Bus boarding trends in the West Midlands Combined Authority during the COVID-19 pandemic

Authors

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1. Summary

This report compares bus boarding patterns before and during the period of the pandemic, specifically the years 2019 and 2020. About 195m transactions pertaining to 675k cardholders captured on SWIFT cards have been analysed. The results indicate different patterns associated with sociodemographic and geographic context, and by extension, suggest different degrees of dependence on bus services. An overall finding includes that the unequal bus patronage across socio-demographic and economic context remained throughout the pandemic and have become amplified as patronage rates recover. Specifically, we found that patterns in relation to

- Gender: Men travelled more than women through the lockdowns and the pandemic
- Ethnicity:
    - Black and Asian cardholders travelled more than white cardholders
    - Recovery of patronage by white cardholders is much slower compared to other ethnic groups
- Location:
    - Decline in boardings more pronounced in rural areas
    - Differential decline by deprivation deciles
    - Slower recovery of boarding rates in more affluent areas
- Groups that are more vulnerable to ill-health continued travelling by bus throughout the pandemic

Overall, the well-known social gradients in bus patronage remained intact throughout the lockdowns in a context of lower overall trip rates. The unequal recovery of patronage between groups may be concerning as it may indicate a trend towards stronger social selectivity and stratification of mode use in the region.

2. Data

The data consisted of 195,186,003 transactions and 846,158 cardholders. Of these cardholders, 674,910 made at least one transaction over the 5 year study period. Table 1 shows the number of transactions and the number of 'active' cardholders, i.e. cardholders that made at least one transaction, for each year of the study period.

Table 1 Total number of transactions and active users

Year	Transactions	Active users
2016	48,359,978	377,345
2017	45,330,130	383,184
2018	42,429,853	302,111
2019	40,455,836	297,713

2020	18,610,157	244,995

The cardholder data also contained the date of birth, gender and ethnicity of cardholders. Date of birth was aggregated into 5-year age bands and ethnicity was aggregated into 5 categories (white, black, Asian, mixed and other) to ensure analyses were easily interpretable. Tables 2 to 4 show the age, gender and ethnicity distributions of the older concessionary cardholders.

Table 2 Age counts and distributions of older concessionary cardholders

Age group	Count	Percentage
66-70	161,257	19.1
71-75	231,030	27.4
76-80	187,051	22.2
81-85	140,569	16.7
>85	122,444	14.5

Table 3 Gender counts and distributions of older concessionary cardholders

Gender	Count	Percentage
Male	370,000	43.7
Female	433,708	51.3
NA	42,450	5.0

Table 4 Ethnic groups counts and distributions of older concessionary cardholders

Ethnic group	Count	Percentage
White	631,918	74.7
Asian	61,125	7.2
Black	24,961	2.9
Mixed	2,512	0.3
Other	18,404	2.2
NA	107,238	12.7

The distributions of age, gender and ethnicity show that the majority of cardholders were aged between 71 and 80 and of a white ethnic background. There were also around 7.6% more female cardholders than male. A number of records were missing some of this demographic information. For analyses that utilise these data, these cardholders were excluded.

3. Temporal Trends

3.1 Weekly boardings

We compare 2019 with 2020 boarding volumes and rates to understand the impact that COVID-19 – and subsequent lockdowns and restrictions – on travel in the WMCA. Figure 1 shows the total number of weekly boardings by older concessionary travellers in both 2019 and 2020. COVID-19 lockdowns and restrictions are highlighted, with red indicating a full lockdown, orange indicating tight restrictions and yellow indicating periods of more relaxed restrictions. Table 5 shows the dates covered by these restrictions.
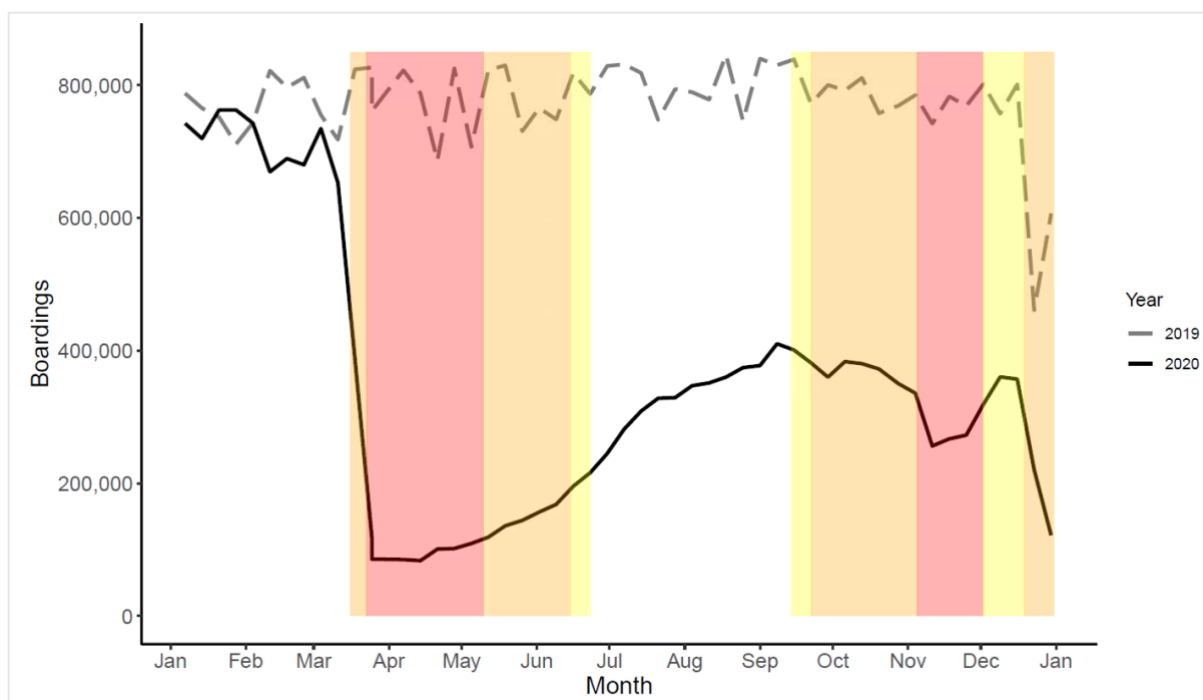
Figure 1 Weekly bus boardings by older concessionary travellers in the West Midlands with 2020 COVID-19 lockdowns and restrictions highlighted

Figure 1 shows a significant reduction in the total number of weekly boarding volumes towards the end of March 2020, which coincides with the introduction of the first lockdown in England. Whilst boarding volumes remained low during the first lockdown, they increased relatively rapidly once restrictions were eased. Despite this, at their peak in September, boarding volumes still remained at only around 50% of their 2019 levels. The reduction in boarding volumes with an increase in restrictions is also clear in October and November.

Table 5 Dates of restrictions and lockdowns

	1st	2nd	3rd	4th
Full lockdown (red)	23/03/2020 – 10/05/2020	05/11/2020 – 02/12/2020		
Tight restrictions (orange)	16/03/2020 – 22/03/2020	11/05/2020 – 15/06/2020	23/09/2020 – 05/11/2020	20/12/2020 – 31/12/2020
Relaxed restrictions (yellow)	16/06/2020 – 23/06/2020	14/09/2020 – 22/09/2020	03/12/2020 – 19/12/2020	

