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Evidence of changes in travel behaviour after the introduction of a new transit mode: Canberra's light rail

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Abstract

This paper analyses the changes in transit ridership due to the introduction of a new mode. The investigation is based on five years (2016-2021) of transit smartcard data collected from Canberra city. Travel disruption is an opportunity to establish new travel habits. Some disruptions are experienced at the individual scale. The introduction of a new transit mode triggers the changes in existing travel behaviour and helps to form new travel habits circling around the new transit mode system. This paper looks for evidence of changes in transit ridership in terms of card ids lost, gain in card ids, changes in the total number of trips, and changes in the intensity of trips. This study found that, in a typical pre-Covid year, about 43% of card IDs are new, showing substantial year-to-year churn in riders (or at least in cards). There was an increase in ridership after the opening of Canberra Metro that is larger than the typical growth in ridership. The growth incorporates riders shifting from bus to light rail as well as card IDs that were previously unobserved. This suggests that the LRT was able to increase transit use in Canberra despite its development along an existing bus corridor. This study can help policymakers to take decisions related to introducing a new transit system and extension of the existing light rail system in busy corridors of a city.

1. Introduction

Good quality public transport is an essential part of any integrated approach to transport planning in large cities. Many communities around the world are introducing light rail transit systems to attract more travellers away from driving. Light rail transit (LRT) is the modern incarnation of trams, typically employing newer vehicles, modern technology, and less shared road use than its predecessor. These advantages are designed to attract riders who might otherwise be driving cars, and that motivates the selection of light rail over less expensive bus systems.

Previous research has debated whether an investment in light rail will be justified by cost-benefit analysis. Part of the challenge is understanding how the light rail influences travel behaviours including the switch from car or bus to light rail. Rather than simply claiming benefit from the new ridership on the LRT, the cost-benefit analysis should account for the baseline dynamics in ridership as well as attrition from the bus system and persistence of the behavioural changes. This study looks at transit smartcard evidence for ridership changes caused by the introduction of a new light rail in Canberra, Australia.

The rest of the paper is structured with subheadings of literature context in section 2, Study area and approach in section 3, results derived from the study in section 4, conclusion of the study in section 5 followed by the list of references.

2. Literature Context

Tramways in Nantes, France (1985) and Grenoble, France (1987) both achieved operating cost recovery of more than 50 per cent within two years of opening (Barry 1991). Hensher (1993) suggested that developers will be more attracted to areas serviced by a fixed track transit than to areas serviced by more flexible modes like buses, which are perceived as less permanent and reliable. Studies show that light rail contributes to reducing mode share of bus trips (Senior, 2009; Engebretsen et al, 2017). Light rail enables transit-liking people to relocate near light rail transit (Cao and Ermagun, 2017) and realise their preference. However, the light rail had no significant effects on changes in car ownership (Cao and Ermagun, 2017; Park et al, 2018) implying those travellers persist in driving.

Part of the confusion about the benefits of light rail systems is due to the time scale of the analysis. Property value benefits might be expected on a decades long time scale (Hensher, 1993), whereas some changes in behaviour can be observed immediately with the commencement of operations (Senior, 2009; Engebretsen et al, 2017). Even for the ridership changes, past studies have used light rail boardings (Senior, 2009) without accounting for how these riders were travelling before light rail. Other studies have used surveys to understand travel behaviours related to the light rail, but these surveys target users who use the lightrail. More recently, transit smartcard data has allowed researchers (John, 2002; Bonotti et al., 2015, Qisheng, 2012) to analyse the complete ridership giving a more comprehensive picture of the system. However, these datasets tend to be focused on an interval of days or weeks, which limits the establishment of before-and-after time periods and prohibits the analysis of longer-term persistent habits.

