

Ride-hailing in Santiago de Chile: users' characterisation and effects on travel behaviour

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Abstract

In this paper, an in-depth examination of ride-hailing use in Santiago de Chile is presented, based on data from an intercept survey applied in 2017 across the city. First, a sociodemographic analysis of ride-hailing users, usage habits and trip characteristics is introduced, together with a discussion on the substitution and complementarity of ride-hailing with existing public transport. It is found that (i) the most substituted modes by ride-hailing are public transport and traditional taxis, and (ii) for every ride-hailing rider that combines with public transport, there are 11 riders that substitute public transport. Then, generalised ordinal logit models are estimated, which show that (iii) the probability of sharing a (non-pooled) ride-hailing trip decreases as a function of the rider household income and increases for leisure trips, and (iv) the monthly frequency of ride-hailing use is larger for wealthier and younger travellers, whereas car availability is not statistically significant to explain frequency of ride-hailing use once controlling for age and income, a finding that is at odds with previous ride-hailing studies. To our knowledge, the type of insights resulting from this paper have only been obtained before in studies with data from the United States; we position our findings in this extant literature and discuss policy implications of our results for the legal regulation of ride-hailing services in Chile.

Keywords: ridesourcing, transportation network companies (TNC), travel behaviour, sustainable transport, public transport, taxis

Ride-hailing en Santiago de Chile: Caracterización de usuarios y efectos en el comportamiento de viajes

Resumen

Este artículo presenta un análisis en profundidad del uso de ride-hailing (plataformas tipo Uber) en Santiago, basado en datos de una encuesta de interceptación aplicada en 2017 en toda la ciudad (encuesta de la Comisión Nacional de Productividad). El tipo de información resultante de este documento solo se ha obtenido anteriormente en estudios con datos mayoritariamente de los Estados Unidos; posicionamos nuestros hallazgos en esta literatura existente y discutimos las implicaciones políticas de nuestros resultados para la regulación legal de estos servicios de transporte en Chile, tema actualmente en discusión en el parlamento. Se encuentra que los modos de transporte más sustituidos por ride-hailing son los taxis y el transporte público. Por cada usuario que combina con transporte público, 11 son los que lo sustituyen el transporte público. Se muestra las principales razones que las personas tienen para preferir ride-hailing en viajes específicos. Se estiman modelos de logit ordinal generalizados que muestran que la probabilidad de compartir un viaje (ir con acompañante) disminuye en función de los ingresos del hogar del usuario y aumenta para los viajes con propósito ocio, y la frecuencia mensual de viajes es más alta para los usuarios con mayor nivel de ingreso del hogar y jóvenes. La alta sustitución de viajes en transporte público y el probable efecto de ride-hailing en aumentar el tráfico deben ser considerados en las decisiones de regulación actualmente en discusión.

Keywords: ridesourcing, transportation network companies (TNC), travel behaviour, sustainable transport, public transport, taxis

1. Introduction

The use of ride-hailing in Chile began with the arrival of competing smartphone apps Cabify in 2012 and Uber in 2014. What followed is a process of steady growth in users and drivers, first in Santiago and then all along the country, even though up to 2018 ride-hailing is still illegal in Chile. Poor law enforcement coupled with strong user support combines to let ride-hailing use to continuously increase. In 2016, the situation got to the point that taxi drivers staged large street demonstrations and there were episodes of violence between taxi drivers and Uber drivers. By then, the central government and the Congress took notice of the problem and started talks to legalise and regulate ride-hailing apps.

In order to outline the main elements that such legislation should have, research is needed to understand the benefits and costs that the irruption of ride-hailing apps might be providing to the transport system in Chile, in terms of benefits for its users and changes in travel behaviour, plus any positive or negative effect on traffic levels, on transport externalities and on the subsidised public transport system. In 2017 the Chilean National Productivity Commission (CNP¹), an autonomous consultation agency to the government, decided to undertake a study on the topic of ride-hailing in the country, in order to publish a report with key findings and recommendations for the regulation of ride-hailing services (CNP, 2018). As part of that work, a users' survey was designed and applied in Santiago, commissioned by CNP, with the goal of understanding the implications of ride-hailing for travel behaviour, the frequency of ride-hailing use as a function of user demographics and the effects on existing private and public transport modes. The survey was applied face-to-face in a number of spots spread across Santiago, that were chosen using Santiago's latest Origin-Destination Survey (SECTRA, 2014).

Scientific research on the topic of ride-hailing is seminal but growing quickly in the past couple of years. So far, most of the academic research on the effects of ride-hailing in urban transport comes from the United States, with few exceptions of studies from countries like Brazil. As pointed out by Brown (2018), ride-hailing is redefining the idea of car access by disentangling it from car ownership. In this context, many authors have elaborated on the expected impact of ride-hailing on reducing car ownership, although robust evidence on the subject is still lacking (Rayle *et al.*, 2016; Henao, 2017; Henao and Marshall, 2017; Rodier, 2018). Brown (2018) studies the effects of ride-hailing in

¹ CNP stands for *Comisión Nacional de Productividad*.

equity and access in Los Angeles, California by means of a database of Lyft trips. It is found that ride-hailing use is ubiquitous across low-income and high-income districts in the city, that more Lyft users live in high-income neighbourhoods but users in low-income districts used Lyft more frequently, thus the author concludes that Lyft mainly provides car access in low car ownership neighbourhoods.

Regarding the effects of ride-hailing on increasing or reducing vehicle-kilometres by motorised transport, despite mixed evidence on early studies (e.g., Li *et al.*, 2016), the latest studies have usually concluded that ride-hailing is more likely increasing vehicle-kilometres², using actual trip data or user surveys from the United States (Clewlow and Mishra, 2017; Schaller, 2017; Gehrke *et al.*, 2018; Henao and Marshall, 2018; Schaller, 2018) and Chile (Tirachini and Gómez-Lobo, 2018). The increase in traffic because of ride-hailing is mainly due to a high substitution of public transport trips and induced demand, i.e., new trips that would not have been made without the existence of ride-hailing. This implies social benefits in terms of increased activity engagement, at the cost of likely increasing traffic related externalities like congestion and pollution (Rodier, 2018). The substitution of trips from public transport and other modes to ride-hailing is explained by the attributes of this new form of mobility: short door-to-door travel time, ease of payment, comfort, security and general convenience when compared with travel alternatives, for a wide range of trips (Rayle *et al.*, 2016; Schaller, 2018; Tirachini and Gómez-Lobo, 2018).

In the case of Chile, the only previous known study on ride-hailing is Tirachini and Gómez-Lobo (2018). By means of a Monte Carlo simulation, the authors estimate that Uber has increased traffic in Santiago, and that this conclusion might be reversed if the occupancy rate of ride-hailing vehicles is significantly increased. Induced ride-hailing trips were found to happen mainly late at night, when public transport supply is reduced. The base for this study is an online survey on Uber users, with a convenience sample (online snowball sampling) not meant to necessarily be representative of the population.

In this paper, the new CNP ride-hailing survey plus relevant results from the existing literature are used to provide a comprehensive review and analysis of the effects of ride-hailing in the transport system and user behaviour in Santiago. We go beyond the previous work of Tirachini and Gómez-Lobo (2018), by analysing the degree of substitution and complementarity of ride-hailing with

² Feigon and Murphy (2018) is not conclusive on this matter.

existing modes of transport and the temporal and spatial structure of ride-hailing trips in Santiago. With this new database, we are able to estimate two generalised ordinal logit models, one for the frequency of ride-hailing use and one for the occupancy rate of ride-hailing vehicles. Results from the new CNP survey used in this paper are expected to be more reliable than those from the previous (Tirachini and Gómez-Lobo) survey, as the new CNP user survey was delivered face-to-face on the street, on spots across the Santiago Metropolitan Area, chosen with a sampling method designed to be representative of the population (as explained in Section 2).