The trends varied by demographic groups. To account for the variations in demographics shown in Tables 2 to 4, the following figures show the average number of weekly boardings per cardholder, i.e. the total number of boardings were divided by the number of cardholders in each demographic group.
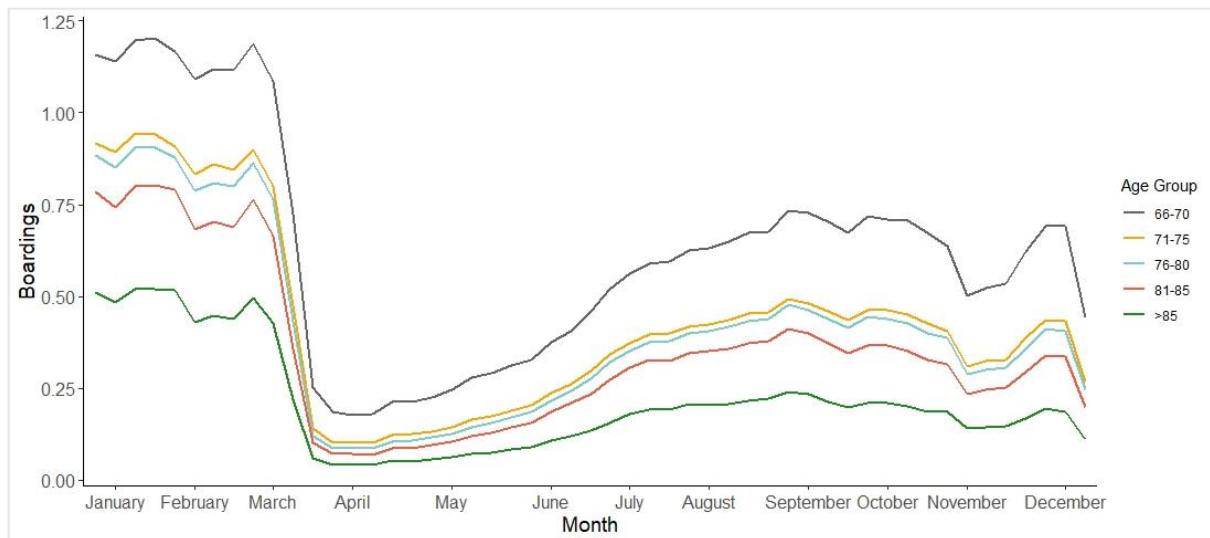
Figure 2 Average weekly boardings per cardholder in 2020, 5-year age bands

Figure 2 shows the average boardings per week per cardholders in each 5-year **age** group in 2020. Breaking down the weekly bus boardings by age group shows that the general trends for each age group were similar, with boarding rates decreasing during lockdown periods and increasing when restrictions were eased. Boarding rates were higher for the youngest age group (66-70) and lowest for the oldest age group (>85). This is due to there likely being a higher proportion of cardholders that are still employed, and therefore may still be commuting, in the younger age groups. The rate at which boarding volumes increased once restrictions were eased over the summer months was also greater for the youngest age group, suggesting that younger cardholders were more willing or able to return to public transport. These younger age groups were also more likely to have had a lower proportion of vulnerable adults, which would also contribute to this trend.
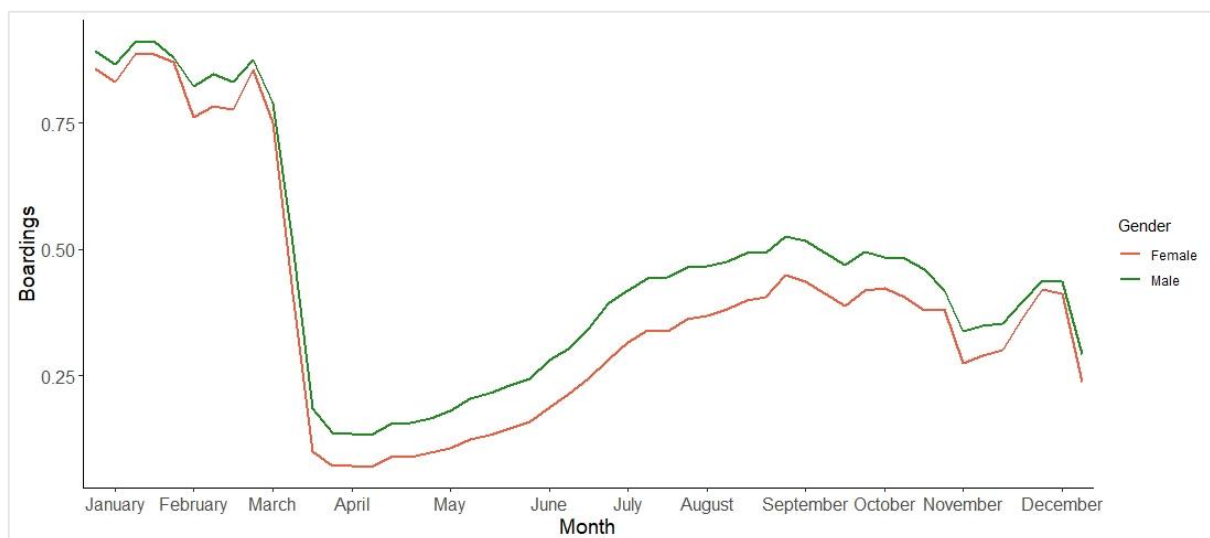

Figure 3 Average weekly boarding volumes by male and female cardholders in 2020

Figure 3 shows the average number of weekly boardings by **gender**, i.e. male and female cardholders in 2020. Cardholders with no recorded gender were excluded from this analysis. Pre-lockdown, male and female cardholders made a similar number of weekly boarding volumes, albeit male cardholders generally made marginally more per week. However, during the first lockdown period the average number of weekly boarding volumes made by female cardholders dropped to a lower level than male cardholders. Similarly to age group, this may be due to a higher proportion of male cardholders still being in employment and therefore commuting using public transport. Boarding volumes by female cardholders remained lower than male once restrictions eased, however there is evidence that towards the end of 2020 this difference had reduced to pre-lockdown levels.
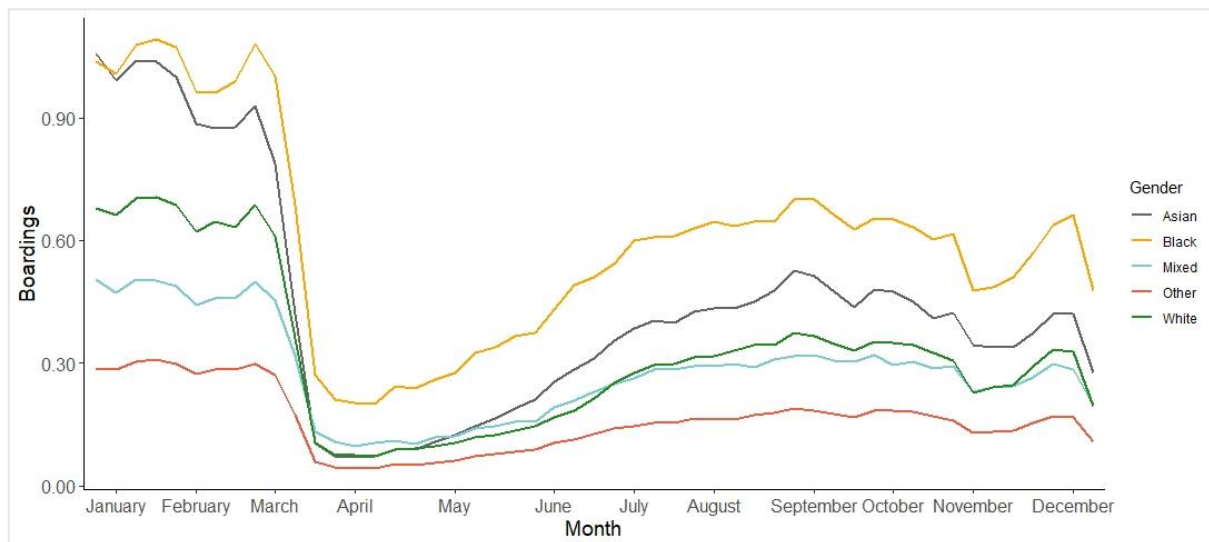

Figure 4 Average weekly boarding volumes per cardholder in 2020, ethnic group

Figure 4 shows the average number of weekly boarding volumes made by cardholders in each **ethnic group** in 2020. Cardholders with no recorded ethnicity were excluded from this analysis. Pre-lockdown, cardholders from black and Asian ethnic backgrounds made the highest number of weekly boarding volumes, followed by cardholders from white, mixed and other ethnic backgrounds. Despite a similar number of weekly boarding rates pre-lockdown, boardings made by cardholders from an Asian ethnic background reduced to a much lower level than those made by cardholders from a black ethnic background during the first lockdown period. This suggests that cardholders from a black ethnic background were more likely than other cardholders to keep using public transport during the pandemic. Boardings made by cardholders from white and mixed ethnic backgrounds decreased to similar levels during the first lockdown and remained similar throughout the remainder of 2020 despite white cardholders making more boardings pre-lockdown. This may suggest greater hesitancy by white cardholders to return to using public transport. Cardholders from 'other' ethnic backgrounds made the fewest weekly boardings both pre-lockdown and throughout the rest of 2020.

