead to a major reduction in leisure travel following COVID-19 (Kim et al. 2021).

Temporal and Geographical Scope of the Study

The initial phase of COVID-19 before lockdown and after lifting of lockdown from March 10 -June 17, 2020 (with breaks) in Kolkata is the study period. WHO declared COVID-19 as a pandemic on March 11, 2020. The first case of COVID-19 was recorded on March 17, 2020 in Kolkata. Following that, there was an upward trend of COVID-19, cases and in an effort to stop the pandemic from spreading, the central government imposed a nationwide lockdown from March

25–May 31, 2020 in line with other industrialized countries like France and Germany. During this lockdown period, public transport and all forms of activities, except movement for emergencies, were suspended.

Explanatory Variables

The dependent variable APP cab fare is collected from primary data of online apps (OLA and UBER) on daily basis from March10 -June 17, 2020. Usually before commencing any ride, for these APP cabs, the commuter is shown the prospective fare based on its current location and time; this fare has been considered for the study as the main dependent variable. We record the app cab fare on daily basis for different zones before and after the lifting of COVID-19 lockdown. The authors recorded the required cab fare data from OLA and UBER online apps for each zone, on a daily basis for different time periods. The entire cross-section was divided into seven zones, with ascending order of distance required to be travelled, respectively for each zone. The details of the different zones are provided in Table 1. Further, the app cab fare was collected on daily basis for three different time periods: morning (8a.m.-9:3a.m.), afternoon (12:30p.m.-2p.m.) and evening (5p.m.-6:30p.m.) to capture peak pricing of cab fare. As both OLA and UBER are prominent players for online cab services in Kolkata, for each zone, fares of both the app cabs were initially noted and then the average of the two fares for a zone at a particular time was considered. Since the services of online app cabs like OLA and UBER were not available during the interim period (March 25-May 31, 2020), when the central government announced a complete lockdown, a balanced panel of 294 observations were collected. Hereafter, we will refer to OLA and UBER as app cabs for the rest of the study.

Table 1. *Description of Zones of App Cab for Study*

| Zones	Distance (in km)
MAIDAN - PARK STREET	5
BOTANICAL GARDEN – BENIAPUKUR	7
BENGAL CHEMICAL – TOPSIA	9
LAKE TOWN – BOSEPUKUR	12
DAKHINESWAR – SANTOSHPUR	15
BELGHORIA - SHAKUNTALA PARK	18
JOKA - KAMALGACCHI MORE	21

Source: Based on Authors Calculation of App Cab Fare Data.

The other major explanatory variables for this study are the number of active COVID-19 cases in Kolkata. The West Bengal government has been updating the number of active cases of COVID-19 in Kolkata on a daily basis on its COVID-19 website. We collected data on the daily active cases in Kolkata from this website. We included a lockdown dummy to account for the decrease in public transport availability after the lifting of restrictions on movement from May 31, 2020 onwards, as compared to the pre-COVID-19 period.

Most of the commuters in Kolkata city depend on private buses, which are almost six times as numerous as government buses. The metros and local trains also provide vital modes of public transport, but during the initial period of lifting

of lockdown, these modes were not operating. Hence, the ordinary commuter had to depend mainly on buses for commuting to their destinations. However, the private bus owners initially refused to resume bus services from June 1-3, 2020 even after the lockdown was lifted from June 1, 2020, in order to negotiate for a fare hike in consideration of cost increase. Although, private buses resumed service from June 3, 2020, they were operating only 30 percent of their usual capacity, as is evident from Figure 1. We include a dummy variable for private buses operating with operation period as one and otherwise zero. This allows to capture the massive supply constraint of public transport caused by private buses not being operational from March 25, to June 3, 2020.