Results show that the most substituted modes are public transport and taxi; moreover, for every ride-hailing rider that combines with public transport, there are 11 riders that substitute public transport; the probability of sharing a (non-pooled) ride-hailing trip decreases with household income and increases for leisure trips and the monthly frequency of ride-hailing use is larger for wealthier and younger travellers, whereas car availability turns out to be not statistically significant to explain frequency of ride-hailing use, once controlling for age and household income. The latter result seems to be at odds with the findings of Pew Research Center (2016), Circella *et al.* (2018) and Brown (2018) in the United States, an issue that is discussed in Section 3.2.

The rest of the paper is organised as follow. Section 2 presents a descriptive analysis of results on ride-hailing use, with comparisons to the existing literature when appropriate. In Section 3 econometric models to explain ride-hailing vehicle occupancy rates and frequency of use are presented and developed. Section 4 presents a discussion on policy implications of our findings for the regulation of ride-hailing. Conclusions and directions of further research are summarised in Section 5.

2. Descriptive statistics of the survey

2.1 Data collection

In 2017, *Centro Microdatos* from Universidad de Chile was commissioned by Chile's National Productivity Commission (CNP) to carry out a survey on knowledge and use of ride-hailing platforms in Santiago, including ride-hailing apps Uber and Cabify and e-hailing taxi apps Easy Taxi and Safer Taxi. For the survey, a target sample size of 1,500 interviewees living in the Santiago Metropolitan Region was defined. A random spatial sampling method was developed, based on spots with a large attraction of trips. An estimation of the number of daily attracted trips at block level (not counting trips to go back home) was made using data from Santiago's latest Origin Destination Survey (SECTRA, 2014) and from the database of existing buildings per land use, as registered by the local

tax office. Then, a universe of 412 spots with a high attraction potential of trips was identified, spread across the city. Out of these 412 local attractors, 64 spots were randomly chosen for the application of the survey, which was applied on working days between November 14th, 2017 and December 5th, 2017.

The survey encompassed both ride-hailing (Uber, Cabify) and taxi e-hailing (Easy Taxi, Safer Taxi) platforms. The questionnaire included questions on socio-economic characteristics of the interviewee (age, education level, occupation, household income, residence zone), whether the person knows about the ride-hailing platforms that are present in Chile, whether the person has used ride-hailing or taxi e-hailing in the past month and how often he/she has used it. If the person declared having used ride-hailing or taxi e-hailing at least two times in the past month, further specific questions to characterise those ride-hailing trips and the travel behaviour effects of ride-hailing were asked. Finally, the questionnaire included two questions on the legal regulation of ride-hailing in Chile.

2.2 Sociodemographic characteristics

Due to the low number of taxi e-hailing users in the sample (34 people, corresponding to 2.6% of the sample of users with two or more trips in the past month), the quantitative analysis of this paper focuses on ride-hailing only (Uber and Cabify). The final sample size of users who have made two or more trips in the month before the application of the survey was $N = 1311$, including both Uber and Cabify mobile applications. The socioeconomic characteristics of this sample are presented below.

The age composition of the users is shown in Table 1. The age group between 18 and 29 years is where there are more users surveyed (30.1%). Second, the age group between 30 and 39 years old represents 21.1% of the users surveyed. Unlike Rayle *et al.* (2016) whose sample from a central area of San Francisco, California, had 92% of the users of ride-hailing platforms that were less than 44 years old and 73% under 34 years old, in the Santiago sample there are users in all age ranges, being 30.1% of users over 49 years old.

Age	N	Total	Frequency of use (rides in the previous month)		
			2 to 4	5 to 8	8 or more
18-29	395	30%	66%	23%	11%
30-39	277	21%	64%	23%	13%
40-49	237	18%	62%	24%	13%
50-59	260	20%	74%	19%	7%
+60	142	11%	75%	20%	5%
Total	1,311	100%	68%	22%	10%

Table 1. Users by age and frequency of use ride-hailing in the previous month

Regarding frequency of use, in total 68% of users travelled 2 to 4 times, 22% travelled 5 to 8 times and 10% travelled 8 or more times using ride-hailing in the previous month. The age groups with the most frequent users are from 30 to 39 years old and from 40 to 49 years old, followed by the group of young users (18 to 29 years old). Secondly, the use of ride-hailing decreases for users older than 50 years, where between 74% and 75% of respondents use the applications between 2 and 4 times per month. The fact that the youngest group uses ride-hailing less often than middle age groups could be because the group 18-29 years old concentrates more students (22.5% of this group are students and 14.2% work and study), who in average have a lower income than people working. Figure 1 shows that the youngest age group has the largest proportion of members that belongs to the lowest household income group³.

³ Income is given in USD. The exchange rate used is \$637 CLP/USD (CLP: Chilean Peso), which is the average dollar exchange rate for the period in which the survey was applied (Nov 14th – Dec 5th, 2017), as reported By the Central Bank of Chile.

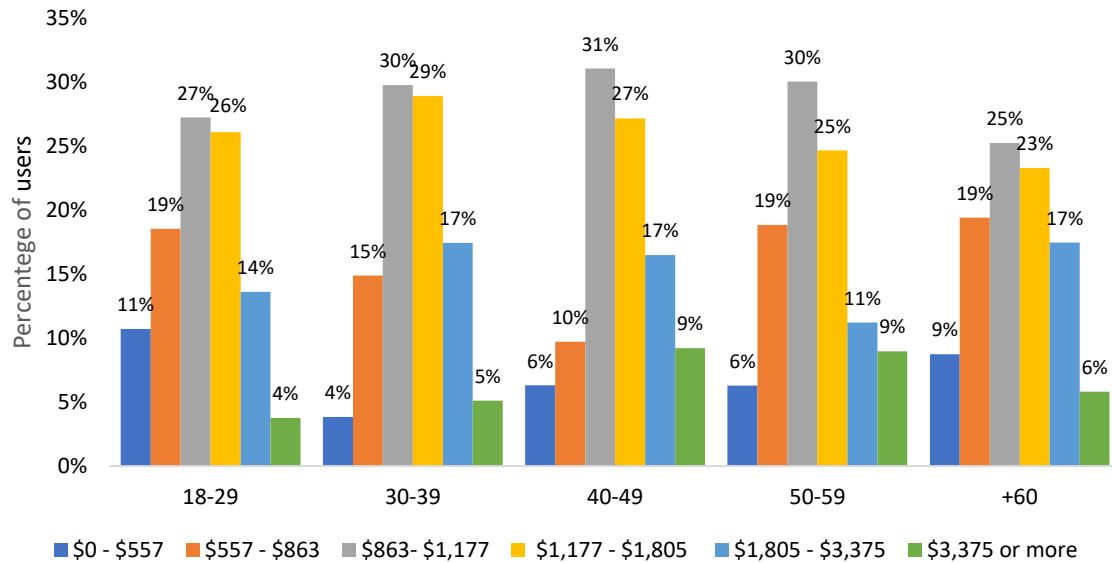


Figure 1. Distribution of household income (USD) by age group.

Note: the household income question was not compulsory, only 1112 respondents (84.8%) answered the income question, Uber users N=1089 of 1266, Cabify users N=63 of 101.

Table 2 shows that more than half of interviewed users have done high school or tertiary education (54.9%) and that the average schooling of users is 15.7 years (with a standard deviation of 3.2). Regarding economic activity, 73.6% of users are employed, whilst students represent 12.3% of the sample. Finally, 5.9% of users neither study nor look for a job and 5.3% are retired. Most users have a household monthly income between \$ 863 to \$ 1,177 (28.9%) or between \$ 1,177 to \$ 1,805 (26.3%), which are middle income groups as shown in the Table 2. The data indicate that the median income of the sample is slightly lower than \$ 1,177, whereas, for all households in the Santiago Metropolitan Area, the median monthly income per household is estimated as \$ 1,335 by Chile's National Institute of Statistics (INE, 2017). In general, the relationship between ride-hailing use and income is mixed in the literature, as for example Clewlow and Mishra (2017) find a positive relationship between income and ride-hailing adoption, whereas Gehrke *et al.* (2018) find that the income profile of ride-hailing users is similar to the general income profile of the population in Boston.