3.2 Hourly bus boardings

In addition to weekly bus boardings, the average number of boardings per hour over weekends and weekdays were explored. Like previous analyses, these trends were broken down by demographics. However, as the trends were similar across all demographic groups the total hourly boardings are presented in Figure 5, and the minor differences that were evident between groups discussed. To compare differences between the first and second lockdown, shown in Figures 1, these analyses compare boarding volumes in both April and November 2019 and 2020.
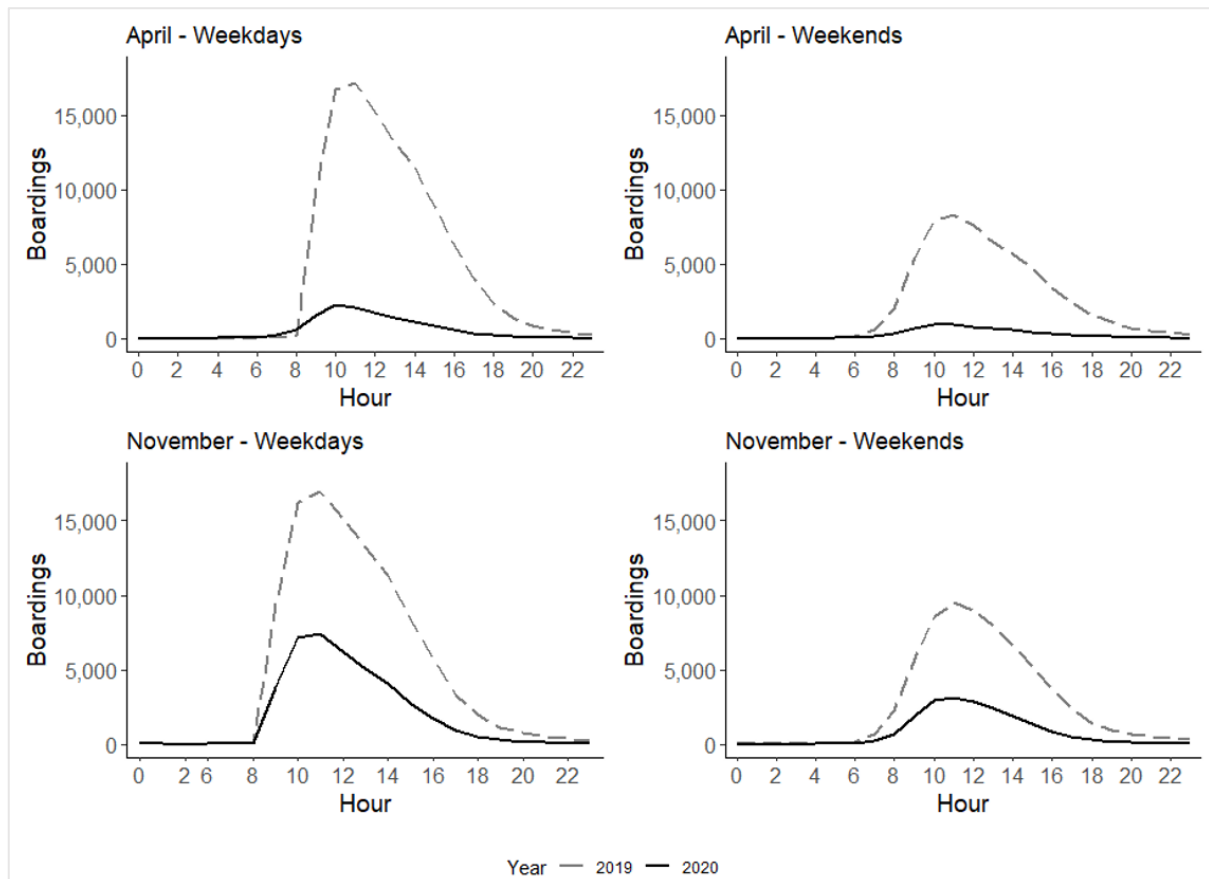

Figure 5 Average hourly boardings for both weekdays and weekends in April and November 2019 and 2020

Figure 5 shows that the general temporal trends were similar across both April and November and weekdays and weekends. Boardings tended to peak between 10am – 12pm before declining over the rest of the day. As the majority of cardholders would have been retired, the lack of a morning or evening peak would be expected. It is also clear that boardings were significantly lower in 2020 than they were in 2019. This was particularly evident during the first lockdown period in April. Compared to April, the average number of hourly boardings in November were greater, in particular for weekdays.

Analysing the demographic breakdowns of these trends showed that the general temporal trends were similar across all demographic groups, with a peak in boardings between 10am to 12pm. In terms of age, boardings decreased during April 2020 to very low levels for all age groups. Younger age groups (66-70 and 71-75) made the most boardings in general, with boardings also increasing the most in November 2020 compared to April 2020. This suggests that younger cardholders were more likely to return to public transport when restrictions eased and could be due to a proportion of these cardholders still being in work and therefore commuting via public transport.

Comparing average hourly boardings between male and female cardholders showed very little difference. As shown in Figure 5, during the first lockdown in April 2020, hourly boardings dropped significantly from their 2019 levels during both weekdays and weekends. There was less of a decrease in boardings during the second lockdown, in particular during weekdays.

In terms of demographics, the biggest differences were evident between ethnic groups. As expected, boardings during the first lockdown period dropped significantly lower than their 2019 levels for all ethnic groups, however remained slightly higher for cardholders from black and mixed ethnic backgrounds. During the second lockdown periods boardings increased, however still remained significantly below their 2019 levels. Boardings were the highest during weekdays and for cardholders from black and mixed ethnic backgrounds. Comparing boardings to 2019, these remained slightly lower for white and Asian cardholders compared to other ethnicities.

4. Geographical patterns in bus patronage

The data also contained the registered postcode of each cardholder. This allowed for the transaction data to be both plotted and joined to other spatial data to further explore the temporal trends.