Figure 1. *Access to Public Transport Availability before and after Lifting the Lockdown*
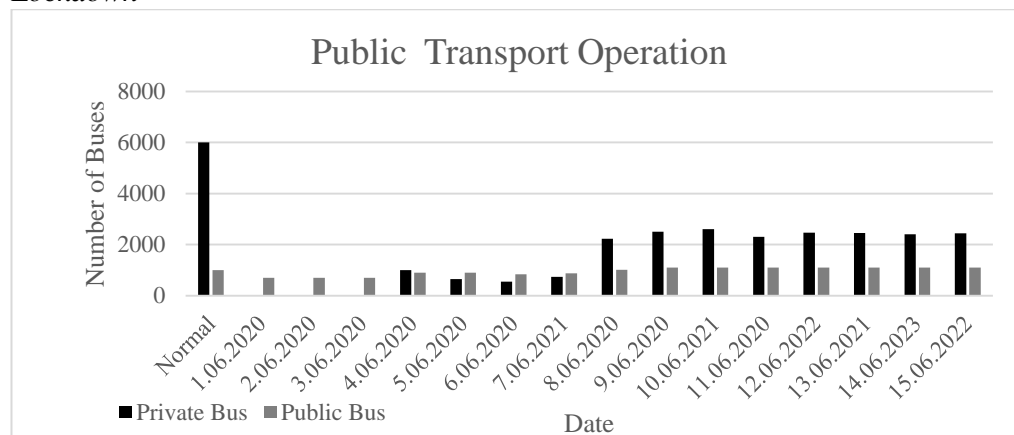
Source: Assorted Issues of Anandabazar Patrika (2020).

With respect to the public transport supply constraint the commuters were experiencing, the West Bengal government introduced a dual shift for government employees, to reallocate the demand of public transport from peak to slack period. To capture this dual shift, we use a dummy variable whose value equals one for time period June 11, 2020 onwards and zero otherwise. We also include a dummy variable to differentiate the travel behavior between weekdays and weekend, with weekends equal to one and zero otherwise.

As shown in Table 2, the average APP cab fare in Kolkata increased by 5 percent after the lifting of lockdown in comparison to the pre-COVID-19 period, when transport availability was normal. Approximately 85 percent of the private buses were operating before lockdown, compared to only 71 percent after lockdown was lifted.

However, as seen in Figure 1, there was a significant drop in the number of buses operating and only 30 percent of the normal scenario were available to commuters. After the lockdown was lifted, additional weekend days were taken into account in the sample data. We also observe that before lockdown there was no dual shift, but after lifting lockdown, in approximately 50 percent of the cases, the government employees could opt for dual shift to perform their duties.

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Table 2. *Comparison of Average APP Cab Fare before and after Lockdown*

	Before Lifting Lockdown	**After Lifting Lockdown**
Average Cab Fare	304 (77)	319 (85)
Private Bus Operation Dummy **Private Bus operation=1, otherwise=0**	0.857 (0.351)	0.714 (0.453)
Weekends Dummy **Weekends=1, Weekday=0**	0.143 (0.351)	0.286 (0.453)
Dual Shift of Government Jobs Dummy **Dual Shift=1, otherwise=0**	0 (0)	0.429 (0.497)
Number of active COVID-19 cases	132	1450
Observations	147	147

Source: Based on Authors' Calculation of App Cab Fare Data. The standard errors are mentioned in parentheses.

Results and Analysis

The results of the study in hand are presented in this section both graphically and analytically.

Graphical Analysis

Figure 2 is a graphical representation of the average app cab fare before lockdown was imposed and after lockdown was lifted in 2020. In the first panel and number of active COVID-19 cases in the second panel. As the regular cab services were not available from March 25 to -May 31, 2020 during the central lockdown, there is a gap in the data. It is evident that there is a discrete jump in the average app cab fare to Rs. 319 from Rs. 302 after the lockdown in comparison to before the lockdown. Interestingly, it is observed that during the pre-lockdown stage there is an increase in the demand for APP cabs, which is reflected in the cab fare. This is coinciding with the first positive case of COVID-19 diagnosed in Kolkata on March 16, 2020. Further, the volatility in the fare has increased after the COVID-19 in comparison to the normal period before imposition of the lockdown.