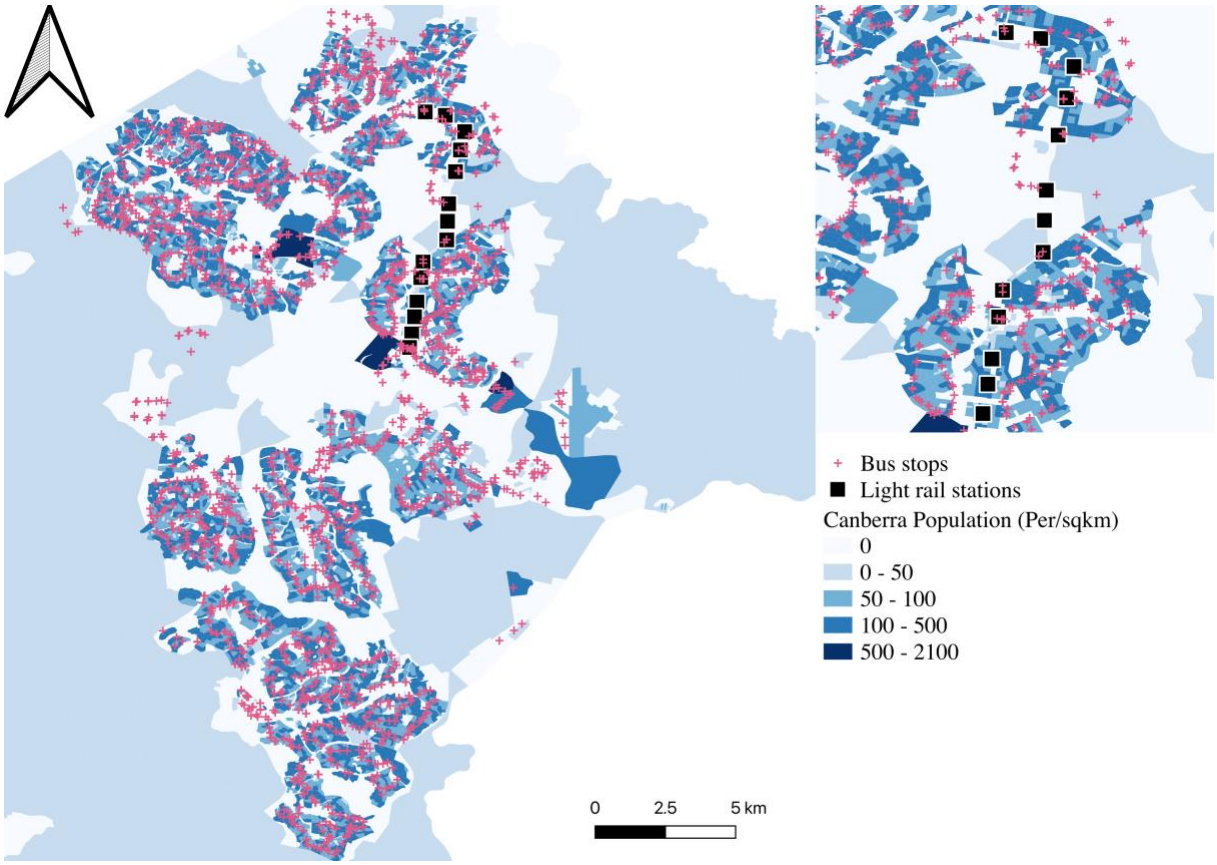
Our current study focuses on the two research questions

1. Is the introduction of light rail associated with an increase in ridership above the typical variation expected in the system?
2. How much of the light rail ridership are new riders attracted from non-transit modes compared to riders who previously used the bus?

3. Study Area and Approach

In 2019, Canberra introduced a light rail network, also known as Canberra Metro with an initial 12 km line which links the northern town centre of Gungahlin to the city center (Civic) and with 14 stops. Services commenced on 20 April 2019. This study analyses the effects on travel behaviour after the introduction of the light rail transit system in Canberra using on-board transaction data generated by MyWay card users over 5.5 years (from January 2016 to July 2021). This paper explores the effects of light rail transit on travel behavior. **Figure 1** shows the locations of bus stops and light rail stations compared to residential density in Canberra.