4.1 Boarding trends by neighbourhood (LSOA)

This section looks at the general spatial boarding patterns in terms of cardholders' registered home locations. Postcodes were aggregated to LSOA level and the total number of boardings made by cardholders residing in each LSOA calculated for both April and November 2019 and 2020. The percentage difference between 2019 and 2020 boardings were then plotted.
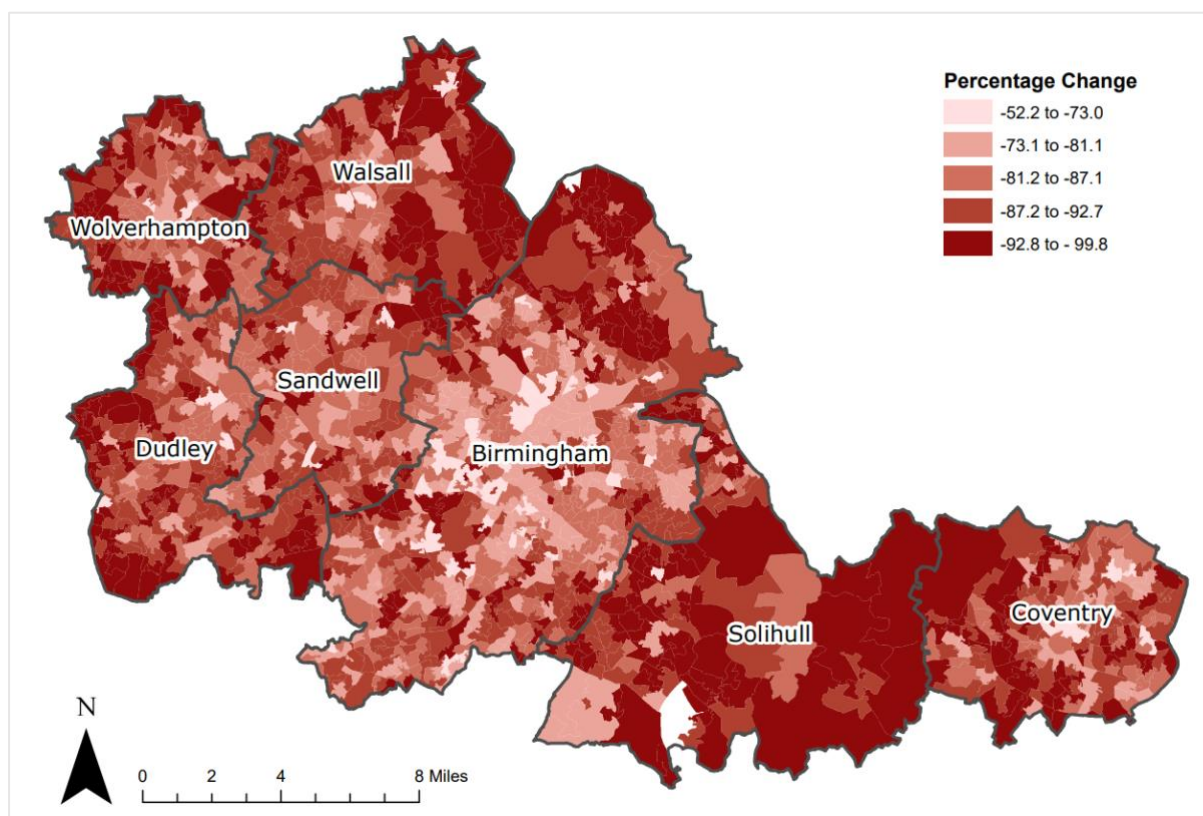
Figure 6 Percentage change in boardings between April 2019 and April 2020 at LSOA level
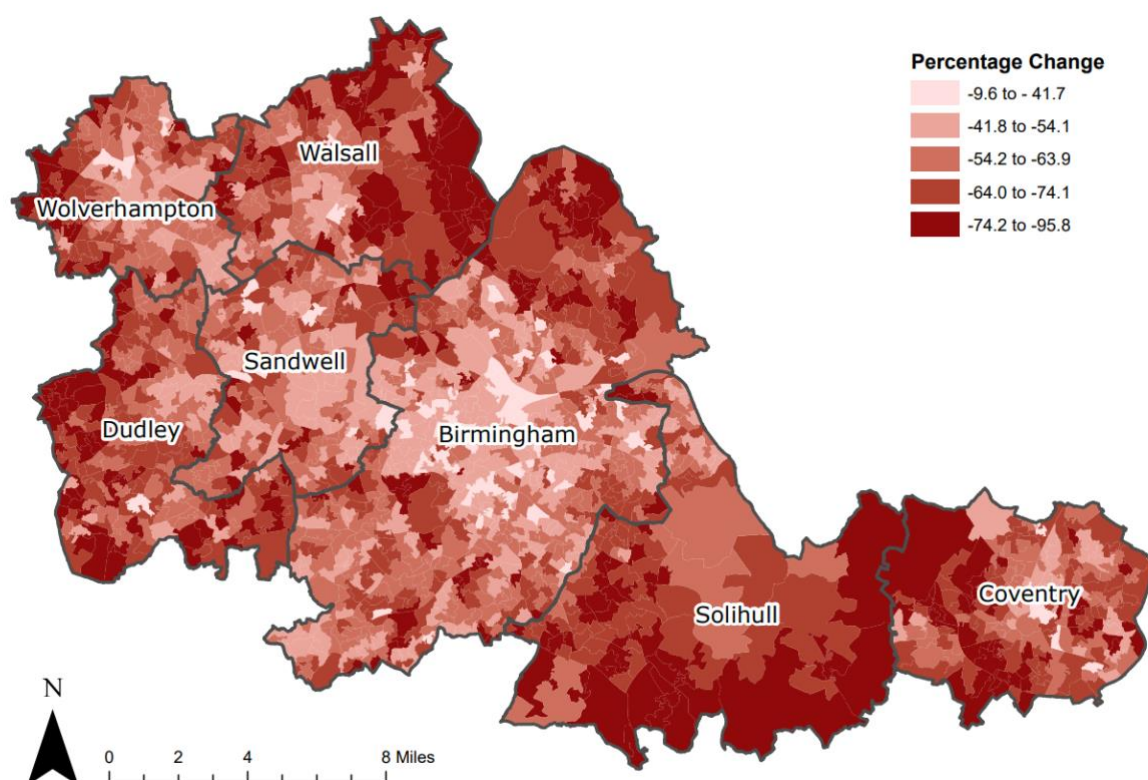

Figure 7 Percentage change in boardings between November 2019 and November 2020 at LSOA level

Figures 6 and 7 show a uniform decline in boardings compared to 2019 levels across the WMCA during both the first and second lockdown periods. During the first lockdown, boarding volumes declined significantly throughout the study area, with a minimum decrease of 52% and a maximum of 100%. This decline was less significant in the majority of areas during the second lockdown, with a minimum of 10% and a maximum of 96%. Rural and suburban locations, including the large green belt area between Birmingham and Coventry, experienced the largest declines with central urban areas experiencing the smallest. As these plots show boardings made by residents of each LSOA, these patterns are likely due to cardholders residing in more rural areas being more likely to be car owners and therefore less reliant on public transport. These areas are also generally more affluent and may have a higher proportion of cardholders that are not in employment or are able to work from home. Section 4.3 explores these patterns further in terms of deprivation.

4.2 Boarding trends by bus route

Transactions made by cardholders could be joined to the routes on which they took place to give an idea of demand during the COVID-19 pandemic for different services and how this differed from demand during the same periods in 2019. Although the joining of transactions to routes was generally successful, there were some missing data for April 2020. Where this is likely to have impacted the results, this is noted.
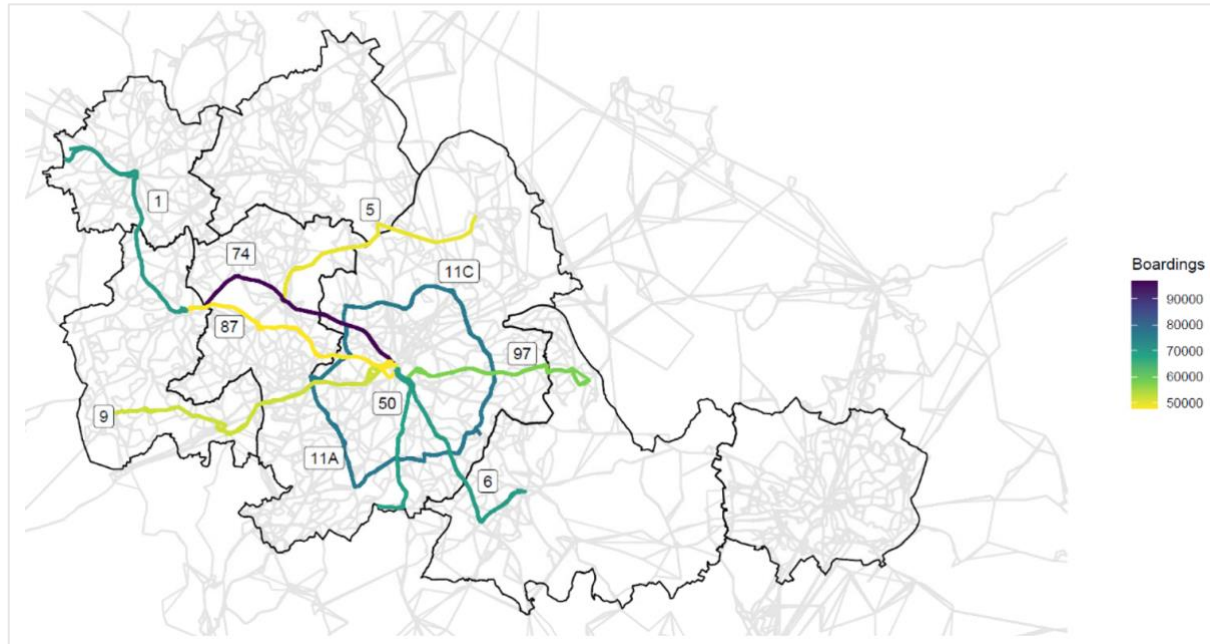

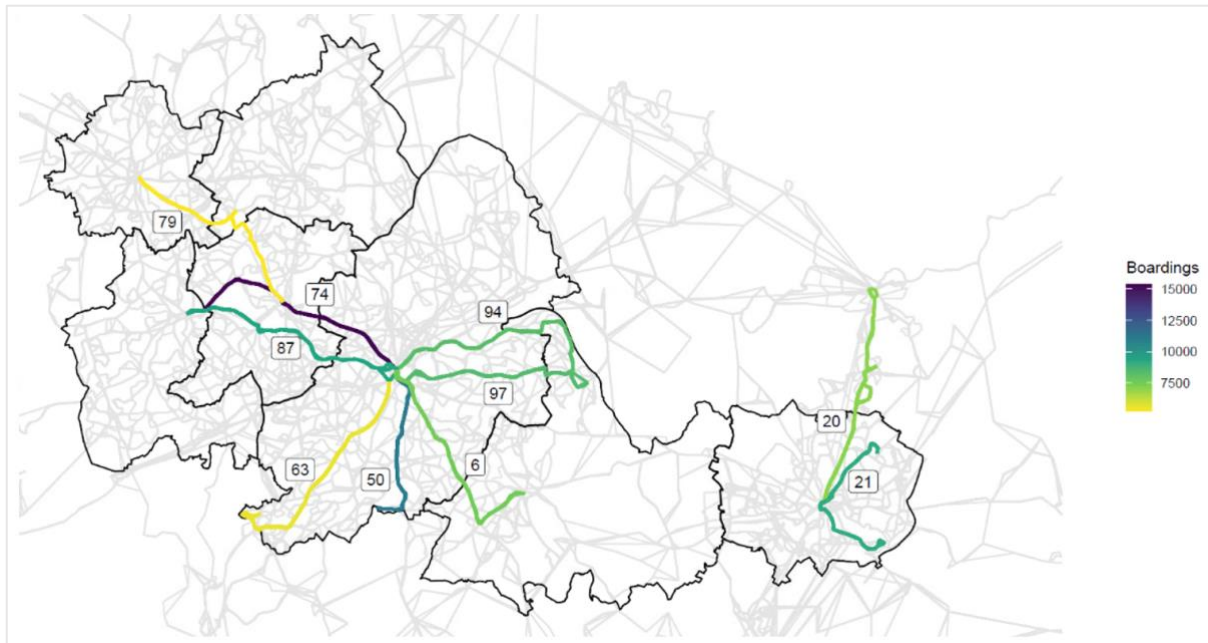**Figure 8a** Top 10 routes by total boardings for April 2019