Maximum level of education reached	Frequency	Main Activity	Frequency	Household income range	Frequency
None	0.4%	Employee	55.0%	\$0 - \$557	7.4%
Preschool	0.1%	Independent contractor	18.6%	\$557 - \$863	16.3%
Primary School	6.5%	Student	7.1%	\$863- \$1,177	28.9%
High School	38.1%	Work and study	5.2%	\$1,177 - \$1,805	26.3%
Technician without degree	4.5%	Retired or pensioned	5.3%	\$1,805 - \$3,375	14.8%
Technician with degree	14.0%	In search of a job.	2.9%	\$3,375 or more	6.3%
Undergraduate without degree	10.3%	Do not study or look for work	5.9%	Total	100%
Undergraduate with degree	23.7%	Total	100%		
Graduate without degree	0.53%				
Graduate with degree	1.83%				
Total	100%				

Table 2. Sociodemographic statistics. Maximum level of education reached; Main activity of users; user distribution by monthly household income.

3.2 Characterisation of ride-hailing use in Santiago

The distribution of respondents according to frequency of use in each ride-hailing platform is shown in Figure 2. The most used platform is Uber with 96.6% of users with two or more rides per month (1266 respondents). Cabify is used by 7.7% of respondents (101 respondents). In total, 32.5% have used ride-hailing at least 5 times and 10.4% have used it at least 9 times in the month before the survey.

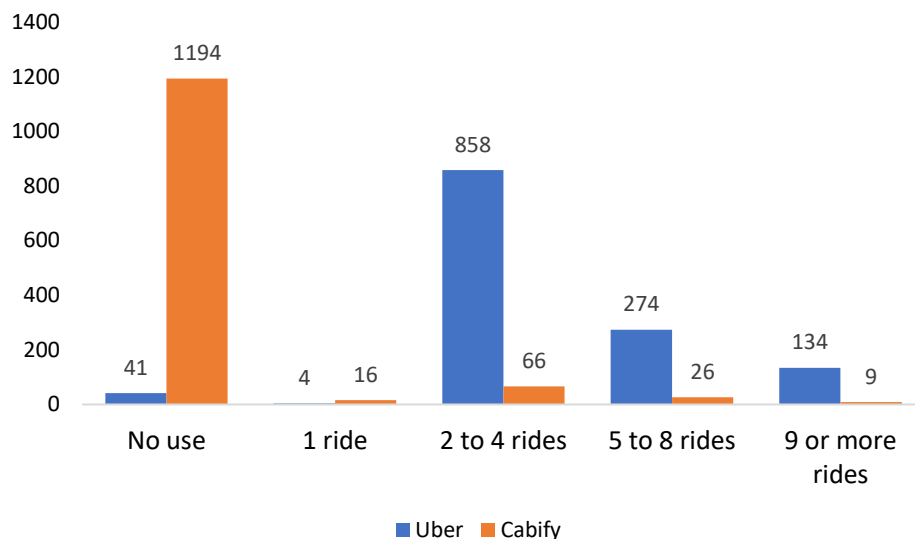


Figure 2. Frequency of use per platforms (N=1311), number of rides in a month.

When looking at the users' household income, Uber is used in all ranges, as shown in Figure 3, whilst the choice of Cabify is concentrated in high income users. This finding is likely explained by the decision of Uber to accept cash as a payment method from July 2016 in Santiago, whereas at the time of the application of the survey, Cabify only accepted payment by debit or credit cards⁴. Most Uber users belong to middle income groups, with household income ranges from \$ 863 to \$ 1,177 (29.2% of Uber users surveyed) and \$ 1,177 to \$ 1,805 (26.3% of Uber users surveyed).

⁴ In February 2018, after the application of the survey, Cabify started to accept cash payments from users in Chile.

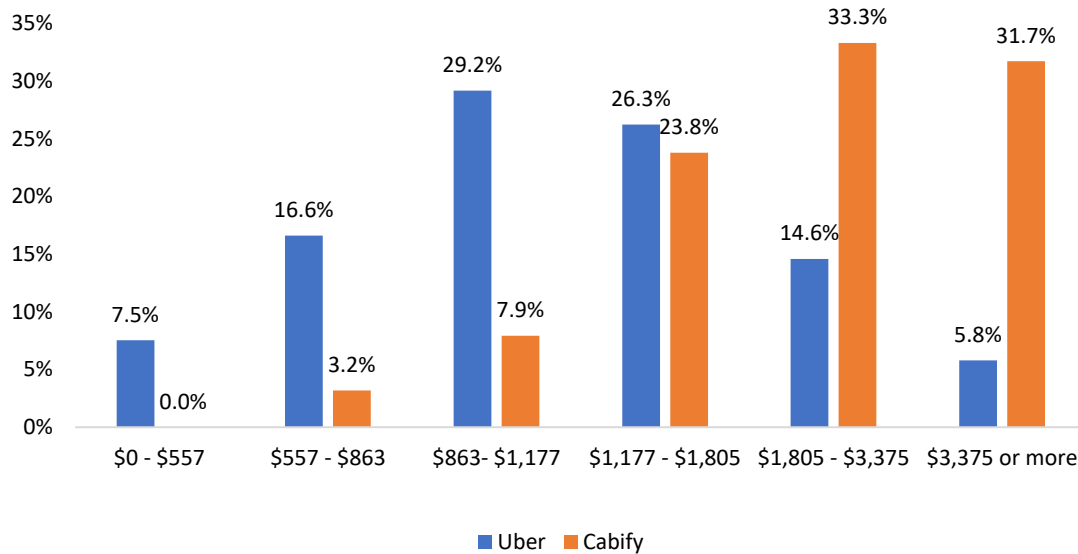


Figure 3. Distribution of household income by mobile platform used

Regarding transport choices by ride-hailing users, respondents were asked about what they consider is their main mode of transport for day-to-day activities. Results in Figure 4 show that ride-hailing is not relevant as the main mode of transport for users, since only 3.9% of their respondents consider the ride-hailing as its main form of mobility. The studies of Brown (2018) in Los Angeles and Feigon and Murphy (2018) in six US cities (Chicago, Los Angeles, Nashville, Seattle, San Francisco and Washington D.C.) also show that ride-hailing is mostly a mode for occasional rather than regular trips. For Santiago respondents, the main mode of transport is Santiago's subway (metro, with 37.8% of preferences), followed by bus (27.2%) and private car (23.5%). Therefore, 65% of users have mass public transport (bus and metro) as their main mode of transport. In Figure 4, "shared taxis" refer to fixed-fare fixed-route taxis are that shared by up to 4 people (named *colectivos* in Chile). See Kickhöfer *et al.* (2016) for a description of Santiago's transport system and modes of transport.