The second panel depicts the number of active COVID-19 cases in Kolkata on a daily basis. There has been an increasing trend in the COVID-19 cases after the lifting of lockdown. Although, Kolkata had already seen few COVID-19 cases before imposition of the lockdown, due to range of scale, it is not depicted visually here.

The vertical lines represent different structural breaks that occurred and their effect on the cab fare. The first and foremost structural break was the imposition of nation-wide lockdown on all modes of transport and activities from March 25, 2020. The second structural break was in the form of lifting of lockdown from June 1, 2020. The third line depicts the partial availability of private bus transport in addition to the government buses in Kolkata from June 4, 2020. Although, in Kolkata, most of the commuters rely on private buses rather than the West Bengal

government buses, only thirty percent of the regular private buses were operating in order to negotiate for a hike in bus fare. The next structural break was in the form of reintroducing work from office for government employees from June 8, 2020. Lastly, the government employees were allowed to operate in dual shifts to ease the commute problem after lifting the lockdown from June 11, 2020.

Figure 2. *Comparison of APP Cab Fare before Imposition and after Lifting Lockdown*
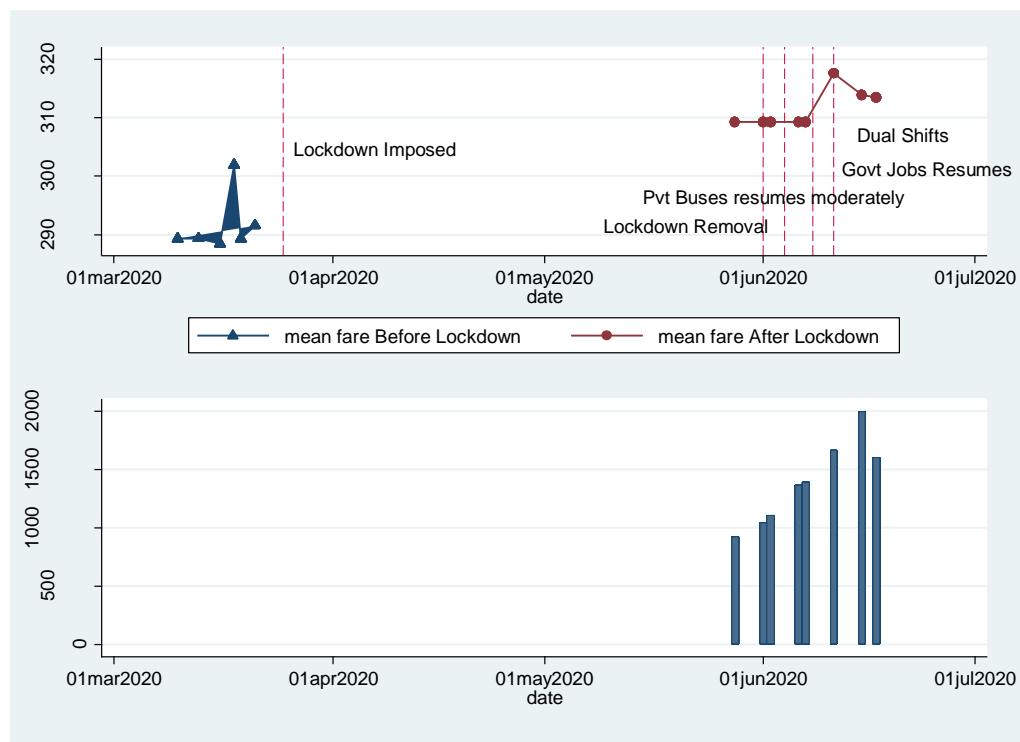
Source: Based on Corona Bulletin of West Bengal Government and Authors' Calculation of App Cab Fare Data of OLA and UBER.