Figure 8b Top 10 routes by total boardings for April 2020

Figures 8a and 8b show the 10 routes with the highest total number of boardings in April 2019 and April 2020. Figure 8a shows that in 2019, route 74 was the busiest, with over 90,000 boardings during April. This was also the busiest route in April 2020, however the total number of boardings decreased to around 15,000. This route runs between Dudley and central Birmingham and therefore suggests that there was still a high demand for this service during the first COVID-19 lockdown. Likewise, route 87, which also runs between Dudley and Birmingham, had a high number of boardings during both 2019 and 2020. Routes 6, 50 and 97 were also in the trop 10 routes in terms of total number of boardings in both April 2019 and 2020 and all run into central Birmingham. Unlike April 2019, routes 20 and 21 had a high number of boardings in 2020. These services run into central Coventry and show a higher demand relative to other routes. Comparing April 2019 to 2020 shows a general trend of high demand into central urban areas during this first COVID-19 lockdown period. It should be noted that there was missing data for routes 1, 11A and 11C for April 2020 and therefore these may also have had a high number of boardings as seen in April 2019.
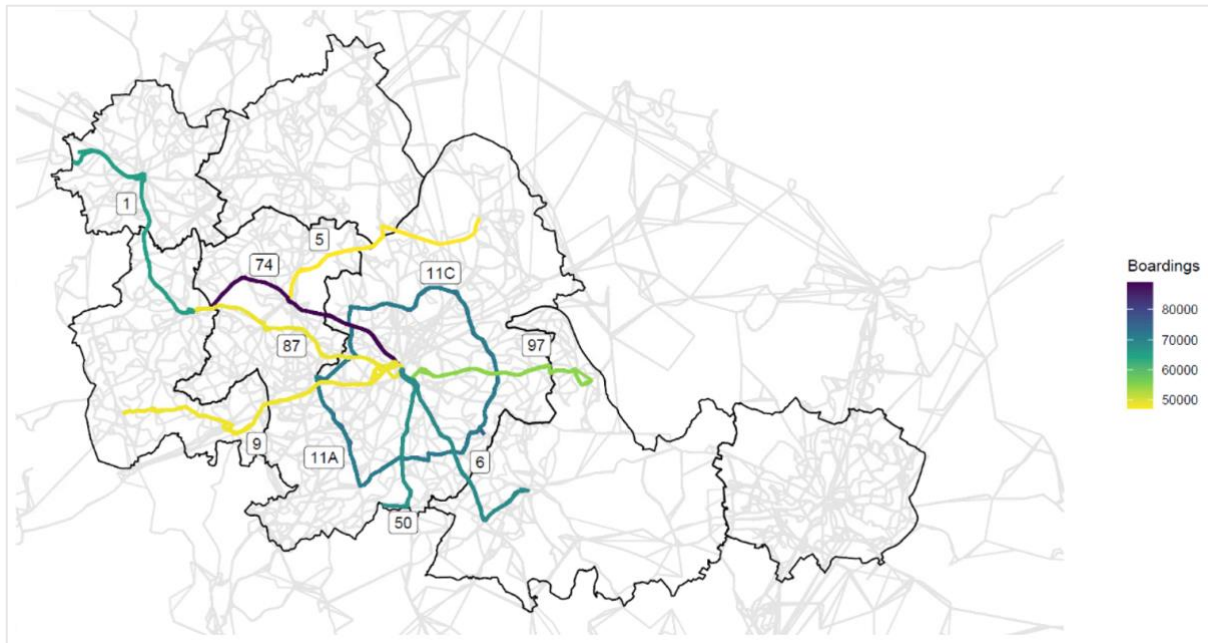
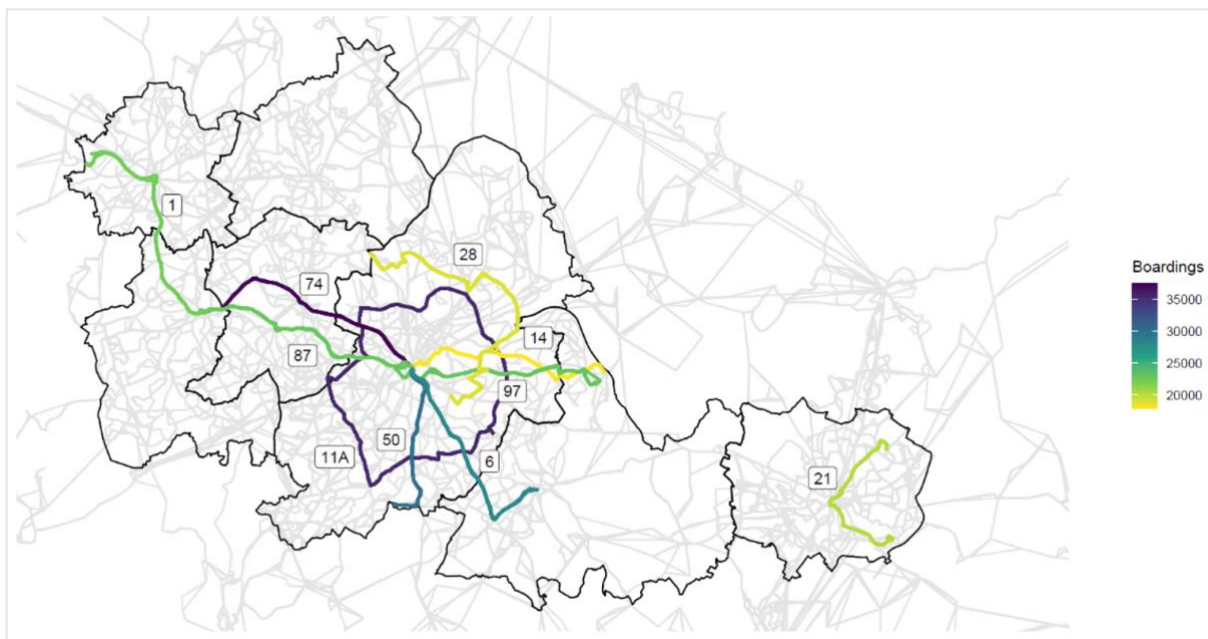**Figure 9a** Top 10 routes by total boarding volumes for November 2019

Figure 9b Top 10 routes by total boarding volumes for November 2020

Figures 9a and 9b show the 10 routes with the highest total number of boardings in November 2019 and November 2020. These figures therefore show demand during the second lockdown period and allow for a comparison to Figure 8 to understand differences between the first and second lockdowns in terms of travel patterns and demand. Like Figure 8, the majority of the busiest routes ran into central Birmingham during both 2019 and 2020. Route 21, running into central Coventry, also had a high number of boardings during both the first and second lockdowns whereas boardings were lower relative to other routes during 2019.