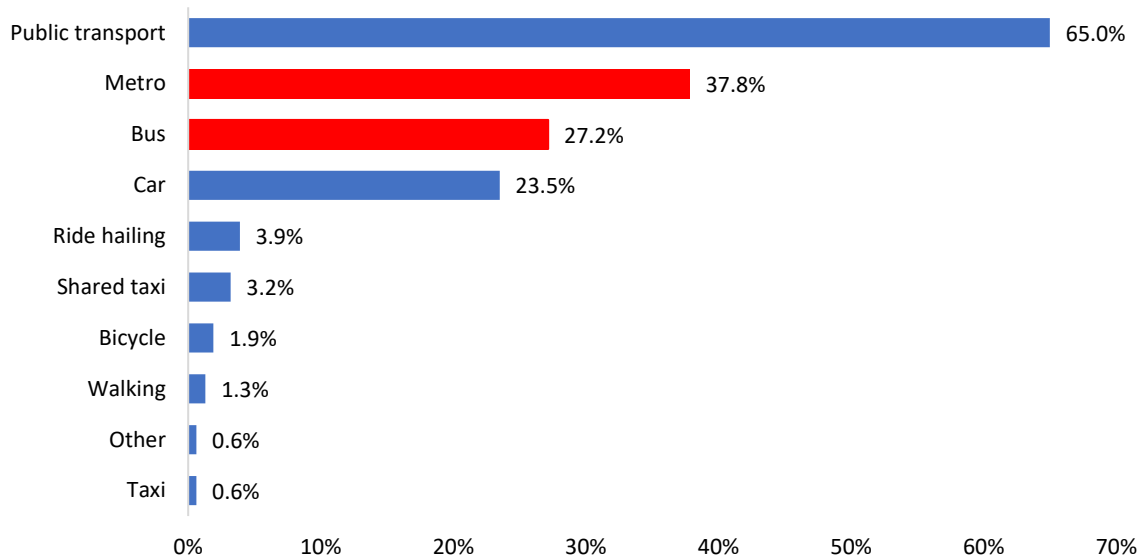


Figure 4. Main mode of transport of users

Table 3 shows the frequency of use of ride-hailing depending on the main mode of transport and if the user has a car available at home. For each level of frequency of use (low, medium or high) it is observed that between 52% and 54% of users do not have a private car available for their use. Among those who do not have a car, they point to the subway and bus as the main form of transport, although it stands out that in the high frequency group, the consideration of ride-hailing as the main mode of transport is in third place with 21.1% of preferences for users who do not have a private car available and 15.4% for users who have a private car available, a remarkable results taking into account the few years that ride-hailing has been in the Chilean market.

The days with larger ride-hailing use⁵ are Friday (28.3%), Saturday (35.9%), and Sunday (10.3%). This day distribution is in line with actual Uber use data by time-of-day and day-of-the week in Santiago, as published by local newspaper *El Mercurio*⁶, where it is graphically shown that weekly peaks of Uber use are on Fridays and Saturdays between 8 PM and 2 AM at night. Additionally, Figure 5 shows that ride-hailing use on weekends decreases with age, whereas the opposite trend is

⁵ Respondents were asked about which days of the week they use ride-hailing the most, with the possibility of naming up to two days for each mobile platform used more than twice in the previous month.

⁶<http://impresa.elmercurio.com/Pages/NewsDetail.aspx?dt=2017-03-04&dtB=04-03-2017%200:00:00&PaginaId=9&bodyid=3>. News piece published on March 4th, 2017, accessed on August 1st, 2018.

observed for weekday use, a finding related to the purpose of trips mainly done on weekends (e.g., leisure) vs weekdays (e.g., work, study).

Frequency of use		2 to 4 rides in the past month		5 to 8 rides in the past month		9 or more rides in the past month		Total	
Have car available for your use		No	Yes	No	Yes	No	Yes	No	Yes
		53.9%	46.1%	53.4%	46.6%	52.2%	47.8%	53.6%	46.4%
Main mode of transport	Car	1.0%	50.0%	1.3%	47.4%	2.8%	47.7%	1.3%	49.2%
	Metro	51.2%	21.8%	52.3%	31.9%	39.4%	16.9%	50.2%	23.5%
	Bus	35.8%	22.3%	32.9%	10.4%	26.8%	15.4%	34.3%	18.9%
	Public transport	87.0%	44.1%	85.2%	42.2%	66.2%	32.3%	84.5%	42.4%
	Taxi	1.0%	0.2%	0.6%	0.0%	0.0%	1.5%	0.9%	0.3%
	Shared taxi	5.0%	1.5%	5.2%	0.7%	2.8%	1.5%	4.8%	1.3%
	Ride-hailing	1.5%	1.5%	3.9%	5.2%	21.1%	15.4%	4.0%	3.8%
	Bicycle	3.4%	0.7%	1.9%	0.7%	1.4%	1.5%	2.8%	0.8%
	Walking	0.8%	1.7%	0.6%	1.5%	4.2%	0.0%	1.1%	1.5%
	Other	0.2%	0.2%	1.3%	2.2%	1.4%	0.0%	0.6%	0.7%
	Total	100%	100%	100%	100%	100%	100%	100%	100%

Table 3. Frequency of use of ride-hailing according to car availability and main mode of transport

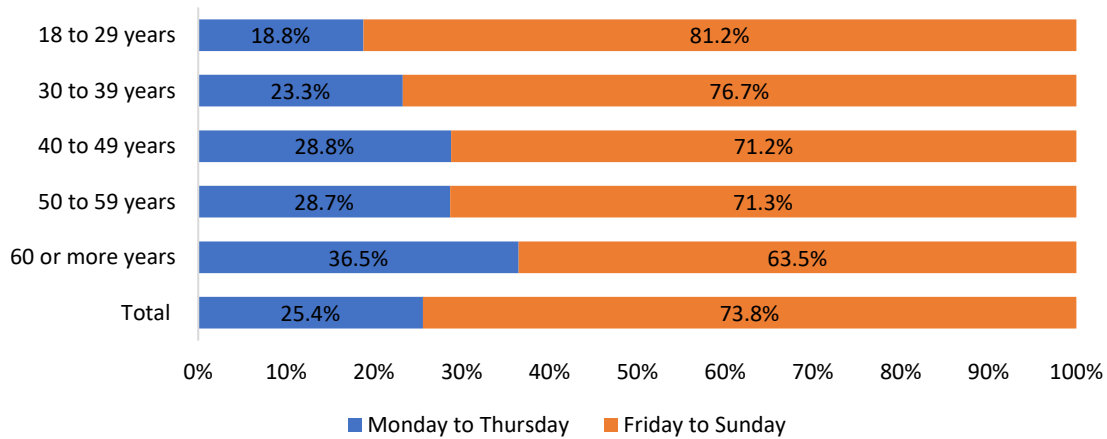


Figure 5. Use of ride-hailing by age and days

The period⁷ in which ride-hailing is most used is between 20:00 to 23:59 (35.6% of mentions, Figure 6), followed by the time period between 17:01 and 20:00 (22.7% of mentions). Night-time use is mainly concentrated among riders between 18 and 29 years old (72.4%, not shown in Figure 6). Similar results regarding a large ride-hailing use at evenings and late at night (specially on weekends) are usually reported in US-based ride-hailing studies (e.g., APTA, 2016; Brown, 2018; Feigon and Murphy, 2018; Gehrke *et al.*, 2018), when the supply of public transport services is lower or not existent.

The literature also finds a significant ride-hailing use at rush hours on weekdays, an issue that raises concerns because of the potential contribution of ride-hailing to traffic congestion. Regarding peak time weekday use, unfortunately our survey is not useful because it is not possible to separate weekdays from weekends from our data in Figure 6 (there were not separate questions on weekends vs weekdays in the survey). However, in the Santiago survey reported in Tirachini (2017) it was found that on weekdays, 25% of trips are made in rush hours (8% between 7 and 9 AM and 17% between 6 and 8 PM), a result that is consistent with Figure 6. As way of comparison, Feigon and Murphy (2018) shows that between 20% and 27% of ride-hailing trips are made during rush hours in Chicago, Los Angeles, Nashville, Seattle, San Francisco and Washington D.C.