Figure 3 graphically represents the average APP cab fare during the different time zones namely morning, afternoon and evening on a daily basis before the imposition of lockdown and after the initial lifting of lockdown in Kolkata. Usually, the demand for transport varies between office hours (peak period) and non-office hours (slack period). Further, with a supply constraint of public transport in the form of private buses, this would directly translate to demand for APP cabs. Here, peak office hours are in the morning and evening and the slack period is in the afternoon.

Figure 3. *Comparison of APP Cab Fare during Different Time Periods of the Day*
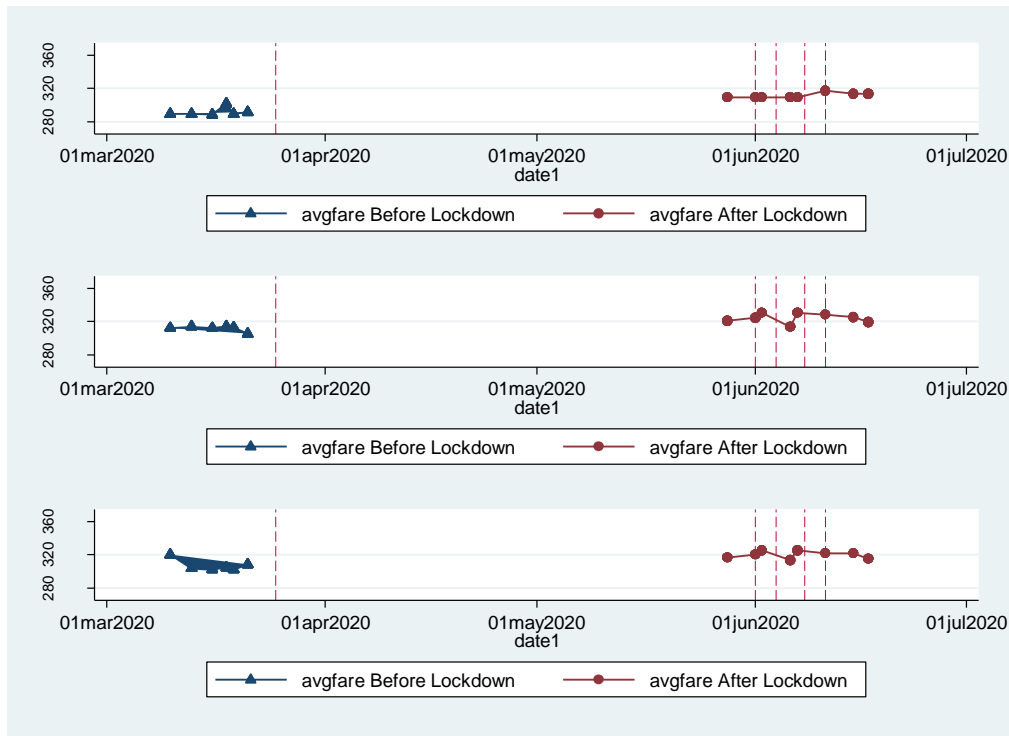
Source: Based on Authors' Calculation of App Cab Fare Data of OLA and UBER.

Few observations are worth noting from the above graphical representation of the daily average APP cab fare for various time zones of the day. Firstly, irrespective of the time of the day, there has been a hike in average cab fare in the post-lockdown stage compared to the pre-lockdown stage; however, the hike is significant mostly in the morning. Further, after the introduction of dual shifts for government employees, there has been a shift in the demand from afternoon to morning commute. This can be explained by the fact that usually the government employees have relaxed office hours compared to the private job employees and they were not penalized for late entry during this period. However, due to the introduction of dual shifts, a considerable section of these government employees had to start their shift from 9 am and the other section started their shift from 12 pm. As a result, after the introduction of the dual shifts, the demand for morning commute increased and evening commute decreased, as some of the government employees would have already completed their shift by 2:30 p.m. and left for the day. Hence, there is a surge in the morning cab fare and reduction in the evening cab fare after June 11, 2020. This indicates a reallocation of demand for transport between various time zones of the day.