Figure 10a Top 10 routes by maximum percentage change in boarding volumes between April 2019 and 2020
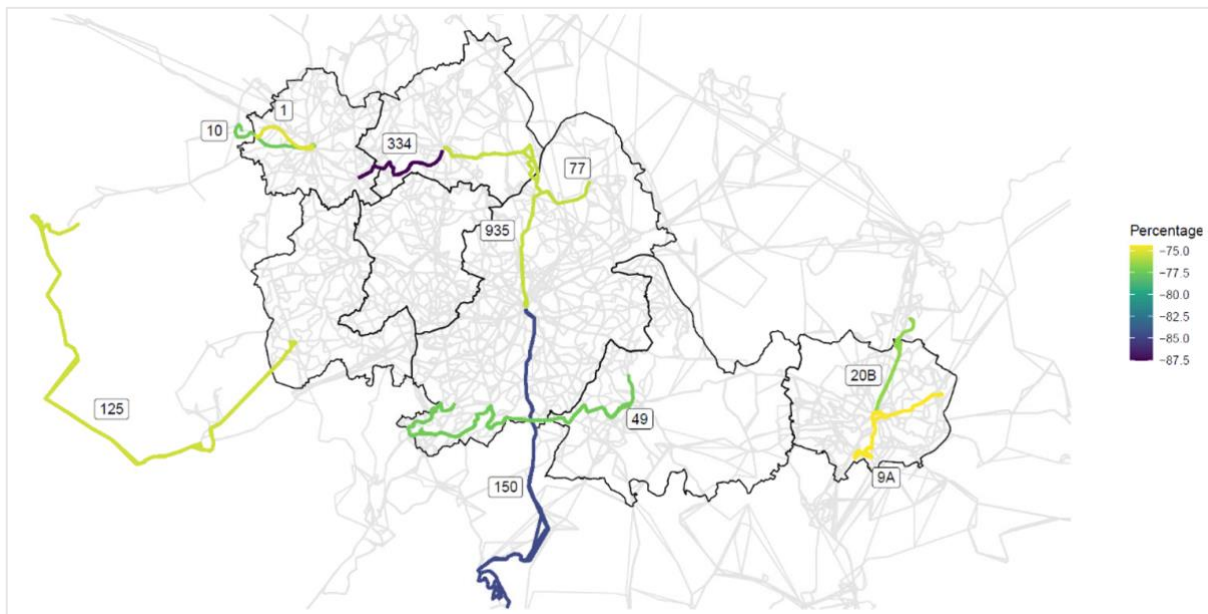

Figure 10 Top 10 routes by maximum percentage change in boarding volumes between November 2019 and 2020

Figures 10a and 10b show the 10 routes that experienced the greatest percentage change in boardings between April 2019 and April 2020 (Figure 10a) and November 2019 and November 2020 (Figure 10b). Only routes with total monthly boardings of >5,000 in 2019 were included in these analyses to exclude routes with a low number of total boardings but a high percentage change. Both figures show that the routes with the greatest percentage change all experienced a reduction in 2020 compared to 2019, which would be expected due to the lockdowns and restrictions in place during the 2020 periods. However, comparing the figures shows that there was a larger percentage decrease in boardings during the first lockdown period. Figure 10a also shows that a number of routes that experienced the greatest decrease in April 2020 were located in Coventry. Route 125, which runs

from outside the West Midlands Combined Authority area in Stourbridge, experienced a large percentage decrease in boardings in both April and November 2020. In comparison to Figure 9, fewer routes that services central Birmingham experienced a large percentage decrease in boardings, suggesting demand for services in this area remained high during both lockdown periods.
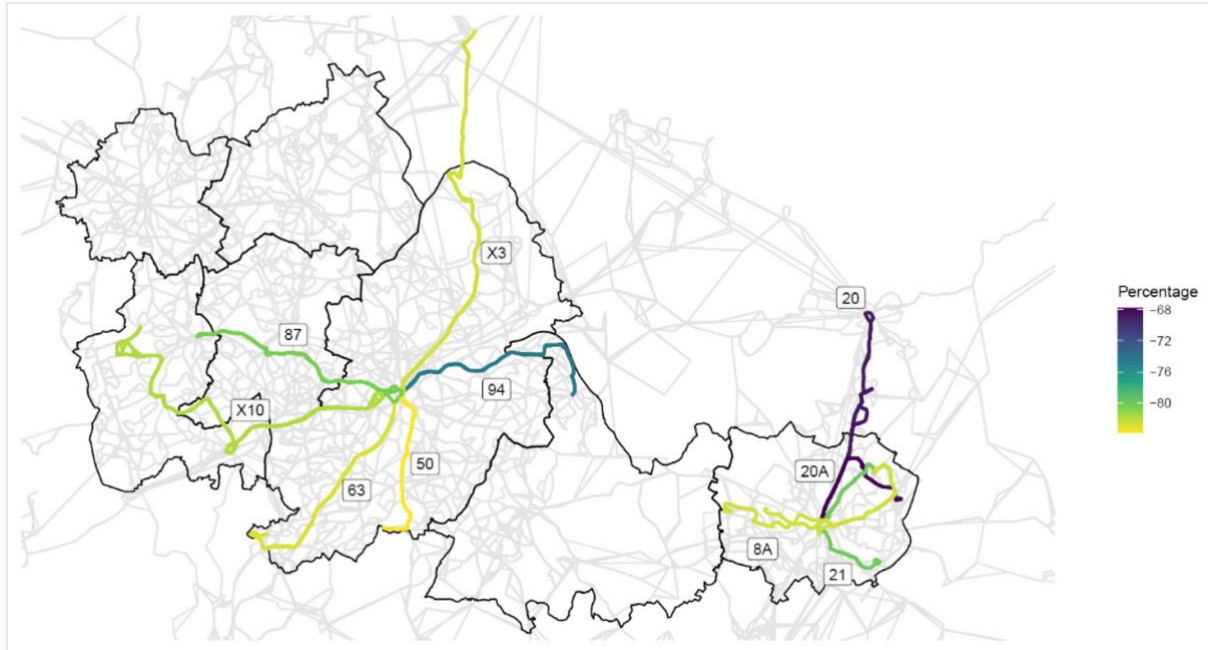

Figure 11a Top 10 routes by minimum percentage change in boarding volumes between April 2019 and 2020.
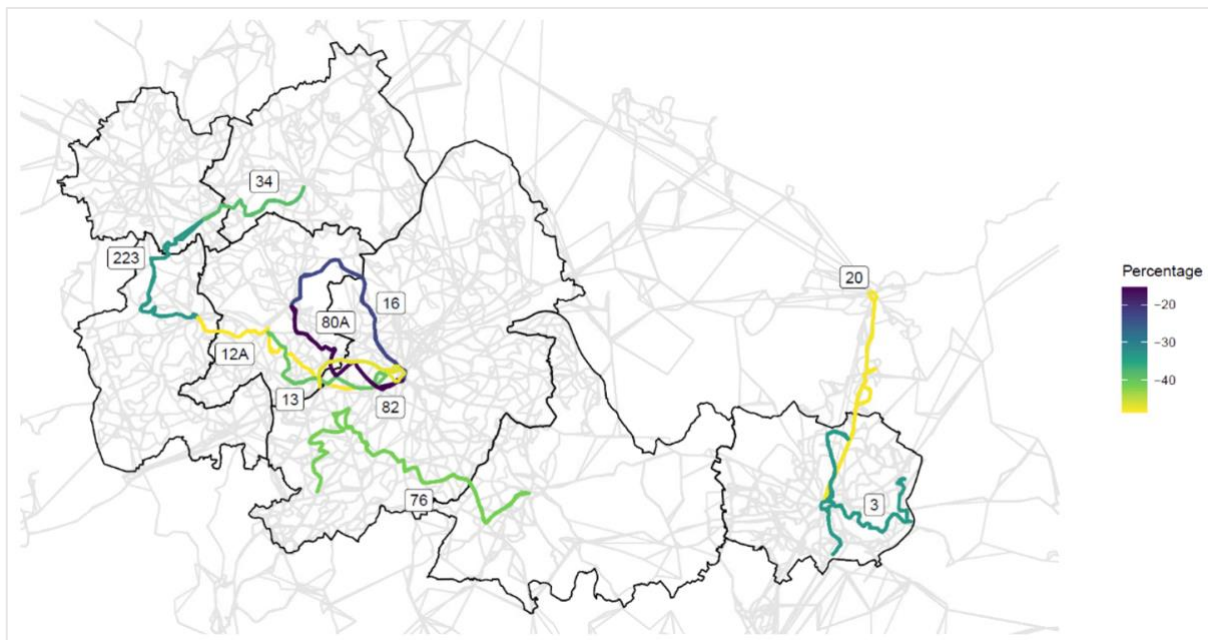

Figure 11b Top 10 routes by minimum percentage change in boarding volumes between November 2019 and 2020.

Figures 11a and 11b show the 10 routes that experienced the minimum percentage change in 2020 compared to 2019 for April and November. These figures therefore show the routes that did not experience as large of a decline in demand as the other routes in the WMCA. Figure 11a clearly shows that during the first lockdown period services into central Birmingham and central Coventry remained in high demand. Similar trends can be seen in the second lockdown period, with the majority of routes servicing Birmingham and Coventry, in addition to routes in and around Solihull, Dudley, Sandwell and Walsall.