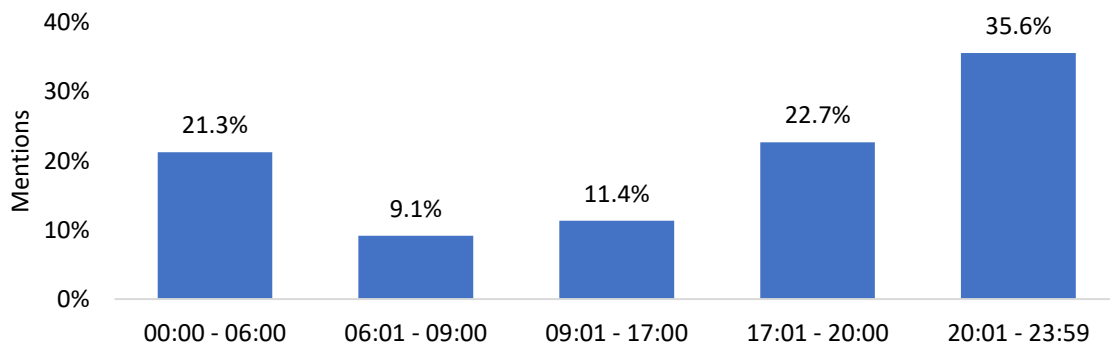


Figure 6. Time periods for ride-hailing trips

2.3 Characteristics of ride-hailing trips

Next, we analyse survey questions that aim at characterising the ride-hailing trips performed in Santiago. First, respondents were asked about how many people travel when they use ride-hailing

⁷ Respondents were asked in which time periods they most frequently used ride-hailing, with the possibility of naming up to two time periods per platform.

services. This is a relevant issue to understand the efficiency on vehicle use as compared with alternatives like taxis and private cars. The answer in Figure 7 shows that in 40% of cases, users travel alone and in 35% of cases trips are shared with another person. It is estimated that the occupancy rate of ride-hailing is 1.9 pax/veh, from the users' perspective⁸ while in passenger service (that is, without counting the driver and without considering the kilometres travelled without passengers). For trips on weekdays only, the average ride-hailing occupancy rate drops to 1.7 pax/veh. Disaggregation by age groups does not show significant differences in ride-hailing occupancy rate, in contrast to the results from central San Francisco, where Rayle *et al.* (2016) found that younger people tended to travel more accompanied.

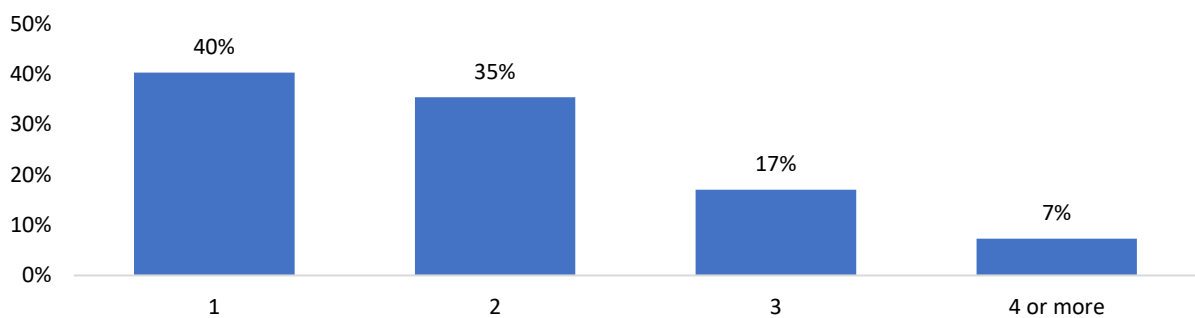


Figure 7. Vehicle occupancy without counting the driver by ride-hailing users

Differences in ride-hailing occupancy rate by household income group are noteworthy (Figure 8), as the higher the household income of a rider, the larger the probability of travelling alone. In other words, group travelling is more common for people from lower income households. For the highest household income group, 51% of riders declare to travel alone. The average occupancy rate per household income range is presented in Table 4. For the lower household income ranges, the rate is 2.2 pax/veh (\$ 0 to \$ 557) and 2.0 pax/veh (\$ 557 to \$ 863), whilst for the higher income ranges,

⁸ Note that the occupancy rate calculated this way is from a users' perspective, i.e., what users see when they are inside ride-hailing vehicles. The average vehicle occupancy rate of vehicles is 1.5 pax/veh, for which the number of respondents that answered 2, 3 and 4 pax/veh as occupancy rates, was divided by 2, 3 and 4, respectively, because people travelling in high occupancy cars are more likely to be sampled than people travelling alone (the so-called "inspection paradox"). In other words, 1.5 pax/veh is what an external observer would estimate after randomly surveying ride-hailing trips with passengers, provided that the sample is representative. For the calculation, a value of 4 pax/veh was assigned to the category "4 or more" in Figure 7.

occupancy rates are 1.8 pax/veh (\$ 1,150,001 to \$ 2,150,000) and 1.7 pax/veh (\$ 2,150,001 or more). Average occupancy rates per income group are shown in Table 4.

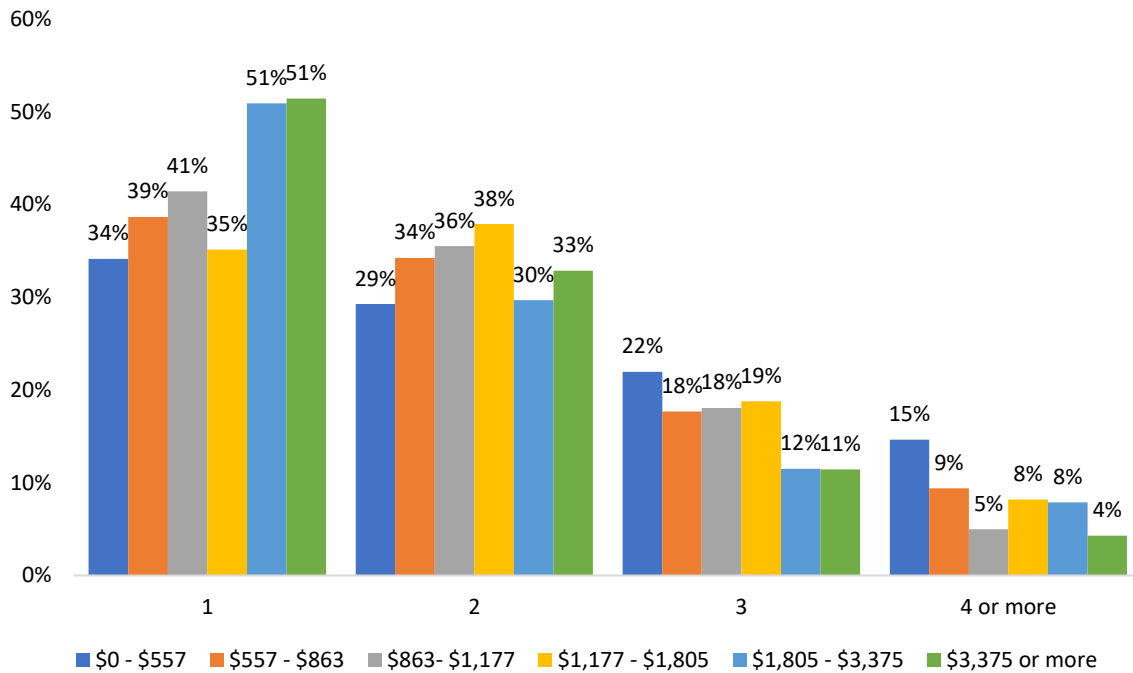


Figure 8. Ride-hailing occupancy rate per household income range

Household Income [USD/month]	N	%	Occupancy rate users' perspective [pax/veh]	t
\$0 - \$557	82	7.4%	2.2	
\$557 - \$863	181	16.3%	2.0	1.399
\$863- \$1,177	321	28.9%	1.9	2.393**
\$1,177 - \$1,805	293	26.3%	2.0	1.319
\$1,805 - \$3,375	165	14.8%	1.8	2.940***
\$3,375 or more	70	6.3%	1.7	3.134***

Table 4. Occupancy rate by household income range, including differences in means with respect to the lowest income group. Significance: *** p <0.01; ** p <0.05; * p <0.1.