Effect of COVID-19 and Public Transport Availability in Cab Search Behavior

The existing literature on transport has found a shift in preferences from public to private mode of transport for the commuters after COVID-19 in many countries. Empirical studies (Paul et al. 2022, Meena 2020) found that low-income

commuters from developing countries are still dependent on public transport to sustain their livelihood, besides choosing cycling or walking. Due to unavailability of real time travel data of private transport like personal cars, bikes or bicycles in this study, we consider the demand for APP cabs as a proxy for private transport preferences. Interestingly, Paul et al. (2022) found that the demand for online cab services and taxis increased in our neighboring country Bangladesh in the post-COVID-19 period. The objective of the study is to analyze whether online cab-service in the post-COVID-19 period is used by commuters as a safer mode of transport or a compulsion due to lack of adequate public transport. In the former case, there would be an increase in demand for online cab services even after controlling for public transport availability, whereas in the latter case, the demand for online cab services would reduce after controlling for public transport availability. In Kolkata city, approximately 60 lakh commuters depend mainly on private buses compared to public buses, which are few. However, private buses were plying only 30 percent of their capacity during the study period. Further, other modes of public transport like local trains and metros were not available for the public commuters during the study period to restrict the spread of virus. Hence, this allows us to consider the travel choice of commuters under public transport constraint.

In Table 3, comparing columns 1 and 2, we find that there is a significant effect of number of active COVID-19 cases and lockdown on the cab fare initially. The coefficient from the interaction of active COVID-19 cases and lockdown lifting dummy indicates that if there is an additional increase of active COVID-19 cases by 100, then the online cab fare would increase by Rs. 1 in the post-lockdown period. However, column 2 depicts that the driving force behind the demand for online cab is not social distancing due to fear of COVID-19, but insufficient public transport availability as captured by the private bus operation dummy. If the private buses are operational, then it leads to an additional Rs 4 reduction in cab fares as the private buses are a substitute for private cabs. It is driven mainly by the evening rush hours when there is a huge shortage of buses compared to the demand (Anandabazar Patrika 2020). The provision of private buses causes an additional Rs.12 reduction in cab fares. As is evident from columns 3, 4 and 5, respectively, during the weekend, people are demanding less cabs compared to the weekdays when they have the compulsion to travel to work. Weekends may require less traveling in comparison to weekdays, due to which the cab fare reduces by Rs3-5.

Table 3. *Driving Force behind Surge of Cab Fare after Lifting of Lockdown*

	Column1	Column2	Column3	Column4	Column5
	All Day	**All Day**	**Morning (8-9:30a.m.)**	**Afternoon (12:30p.m.-2p.m.)**	**Evening (5p.m.-6:30p.m.)**
Number of Active COVID-19 Cases	0.013** (0.005)	0.008 (0.006)	0.017 (0.013)	0.009 (0.009)	0.0007 (0.0081)
Lockdown Removal Dummy	15.636** (-5.158)	6.567 (7.016)	15.323 (16.776)	12.222 (9.791)	-7.843 (8.966)
Active Cases*Lockdown Removal	-0.014** (0.005)	-0.004 (0.008)	-0.018 (0.018)	-0.006 (0.010)	0.013 (0.010)
Private Bus Operation Dummy	-	-4.329* (2.175)	2.043 (2.537)	-2.390 (3.974)	-12.640** (2.648)
Weekend	-2.087** (0.927)	-0.634 (1.708)	-3.340* (1.614)	-3.857** (0.860)	5.295** (1.473)
Trend Effect	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	294	294	98	98	98
Methodology	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect

Note: **, * Significant at 5% and 10 % confidence level, respectively. The robust standard errors are mentioned in parentheses.