Figure 1: Map of bus stops and light rail stations of Canberra. Canberra is a planned city with bushland reserve (pale spaces) separating town centres. The bus network is a multi-hub-and-spoke design around town centres



4. Results

Canberra has a steady growth in population from 2016 to 2021. The number of trips drops around 2020 because of Covid-19. **Figure 2** shows the percentage change in population, active MyWay users, and the number of trips indexed to January 2016. There are strong seasonal patterns in the number of active card users and number of trips. Controlling for the seasonal patterns, there is year-on-year growth in 2016, 2017 and 2018, and the opening of the light rail is visible in 2019. These values are represented in **Error! Reference source not found.**.

Table 2 shows the number of unique card IDs, active card IDs, inactive card IDs and new addition of card IDs.

Figure 2: Population, number of trips and MyWay card users in 5 years indexed to January 2016. The population shows a stable increasing trend in 5 years. MyWay card users have a drastic increase in the year 2019 and slows down in later years.

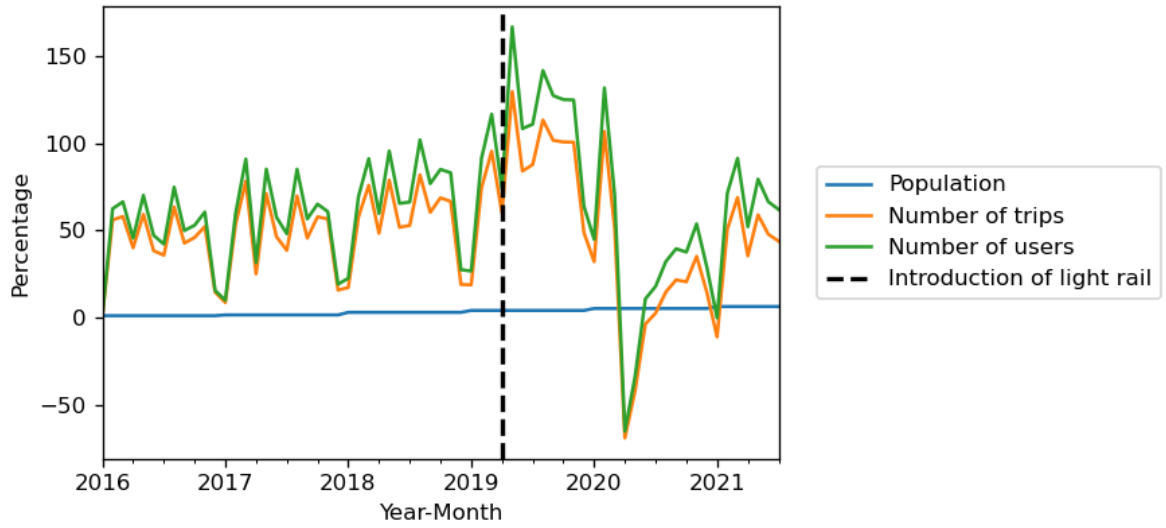


Table 1: Number of trips, Number of Population, and number of MyWay card users in 5.5 consecutive years.

Year	Number of trips	Population	MyWay User
2016	15,983,733	435,036	166,929
2017	16,549,315	441,318	182,717
2018	17,605,348	447,692	195,969
2019	20,753,876	452,497	250,495
2020	12,963,750	457,330	205,689
2021	9,314,899	462,213	175,939

Table 2: Number of unique card IDs, active card IDs, inactive card IDs and new addition of card IDs.

Year	Unique Cards	Persists from previous year	Deactivated since previous year	New since previous year
2016	166,929			
2017	182,717	101,572	65,357	81,145
2018	195,969	110,996	71,721	84,973
2019	250,495	124,949	71,020	125,546
2020	205,689	136,735	113,760	68,954
2021	175,939	116,055	89,634	59,884

In the year 2016, 166,929 active MyWay users were observed. The increase of 15,788 of active card IDs in 2017 is comprised of 81,145 card IDs not previously observed and 71,721 card IDs

that became inactive. This churn in the card population is comprised of people losing or rotating their cards, moving in or out of the area, or changing their travel habits. There were 328721 unique MyWay card IDs in the 3.5 years of data before the introduction of light rail. Starting with the introduction of the light rail in mid-2019, an additional 125,563 MyWay cards appeared in the dataset in 2019, which is substantially larger than any other year. Out of a total 563,509 MyWay card users in the dataset, 199,754 (35%) number of people make at least one light rail journey and 363,755 (65%) use only bus.