To corroborate whether the differences observed in Table 4 are statistically significant, the difference in means of the occupancy rate of the lowest household income segment is calculated with respect to the other five segments, as shown by the p-values in the rightmost column in Table

4. The differences in means are not significant for the second and fourth lowest household income ranges. The larger household income segments have an occupancy per vehicle that is significantly lower than the occupancy rate of trips by users who belong to households with a monthly household income lower than \$863. Splitting the fare payment among more travellers and social reasons may explain that lower income groups tend to share more their rides.

With respect to the purpose of the trips in which ride-hailing is used (Figure 9), the main purpose is leisure⁹ (55.4% of the mentions), which is relevant for all age groups. In the US, studies are also consistent in showing that leisure and going out are the most common trip purposes for ride-hailing users (APTA, 2016; Rayle *et al.*, 2016; Clewlow and Mishra, 2017; Henao, 2017).

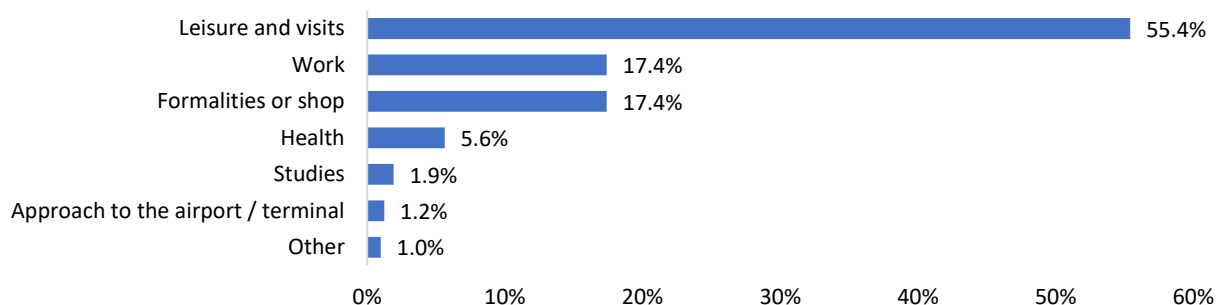


Figure 9. Travel purpose of ride-hailing users

When choosing ride-hailing, the attributes more valued by users¹⁰ are comfort and safety/security (28.9% of mentions), cost (14.4 %) and travel time (9%), as shown in Figure 10. There are relevant differences on the reasons to choose ride-hailing when analysed by household income, for example, the reason "because I drank or was going to drink alcohol" has more mentions in the higher income groups¹¹.

⁹ Respondents were asked to report the trip purposes for which they use ride-hailing, with the possibility of naming up to three trip purposes.

¹⁰ The question was: "What are the top two reasons to use ride-hailing in the past month?" with the possibility of naming up to three trip purposes.

¹¹ The reason "because I drank or was going to drink alcohol" was mentioned between 13% and 15% of times by users from the two largest income groups, whilst the other income groups mentioned it between 3 and 6% of times.

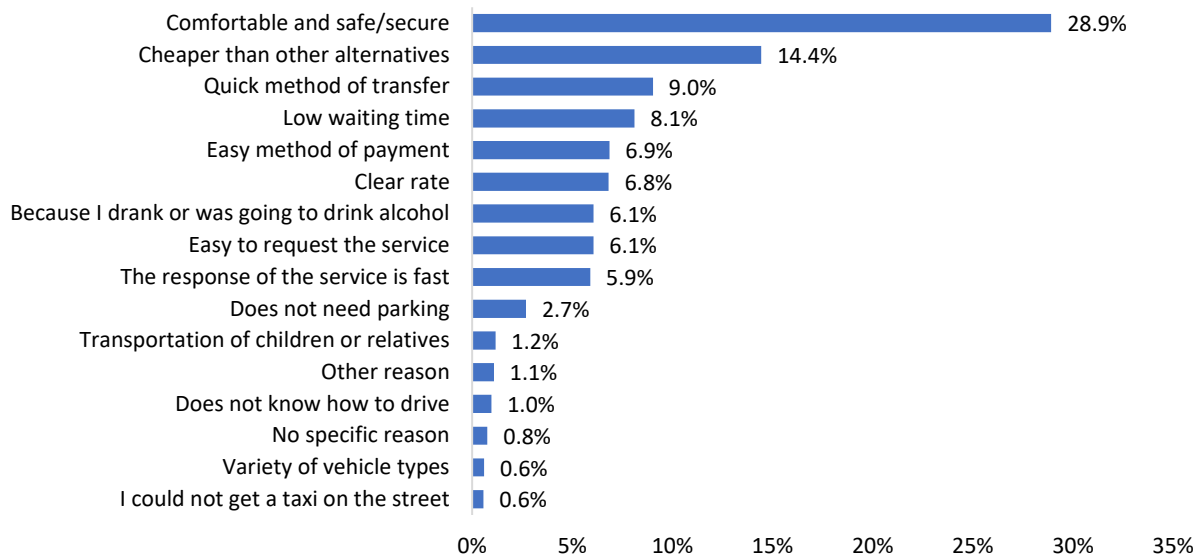


Figure 10. Main reasons for using ride-hailing

2.4 Substitution and complementarity with other modes of transport

A couple of further key elements to understanding the impact of ride-hailing on Santiago's transport system are, first, which modes are being replaced by ride-hailing, and second, to what extent ride-hailing is a complement to public transport, the latter being an issue for which mixed results have been obtained in the literature from the United States (Clewlow and Mishra, 2017; Hall *et al.*, 2018; Henao and Marshall, 2018). Our survey results show that 96.1% of respondents report using ride-hailing without combination with other modes, while 2.6% of users reported trips combined with Metro, 0.8% with bus and 0.4% with other modes of transport. Therefore, ride-hailing is by large a mode used to make full door-to-door trips. These results are similar to those found by Henao and Marshall (2018), who report that only 5.5% of ride-hailing trips in Denver, Colorado, combine with another mode of transport. In the Santiago sample, there are no relevant differences when complementarity is analysed by ranges of household income and sex.

This finding adds to the emerging research topics that, on the one hand, analyse the effect of ride-hailing on traffic, and on the other hand, if ride-hailing is mostly a substitute or complement of public transport. The evidence from this survey contradicts conclusions from earlier Uber studies, which point out that Uber trips usually combine with public transport, rather than substitute it (Alpha & Beta, 2017) and partially contradicts the independent study by Hall *et al.* (2018), which finds that Uber is a complement for the average US public transport agency, but there is great

heterogeneity in the effects, as the authors estimate a public transport demand reduction by 5.9% for agencies in small cities and a demand increase by 0.8% for agencies in large cities. Hall *et al.* (2018) argues that the combination between ride-hailing and public transport is encouraged because public transport is relatively cheaper in the United States. In contrast, in Santiago, if a ride-hailing trip is shared by 2, 3 or 4 people can be even cheaper than in buses or metro¹². Another relevant study is Clewlow and Mishra (2017), which presents data from seven cities (Boston, Chicago, Los Angeles, New York, San Francisco, Seattle and Washington DC) and finds that ride-hailing may decrease demand for urban buses and urban trams, and may increase demand for suburban trains (commuter rail), for which ride-hailing serves as a "last mile" mode.

Ride-hailing can increase or reduce road traffic, measured in vehicles-kilometres travelled (VKT). The relevance of such analysis lays on the fact that notorious traffic externalities like congestion, pollution and accidents are directly linked to the number of cars cruising city streets. The effect of ride-hailing on traffic critically depends on the mode that ride-hailing users are substituting and, on the long run, if car ownership decisions are influenced by the use of ride-hailing. In the survey there was a question of what mode of transport users would have generally used if ride-hailing did not exist. Results are depicted in Figure 11. Respondents were allowed to choose more than one alternative; in total, 80.5% of respondents chose only one alternative, 18.1% chose 2 alternatives and 1.4% chose 3 or more (therefore, numbers in Figure 11 sum more than 100%).