The above results indicate that in the post-lockdown period, commuters choose cabs not as a means of social distancing but due to unavailability of public transport. Especially during peak periods (evening and morning), when public transport is limited, the impact on cab fare is significant. Further, on weekends, when traveling is not compulsory, there is a significant reduction in cab fares.

However, till now, we have ignored the commuter's capacity to choose the time of travel to go to work. In the following section, we will study the effect of the introduction of dual shifts for government employees on online cab service usage.

Effect of Dual Shift of Government Jobs in Shifting Transport Demand

Keeping in view the availability of public transport, private buses were operating only at 30 percent of their full capacity, the Government of West Bengal introduced a dual shift for government employees from June 11, 2020. The morning shift allowed employees to function from 9a.m. to 2:30p.m., and the afternoon shift operated from 12p.m. to 5:30p.m. (Anandabazar Patrika 2020). The purpose of the dual shift was to reallocate the commuter demand for transport and reduce the load on public transport. The result of the analysis of dual shift on APP cab demand is provided in Table 4.

Table 4. *Effect of Dual Shift Introduction on Peak Price Loading of APP Cab Fare*

	Column1	Column2	Column3	Column4	Column5
	All Day	**All Day**	**Morning (8-9:30a.m.)**	**Afternoon (12:30p.m.-2p.m.)**	**Evening (5p.m.-6:30p.m.)**
Number of Active COVID-19 Cases	0.008 (0.006)	0.008 (0.005)	0.018 (0.012)	0.007 (0.009)	0.001 (0.008)
Lockdown Removal Dummy	6.567 (7.016)	3.519 (6.127)	18.595 (12.971)	0.453 (8.032)	-8.491 (9.685)
Active Cases*Lockdown Removal	-0.004 (0.008)	-0.001 (0.007)	-0.021 (0.014)	0.004 (0.009)	0.013 (0.010)
Private Buses Operation Dummy	-4.329* (2.175)	-3.908 (2.281)	1.591 (2.820)	-0.764 (4.280)	-12.551** (2.802)
Weekend	-0.634 (1.708)	-1.859 (1.708)	-2.024 (2.679)	-8.588** (1.581)	5.034* (2.082)
Dual Shift of Government Jobs Dummy	-	-2.938 2.307	3.154 (5.027)	-11.342** (2.597)	-0.625 (1.910)
Trend Effect	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	294	294	98	98	98
Methodology	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect

Note: ** Significant at 5% * Significant at 10% confidence level. The standard errors are mentioned in parentheses.

Comparing columns 1 and 2 of Table 4, we observe that after incorporating the dual shift dummy for government employees, the private buses are no longer acting as a driving force behind app cab fare determination. In other words, the dependency on private bus operation has been considerably reduced for afternoon commuters. After introduction of dual shift for the government employees, cab fare for the average afternoon cab commuter decreased by Rs. 11 or 3 percentage compared to the base fare. However, private bus operations continue to have an impact on cab preference in the evening rush hour, and consequently, the fare. Cab fare reduces significantly by Rs 12 when private buses are operational as opposed to not operational. This is because a smaller number of private buses were operational in the evening than in the morning. This shows that the state government was successful in transferring some of the demand from peak period to off-peak period by introducing dual shift for government employees.

The study so far has considered regional uniformity in availability of public transport. However, usually, not all sections of the city have similar access to public transport. Keeping this in view, we use a natural shock, closure of Tala Bridge for reconstruction in Kolkata that created additional barriers for commuters to access public transport. In the following section, we study the effect of infrastructure blockage on cab fare.