4.3 Trends by neighbourhood deciles of income deprivation affecting older people

The Income Deprivation Affecting Older People Index (IDAOPI)[1] is a subset of the Income Deprivation Domain in the Index of Multiple Deprivation (IMD)[2]. This index is based on the percentage of the 60 plus population who receive income support, income based jobs seekers allowance, pension credit or child tax credit. It therefore gives an indication of deprivation specifically for the older population.
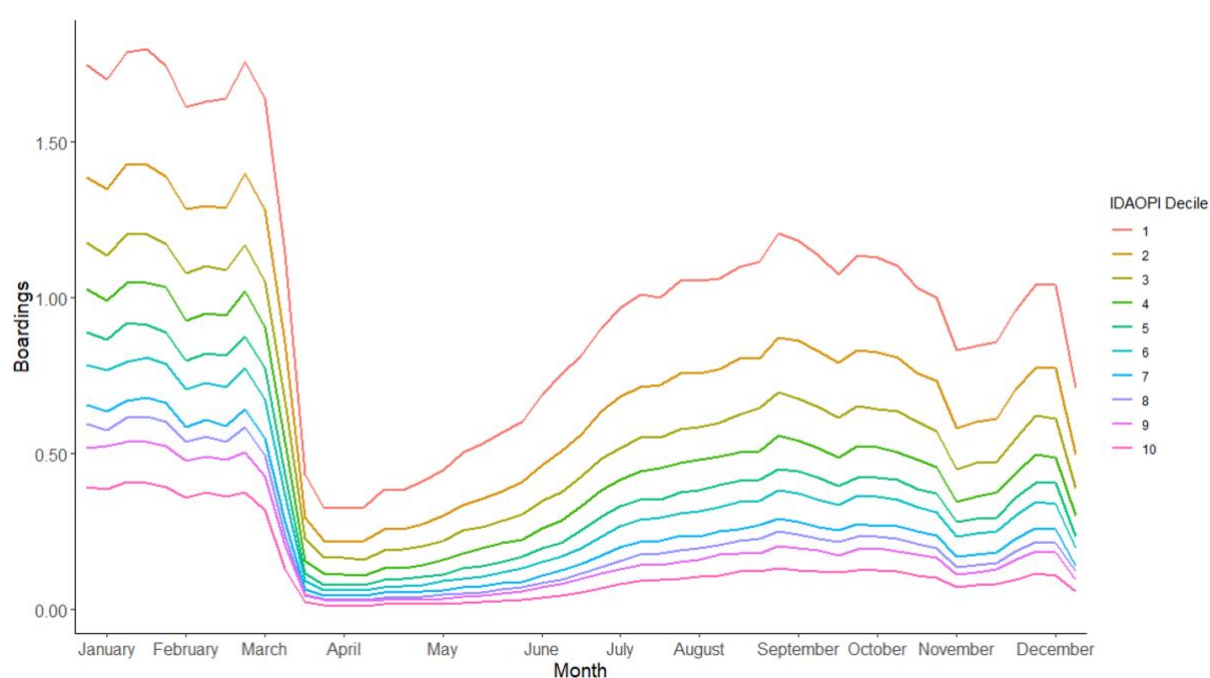

Figure 12 Average weekly bus boardings per cardholder – IDAOPI decile (1 = most deprived, 10 = least deprived)

To explore how deprivation is related to boarding patterns, IDAOPI data was joined to the transaction data, with the number of weekly boardings per cardholders in each IDAOPI decile calculated. Figure 12 shows a clear gradient, with cardholders residing in the most deprived areas making more

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[1] https://opendatacommunities.org/resource?uri=http%3A%2F%2Fopendatacommunities.org%2Fdef%2Fconcept%2Fgeneral-concepts%2Fimd%2Fidaopi

[2] https://www.gov.uk/guidance/english-indices-of-deprivation-2019-mapping-resources

boardings per week on average than those in the least deprived areas. The boarding levels during the first lockdown period and the subsequent increase once restrictions had eased were also higher for cardholders residing in more deprived areas. This trend suggests that these cardholders were more likely to rely on bus services and may have been less likely to have access to private transport and less able to use other modes, such as taxis, than those that reside in the least deprived areas.

Whilst Figure 12 presents a very clear trend, it is important to account for other factors when interpreting this. The most deprived areas in the WMCA were generally located in central urban areas, and therefore more likely to have access to efficient public transport services which would therefore reduce the need for a car, regardless of deprivation level. Figure 13 shows the distribution of IDAOPI deciles in the West Midlands.
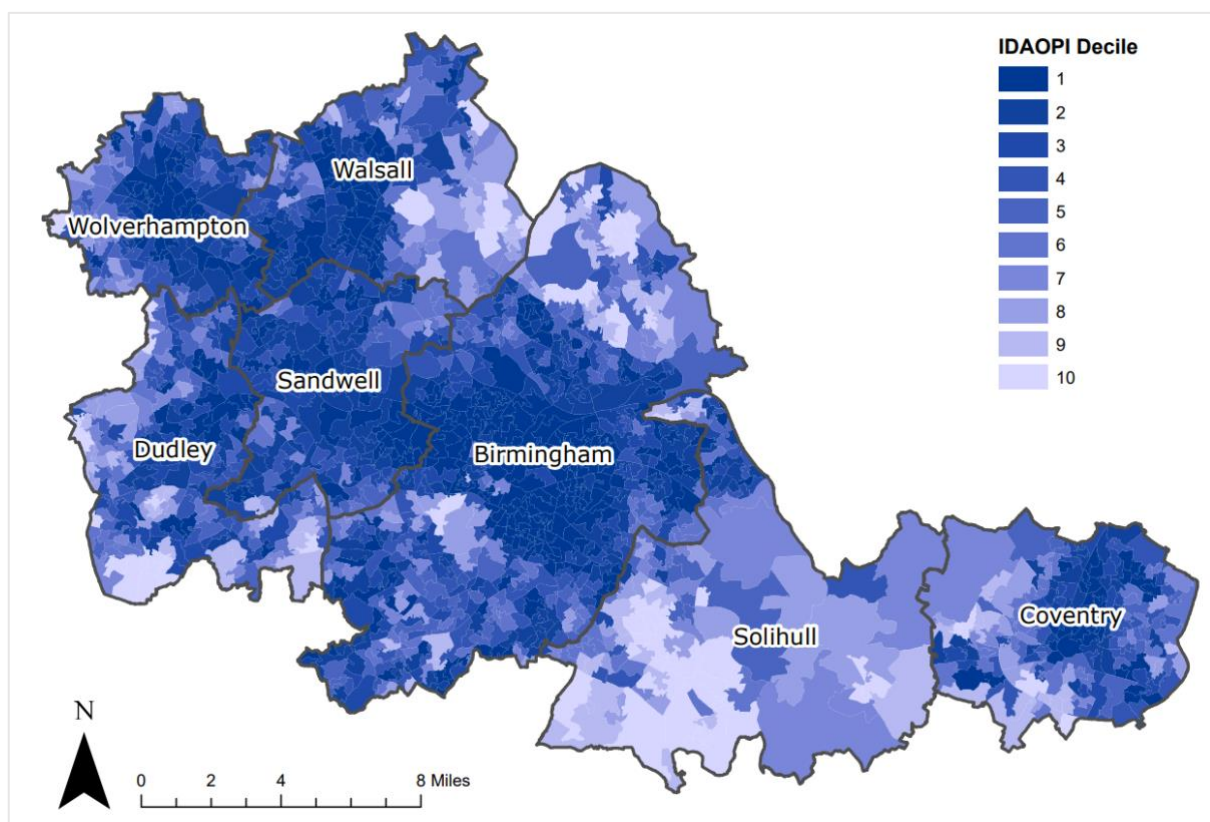

Figure 13 IDAOPI deciles at LSOA level (2019)