The two more replaced modes are, by far, taxis and public transport. We observe that 39.2% of users stated that they have replaced taxi trips and 37.6% have replaced mass public transport, i.e., bus, metro or combined bus-metro trips¹³. Within public transport, 32.8% of users have substituted bus trips, either used as a single mode (19.4%) or in combined bus-Metro trips (13.4%). Then, in third and fourth place, ride-hailing users have substituted car (15.9%) and shared taxi (12.9%). In parallel, when asked about using ride-hailing in combination with other modes, only 43 respondents (3.3% of the sample) replied having used ride-hailing in trips combined with mass public transport (bus and/or Metro), thus, for every ride-hailing rider that combines with public transport, there are

¹² The minimum fare of UberX in Santiago is USD 1.7, while the bus fare is around USD 1 per person and up to USD 1.2 if the trip combines with metro.

¹³ The total number of users that replace public transport (37.6%) is lower than the summation of bus, metro and metro-bus combined (41.7%), because if a user stated having replaced bus trips and metro trips due to using ride-hailing, it only counts once when accounted in the number of users that replace public transport as a whole.

11 riders that substitute public transport. Therefore, we estimate that ride-hailing is overwhelmingly substituting, rather than complementing, public transport in Santiago, a city whose public transport system, Transantiago, after its launch in 2007, continues to underperform in terms of quality of service delivered to the users (Kickhöfer *et al.*, 2016).

The aforementioned results, in terms of sustainable transport outputs, are in line with those shown by Tirachini and Gómez-Lobo (2018) in Santiago, who reported a large ride-hailing substitution of taxis (40%) and of public transport (32%), in a question over modal substitution in the last ride-hailing trip made by the respondent. A large replacement of public transport is an indication of an increase in vehicle-kilometres that is unlikely to be compensated by the efficiency gain from the substitution from taxis into ride-hailing, as shown by Tirachini and Gómez-Lobo (2018). By way of comparison, in Henao and Marshall (2018), with surveys from Denver, the mode most substituted by ride-hailing was public transport (22.2%), while the taxi was in fifth place after driving alone (car), whilst in Boston, Gehrke *et al.* (2018) find a 42% substitution of public transport, 23% of taxi and 19% of private cars, and in California, Alemi *et al.* (2018) estimate a larger ride-hailing substitution rate of taxis (45-56%) relative to the substitution of cars (38%) and public transport (12-27%). Outside the United States, de Souza Silva *et al.* (2018) report a 50% substitution of taxis, 30% substitution of public transport and 18% substitution of car trips with an online survey delivered in several Brazilian cities. Finally, we note that 5.4% of the survey answers in Santiago indicate that they made trips that they would not have made, if ride-hailing was not available. In the United States, the rate of induced ride-hailing trips estimated in studies so far is between 5% and 12% (Alemi *et al.*, 2018; Gehrke *et al.*, 2018; Henao and Marshall, 2018).

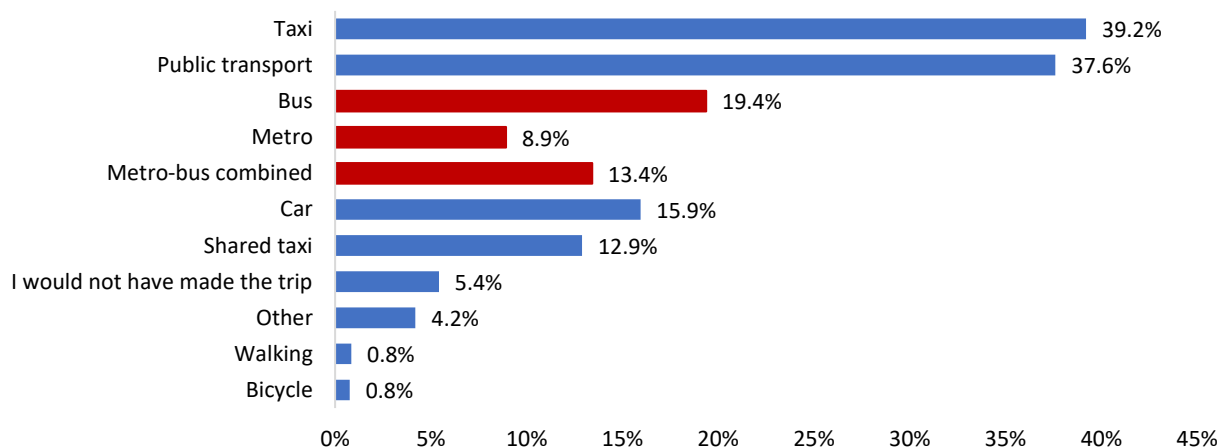


Figure 11. Modal substitution for travel by ride-hailing users (proportion of respondents that replace trips, per substituted mode)

3. Estimation of Multivariate Econometric Models

3.1 Introduction: generalized ordinal logit model

In this section we introduce and estimate econometric models for the study of two relevant variables for the characterization of ride-hailing use in Chile: the vehicle occupancy rate [pax/veh] and the monthly frequency of ride-hailing use. Our objective is to find attributes that are statistically significant in explaining both variables, which are modelled as ordinal variables in Section 3.2. To model ordinal variables, specific modelling tools are ordinal logit, ordinal probit and generalized ordinal logit models, among others (Greene and Hensher, 2010). In these models, the objective is to explain the probability p of occurrence of an ordinal value of a dependent variable, that could be related to different values taken by independent variables.

For the two dependent variables, ordinal logit models were first estimated. However, in both cases the assumption of parallel lines (also known as proportional odds constraint, see below) was violated. This assumption must be fulfilled for the correct specification of an ordinal logit model. For this reason, generalized ordinal logit models are finally chosen for estimation, as in this type of models, variables are freed from the proportional odds constraint (for details see Williams, 2006; Greene and Hensher, 2010).

Let us assume that we have an ordinal dependent variable that has M categories. A generalised ordinal logit model can be expressed as follows (Williams, 2006),

$$P(Y_i > j) = g(X\beta_j) = \frac{\exp(\alpha_j + X_i\beta_j)}{1 + [\exp(\alpha_j + X_i\beta_j)]} \quad (1)$$

where $j \in \{1, 2, \dots, M - 1\}$ and β_j are estimation parameters. Then, the probability that Y takes any of the values 1 through M is:

$$\begin{aligned} P(Y_i = 1) &= 1 - g(X_i\beta_1) \\ P(Y_i = j) &= g(X_i\beta_{j-1}) - g(X_i\beta_j) \quad \text{if } j \in \{2, \dots, M - 1\} \\ P(Y_i = M) &= g(X_i\beta_{M-1}) \end{aligned}$$

Note that the ordinal logit model is a particular case of formulation (1), which is obtained when $\beta_j = \beta, \forall j \in \{1, 2, \dots, M - 1\}$, the so-called assumption of parallel lines or proportional odds (Williams, 2006). The models presented in this section are estimated with the statistical package Stata¹⁴.

3.2 Occupancy rate model

As can be seen in Section 2.3, there is a relationship between the level of household income of users and the occupancy rate of cars when they travel by ride-hailing. In this section, a generalized ordinal logit model is estimated, which allows us to extend the difference of means analysis of Section 2.3 and include other variables. The explained variable is the number of travellers per ride-hailing trip, coded using four ordinal categories: (1), (2), (3), (4 or more) passengers per vehicle. After testing different specifications, it was found that along with the relevance of the household income variable, the fact that a trip is for leisure has a significant influence on the number of people sharing a ride-hailing vehicle. Having four levels for the ordinal variable, the generalised logit specification estimates a series of three binary logit models, which are presented in the three panels of Table 5.