Effect of Infrastructure Blockage on Transport Demand

Infrastructural blockage creates a major problem in commuting and accessing public transport. In a city, not every location may have similar access to public transport during a pandemic. Alemi et al. (2018) found that usage of online cab services depends on regional accessibility by cars. In this study, we use a natural infrastructural shock of Tala bridge closure in north Kolkata for reconstruction purpose from February 2020 to September 2022, to study the impact of infrastructure blockage on transport demand for online cabs services. The commuters in northern parts of Kolkata had been severely affected by the closure of Tala Bridge from February 2020 and unavailability of public transport (Anandabazar Patrika 2020). Under normal circumstances, commuters in northern Kolkata depended on local train and metro for commuting regularly after closure of Tala Bridge for reconstruction. However, after lifting of lockdown, due to metro and local trains not being operational, commuters in this area of the city became dependent on either buses or private transport for regular commuting. In the following section, we segregate the zones of study into those affected by Tala Bridge closure (treatment) and those not affected by Tala Bridge closure (control). In our sample, three zones were affected by Tala bridge closure, and the remaining four zones were not affected by it (refer to Appendix). The result of the analysis is summarized in Table 5.

Table 5. *Effect of Tala Bridge Inaccessibility and Dual Shift on APP Cab Fare*

	Tala Bridge Affected Zones			Tala Bridge Not Affected Zones		
	Coulmn1	Coulmn2	Coulmn3	Coulmn4	Coulmn5	Coulmn6
	Morning (8-9:30a.m)	Afternoon (12:30p.m.-2p.m.)	Evening (5p.m.-6:30p.m)	Morning (8-9:30a.m)	Afternoon (12:30p.m.-2p.m.)	Evening (5p.m.-6:30p.m)
Number of Active COVID-19 Cases	0.002 (0.010)	0.003 (0.009)	0.003 (0.010)	0.013^{**} (0.006)	0.012^{*} (0.007)	0.013^{*} (0.007)
Lockdown Removal Dummy	-6.868 (12.683)	-3.486 (10.645)	-3.545 (10.625)	13.427^{**} (4.356)	8.948 (7.435)	8.817 (7.404)
Active Cases*Lockdown Removal	0.010 (0.013)	0.007 (0.012)	0.007 (0.012)	-0.011^{**} (0.005)	-0.007 (0.008)	-0.007 (0.008)
Private Buses Operation Dummy	-9.373^{**} (3.115)	-8.810^{**} (3.370)	-7.995^{*} (4.294)	-1.924 (1.320)	-2.670^{*} (1.425)	-0.842 (2.209)
Dual Shift of Government Jobs Dummy	-	1.505 (3.014)	0.077 (5.078)	-	-1.993 (1.877)	-5.199^{**} (1.504)
Weekend Dummy	-	-	-1.086 (3.426)	-	-	-2.439 (1.753)
Trend Effect	Controlled	Controlled	Controlled	Controlled	Controlled	Controlled
Observations	126	126	126	168	168	168
Methodology	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect	Fixed Effect

Note: ** Significant at 5%; * Significant at 10% confidence level. The standard errors are mentioned in parentheses.

As we move from column 1 to 6 of Table 5, the effect of Tala Bridge closure and dual shift is apparent. Firstly, comparing the column 1 and Column 3, we find that the infrastructure blockage is creating major dependency on private bus operation, consequently decreasing the cab fare by Rs 9 in the treatment zones and Rs 2 in the control zones. This is because when infrastructure blockage affects public transport availability, private cabs may increase their fare. Further, dual

shift for government employees has an opposite impact on the treatment zones in comparison to the control zones with respect to private bus operation. Following the introduction of dual shift, private bus operation in comparison to non-operation causes surge in cab fares in the affected areas. However, in the non-affected areas, it is successful in transferring public transport demand and reducing the fares. A potential reason may be that due to infrastructure blockage, public bus accessibility is constrained, reducing the ability to transfer the demand to public transport successfully. Lastly, we find that the number of COVID-19 cases does influence the surge in APP cab fares in treatment areas, compared to the control zones. A possible explanation is that easy accessibility by cars can increase usage of online cab service, leading to increase in cab fare.