Since LRT is often built along the busiest bus corridors, some critics claim that ridership gains are dominated by trips previously taken by bus. Persistent smartcard use reveals the shift from bus to LRT compared to the attraction of new users. **Error! Reference source not found.** shows the breakdown of bus trips and light rail trips in 5 years. While a loss of bus ridership might explain some of the new light rail ridership, the period between the opening of the light rail (May 2019) and the start of Covid-19 shows that the number of boardings increased overall compared to the same period in previous years. A substantial increase in bus strips after the introduction of light rail denotes that many buses stop feed ridership to the light rail and act as transfer stops for light rail. There is a significant difference in the number of total boardings after the introduction of light rail.

Figure 3: Breakdown of bus trips and light rail boardings in five years. The total number of boardings per month increased by about 50% in the period between LRT commencing operations and Covid-19 starting. This plot suggests that the ridership gains were not made at the expense of bus ridership.

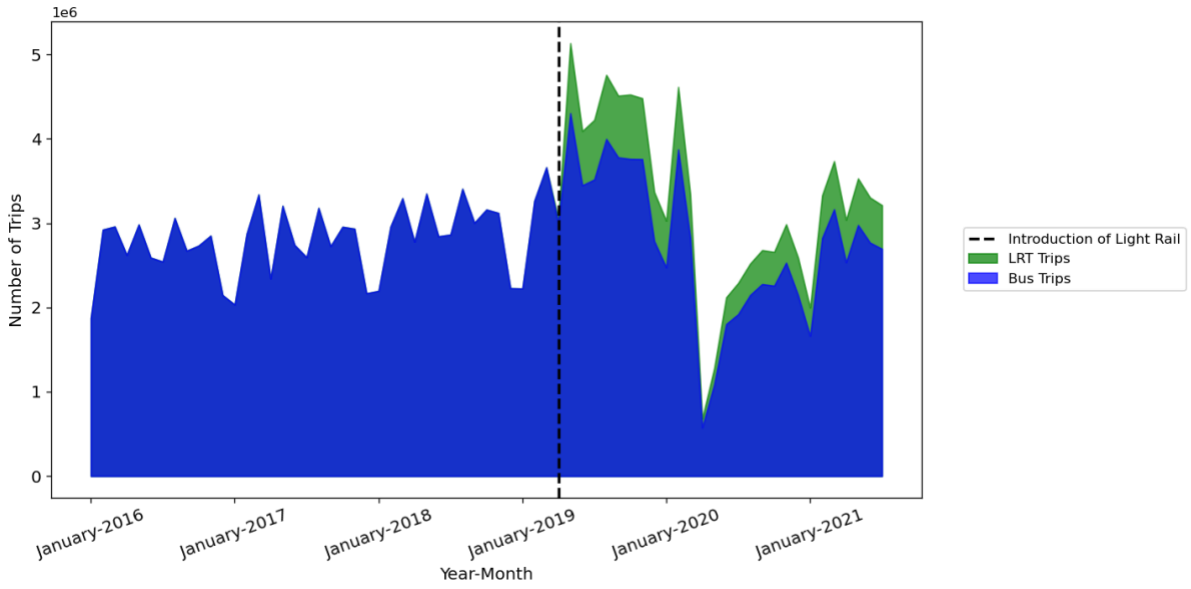


Figure 4: Addition of new card IDs after the introduction of light rail. Light rail boardings made by IDs which existed before the introduction of light rail vs boardings made by unique IDs which were added after the introduction of light rail. The timeline focuses on the pre-covid-19 and post-light rail interval.