To understand differences in the boarding trends between urban, suburban and rural areas, weekly boarding rates were broken down by population density. In this context, population density was used as a proxy for how urban, and therefore likely to have better public transport access, each LSOA was. Population density was divided into 3 classes using the Jenks natural breaks classification method: low, moderate and high density. Weekly boarding rates made by cardholders within each population density class was then plotted to account for how urban and well-connected these areas are. Figure 14 shows population density in the WMCA, and Figure 15 shows the average number of weekly boardings made by cardholders residing in each population density class.
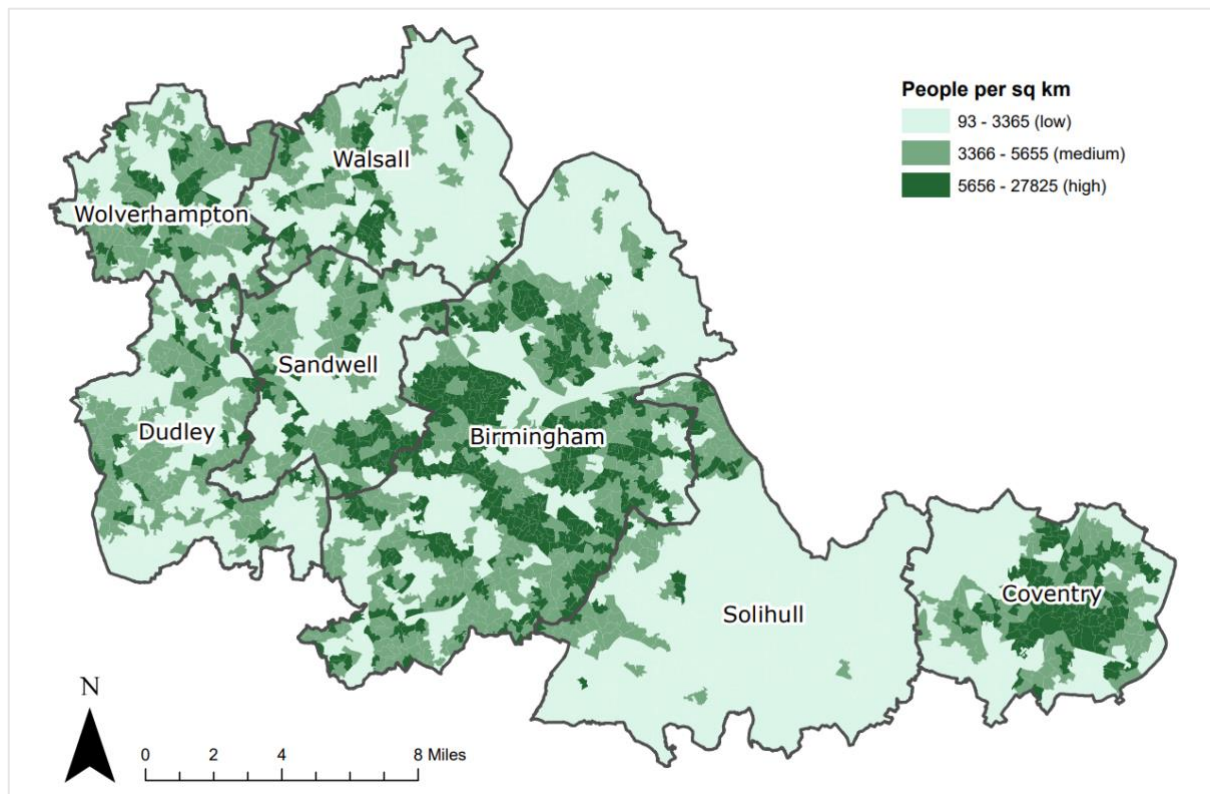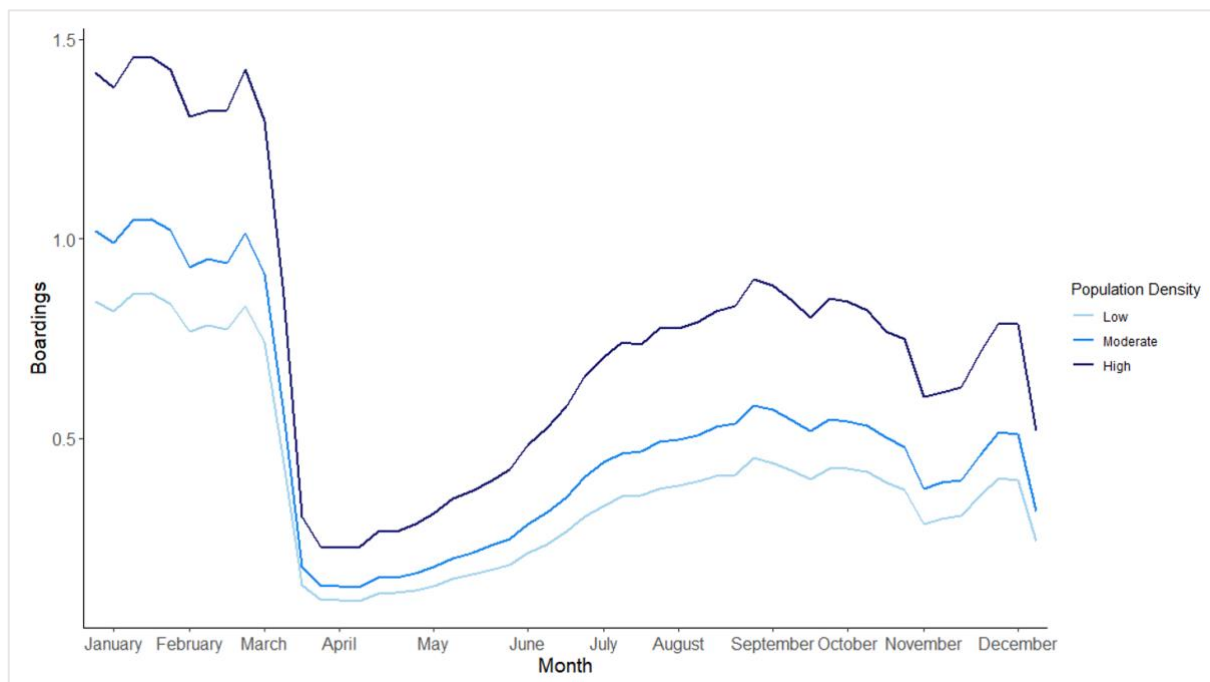
Figure 14 Population density at LSOA level (2019)

Figure 15 Average weekly bus boardings per cardholder in low (93-3,365 people per m^2), moderate (3,366-5,655 people per m^2) and high (5,655-27,825 people per m^2) population density areas

As expected, the areas with the highest population densities were located in and around central urban areas. However, the most central areas had lower population densities due to the higher number of commercial rather than residential buildings. Still, population density was deemed to be an appropriate proxy for centrality.

There was a clear relationship between population density, and therefore how urban an area could be deemed, and the average number of weekly boardings per cardholder. Cardholders residing in areas with higher population densities generally made significantly more weekly boardings than those in lower density areas. Whilst the general temporal boarding patterns over 2020 followed the same trend, boarding rates by cardholders residing in high population density areas remained higher during lockdown periods and recovered at a quicker rate once restrictions eased than those residing in lower population density areas. As expected, this suggests that cardholders residing in urban areas are more likely to rely on public transport and less likely to have access to private transport modes.

5. Conclusions

Bus boardings decreased significantly throughout the WMCA during 2020, particularly during the first lockdown period. This decrease was most significant for older cardholders, female cardholders and those from a non-black ethnic background. The decline in bus patronage was greater for cardholders residing in rural and suburban areas compared to central urban areas. This is likely due to those residing in central urban areas being less likely to have access to private transport modes.

Before additional restrictions and a further lockdown were introduced later in the year, there was evidence that boardings were steadily increasing. This increase in boardings was generally greater for younger cardholders, male cardholders and those from a black ethnic background. This suggests that these groups were either more willing to use public transport services throughout the pandemic of were constrained in their mode choice and therefore had to use bus services out of necessity.

Although total monthly boarding volumes decreased in 2020 compared to 2019, the busiest routes were similar between all study periods. While all routes experienced a decline in boardings in April and November 2020 compared to 2019, demand for some routes remained higher than for others. These routes were primarily those servicing central Birmingham and central Coventry, whereas demand for more peripheral routes generally experienced more significant declines in demand.

Cardholders residing in more deprived areas tended to take more bus journeys and were more likely to continue to use public transport throughout both lockdowns. These areas tended to be more urban and therefore were likely to have lower car ownership levels meaning cardholders in these areas may be constrained in their mode choice.

Overall, it seems that during the pandemic, well-known social and geographical inequalities in bus patronage seem be amplified and are likely to persist over a longer time. The unequal recovery of patronage between groups may be concerning as it may indicate a reinforced trend towards stronger social selectivity and stratification of mode use in the region; and thus it may present barriers in moving the region's transport system towards greater sharing as part of inclusive, healthy and more sustainable travel.