Discussion

The purpose of the study was to empirically examine the possibility of online cab service becoming a viable option in a developing country context, following COVID-19, where the lower income commuters cannot afford private cars. The study tried to analyze impact of COVID-19 and public transport constraints on online cab travel choice cab fare, using potential trip information for Kolkata city, India. We considered potential cab trip fares before and after the city was locked down on account of COVID-19 across various locations. We used a fixed effect panel methodology for capturing the attributes of the longitudinal data and to control unobserved location disturbances. We also tried to capture the dual shift of jobs and infrastructure blockage on cab fares.

The modeling outcomes demonstrated the public transport supply constraint was more important in app cab fare determination than the shift in preference to individual transport caused by fear of COVID-19. The key findings are summarized below (i) public transport availability, especially private bus transport plays an important role in online cab fare determination, (ii) dual shifts of jobs are successful in reducing pressure on transport demand and reallocating transport demand during various times of the day, (iii) preference for social-distancing to prevent COVID-19 in the form of personal transport over collective transport is more feasible in scenarios with no infrastructure problem, causing smaller surge in fares, (iv) infrastructure blockage reduces the effectiveness of dual shifts of jobs in reallocating transport demand and usage of online cab services and (v) fare is reduced substantially during weekends and due to dual shifts of jobs.

This study indicates that although social distancing is essential to curb the spread of pandemic, lower income commuters depend on public transport for commuting. There is a high proportion of captive users in Kolkata. Especially, in developing countries like India, where people depend mainly on public transport for commute, imposition of social distancing without adequate public transport would be a failure and only lead to harassment of regular commuters. Hence, planning of adequate availability of public transport along with social distancing would be effective to curb the pandemic. This is similar to the strategy proposed by Asian Development Bank (Asian Development Bank Report 2020, Asian

Development Bank Policy Brief 2022) to encourage use of public transport by enhancing the existing system and implementing new initiatives as a long-term sustainable solution to the urban transport problem in a developing country context. Further, dual shifts of jobs are an effective policy measure, which the government can adopt to transfer the transport demand and prevent the spread of pandemics. Also, this study assesses how a regular commuter benefits from private bus operations. Approximately, there is a decrease of Rs. 5 in cab fare occurs in general due to operation of private buses as opposed to their non-operation. The government can use this data to set a benchmark for hike in private bus fares while negotiating with private bus owners.

Conclusion

This is the first study to attempt an evaluation of the impact of public transport on online cab services in a developing country context, following COVID-19, especially for low income commuters, who mainly depend on public transport. It also tries to highlight the public transport supply constraint following the initial lifting of COVID-19 lockdown. Although these studies reveal the effectiveness of public transport in low-income countries, where people are restricted by income to avail public transport, it suffers from some limitations. The first limitation is that the actual transport trip data of cabs and private and public buses is not included in this study due to lack of availability. The second limitation is the inability to examine the actual number of public transport buses because the data was not officially available. The third limitation of the study is that it cannot capture the effect of other modes of transport like cycling, bikes and walking, which have gained importance following the pandemic and will have an effect on the online cab fare.

The study demonstrates that online cab services can substitute public transport, even in a metropolitan city like Kolkata with good accessibility, where most commuters are captive users with low income. This is in contrast to the findings of Hall et al. (2018). In metros like Bangalore and Mumbai, where commuters have higher income and public transport like local trains or metros acts as lifeline of the cities, online cab service can act as a substitute for public transport. However, it needs to be studied separately as an area of future potential research.

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Appendix

A1. *Segregating Zones Affected due to Tala Bridge Closure*

Zones	Distance (in km)	Tala Bridge Closure
MAIDAN - PARK STREET	5	Unaffected
BOTANICAL GARDEN - BENIAPUKUR	7	Unaffected
BENGAL CHEMICAL - TOPSIA	9	Unaffected
LAKE TOWN - BOSEPUKUR	12	Affected
DAKHINESWAR - SANTOSHPUR	15	Affected
BELGHORIA - SHAKUNTALA PARK	18	Affected
JOKA - KAMALGACCHI MORE	21	Unaffected