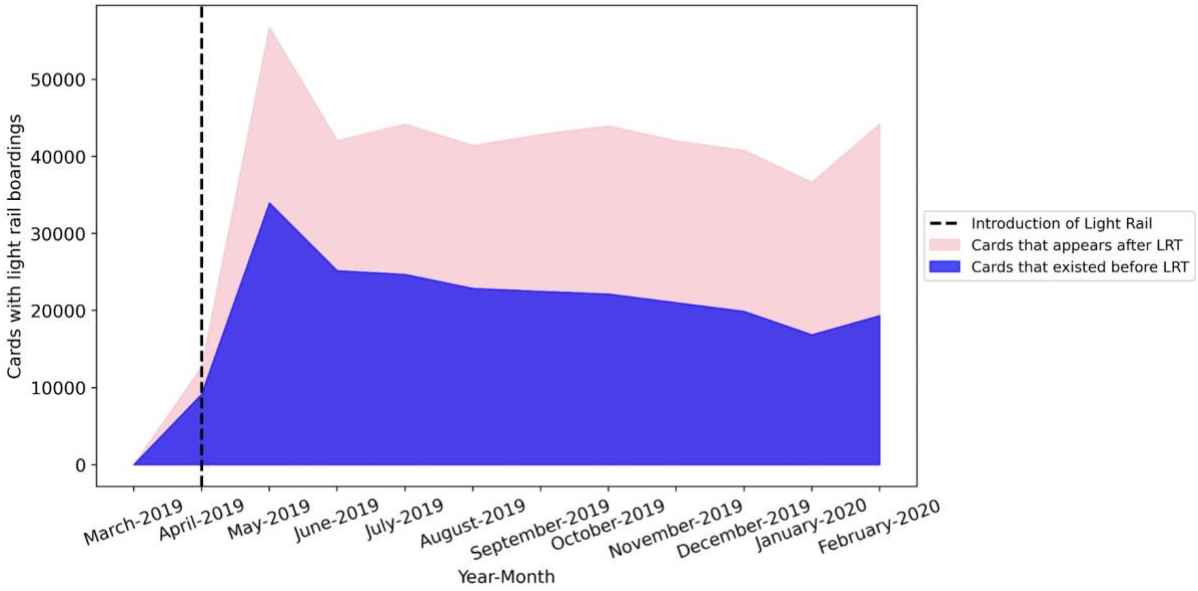


Figure 4 shows the churn of the cards after the introduction of the light rail. Around double of the new card IDs were added after the introduction of light rail which never existed before.12 5,563 new card users appeared after the introduction of light rail. 71,020 users are not observe d after the introduction of light rail in 2019. A total number of 135,501 (24.04 %) unique users were found in 5 years who had evidence of trips before and after the introduction of light rail. Of these, 31,898 users (23.54 %) increased their intensity of use after the introduction of light rail and before Covid-19. 43,581 users (32.16 %) have decreased their intensity of use after th e introduction of light rail. 60,022 users (44. 29 %) remained approximately the same with a c hange in the number of trips per year within 10 of their pre-LRT rate.

5. Conclusions

This study found that, in a typical pre-Covid year, about 43% of card IDs are new, showing substantial year-to-year churn in riders (or at least in cards). There was an increase in ridership after the opening of Canberra Metro that is larger than the typical growth in ridership. It is seen that 50% of the ridership has been increased after the introduction of the light rail. The growth incorporates riders shifting from bus to light rail as well as card IDs that were previously unobserved. This suggests that the LRT was able to increase transit use in Canberra despite its development along an existing bus corridor. A substantial fraction of smartcard users increased their public transport use after the opening of the LRT.

The results demonstrate the value of smartcard data for evaluating the financial and operational performance of a new mode. The results from this study can help transit planners to understand stochasticity in ridership and the time scale of new habit formations. The results from the case study can help the transit planners to have an overview on the riders' preferences of transit modes, thus study followed by characterization of travel habits circling around the light rail can help planners to provide a more personalized travel option. An increased amount of light rail ridership can help in decision related to extension of the existing transit line. This work is part of a larger study looking at spatial and temporal aspects of public transport behaviour in response to disruptions. Results from on-going analysis will include the spatial analysis of the mode shift of riders and the period of habit formation in the use of the new mode.

6. References

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