The first panel compares the occupancy rate 1 pax/veh with rates 2, 3 and 4 or more pax/veh; the second panel compares occupation rates 1 and 2 pax/veh with rates 3 and 4 or more, while the third panel compares rates 1, 2 and 3 pax/veh against rate 4 or more. The three panels show that the leisure travel purpose has a positive and statistically significant parameter. Therefore, leisure trips have an average occupancy rate that is significantly larger than trips with other purposes. With respect to the household income segments, it is found that the higher the household income, the lower the probability of having a higher occupancy rate, since all the estimated parameters are significant and negative. A similar conclusion was obtained in Section 2.3. For example, observing the second panel, it is concluded that for users with a household income greater than \$ 863, the user is more likely to make a trip with occupancy rate of 1 or 2 pax/veh, compared to a user from a household with income lower than \$ 863.

¹⁴ The command used is *gologit2*, which is a contribution from Williams (2006).

Vehicle Occupancy [pax/veh]	1 vs (2,3,4 or more)		(1,2) vs (3, 4 or more)		(1,2,3) vs 4 or more	
Attribute	Coef	Std. Err	Coef	Std. Err	Coef	Std. Err
Leisure	0.766***	(0.134)	0.556***	(0.163)	0.496*	(0.287)
Household Income						
\$557 - \$863	-0.155	(0.285)	-0.452	(0.291)	-0.521	(0.409)
\$863- \$1,177	-0.304	(0.265)	-0.686**	(0.272)	-1.214***	(0.417)
\$1,177 - \$1,805	-0.167	(0.272)	-0.550**	(0.273)	-0.747*	(0.388)
\$1,805 - \$3,375	-0.792***	(0.285)	-0.970***	(0.309)	-0.775*	(0.455)
\$3,375 or more	-0.715**	(0.334)	-1.158***	(0.408)	-1.366**	(0.676)
Constant	0.172	(0.254)	-0.900***	(0.263)	-2.077***	(0.344)

Table 5. Generalized ordinal logit model for occupancy rate. Significance: * p<0,01; ** p<0,05;**

*** p<0,1. Obs: 1,112 ; Wald Chi2(18)= 60.91 ; Prob>chi2=0.000 ; Pseudo R2=0.0224**

3.3 Frequency of use model

The characterisation of frequent users of ride-hailing is useful to understand, for example, what type of traveller is driving the increase in traffic that has likely taken place due to ride-hailing in Santiago, as discussed in Section 2.4. In this section we estimate a function that relates the monthly frequency of ride-hailing use with the sociodemographic characteristics and preferences captured by our survey. The dependent variable is the frequency of monthly ride-hailing use, with the following three categories:

- Low frequency: use at least one ride-hailing app, 2 to 4 times in the previous month.
- Medium frequency: use at least one ride-hailing app, 5 to 8 times in the previous month.
- High frequency: use at least one ride-hailing app, 9 or more times in the previous month.

If a respondent declared to use both Uber and Cabify, the one declared to be used more frequently is used for the categorisation of the ordinal variable. The estimation of the generalized logit ordinal model is presented in Table 6, in which the candidate variables to be significant are age, whether or not the respondent has a car available at home, and the household income level. In the case of the first model (first panel in Table 6) in which the dependent variable is 0 if the respondent is a low frequency user and 1 if he/she is a medium or high frequency user, the age variable is statistically significant and negative, that is, younger people are more likely to use ride-hailing more frequently. Regarding household income, it is observed that only the highest household income group is significant at 6% significance level.

Frequency of use	Low vs (Medium, High)		(Low, Medium) vs (High)	
	Coef	Std. Err	Coef	Std. Err
Age	-0.009**	(0.004)	-0.007	(0.007)
Car	-0.165	(0.146)	-0.0219	(0.240)
Household Income				
\$557 - \$863	-0.330	(0.285)	-0.712	(0.440)
\$863- \$1,177	-0.226	(0.260)	-0.395	(0.393)
\$1,177 - \$1,805	-0.002	(0.264)	-0.651	(0.420)
\$1,805 - \$3,375	0.282	(0.296)	-0.388	(0.482)
\$3,375 or more	0.674*	(0.349)	0.751	(0.495)
Constant	-0.292	(0.280)	-1.496***	(0.347)

Table 6. Model 1, generalized ordinal logit model for ride-hailing use frequency. Significance: *** p<0.01; ** p<0.05; * p<0.1. Obs: 1,112 ; Wald Chi2(18)= 35.67 ; Prob>chi2=0.0012 ; Pseudo R2=0.0177.

A second model is estimated that only has age and those household income segments that are statistically significant in Model 1, as explanatory variables. Household income groups were entered incrementally, beginning with the highest income group and then following with the next lower income groups. With this procedure, it was found that only the two highest household income groups are statistically significant in explaining ride-hailing use frequency, as shown in Table 7.

Frequency of use	Low vs (Half, High)		(Low, Half) vs (High)	
	Coef	Std. Err	Coef	Std. Err
Age	-0.010**	(0.004)	-0.009	(0.006)
Household Income				
\$1,805 - \$3,375	0.362**	(0.179)	0.104	(0.283)
\$3,375 or more	0.734***	(0.250)	1.236***	(0.297)
Constant	-0.484***	(0.185)	-1.920***	(0.274)

Table 7. Model 2, generalized ordinal logit model for ride-hailing use frequency. Significance: *** p<0,01; ** p<0,05; * p<0,1. Obs: 1,112 ; Wald Chi2(18)= 26.69 ; Prob>chi2=0.0002 ; Pseudo R2=0.0127

It is worth mentioning that once controlling for household income and age, car availability at home turned out to be not statistically significant. This result seems to be at odds with previous findings

or conclusions reached in studies performed with data collected in the United States. For example, Pew Research Center (2016) reports that frequent ride-hailing users are less likely than others to own a car, Brown (2018), finds that ride-hailing app Lyft is more frequently used by riders in neighbourhoods with low car ownership in Los Angeles, and Circella *et al.* (2018) estimate a statistically significant effect of car availability at home as reducing the frequency of ride-hailing use in the State of California. On the other hand, using data from Puget Sound (State of Washington), Dias *et al.* (2017) find that the relationship between car ownership and frequency of ride-hailing use is mediated by neighbourhood density, as having vehicles at home reduces frequency of ride-hailing use in low density suburbs but increases frequency of ride-hailing use in high density suburbs, relative to households with no car. The difference in our Santiago data lays on the fact that the percentage of users with a car available at home remains almost constant per category of intensity of ride-hailing use, since the rates of low, middle and high frequency ride-hailing users that have a car at home are 45%, 45% and 47%, respectively. Therefore, there is no correlation between car availability and frequency of ride-hailing use. Note that our frequency of use model only takes into account people that have already used ride-hailing, it is not an adoption model that compares users vs non-users as in Alemi *et al.* (2018). The question if the lack of a car influences people to start using ride-hailing in the first place is not addressed in this study.

4. Implications for the regulation of ride-hailing in Chile

Some of the findings discussed in Section 3 have implications for the regulation of ride-hailing, currently under discussion in Chile¹⁵. As summarised by Beer *et al.* (2017), ride-hailing regulatory frameworks usually have driver-related and company-related regulations. Regarding driver-related requirements, a city, state or nation can decide whether or not is going to require driver background checks (e.g., specific types of crime, driving while intoxicated felonies), external vehicle displays, special driving licences and so on. Concerning company-related requirements, the regulator may ask that ride-hailing companies should be officially constituted in the state or country, that companies share meaningful (anonymised) trip data with the regulator (in order, for example, to characterise congestion in the city) or to set supply controls, either by price or by quantity. This latter issue spurs an unresolved debate amongst researchers, practitioners and policy makers, as some cities have decided to apply price regulations like special taxes to ride-hailing (e.g.,

¹⁵ See de Souza Silva *et al.* (2018) for a discussion on the regulatory issues of ride-hailing in Brazil. For Chile, regulatory issues are also discussed in CNP (2018).

Washington DC¹⁶) or a fee per kilometre driven with passengers, that may include kilometre credits allocated to ride-hailing companies as in Sao Paulo (de Souza Silva *et al.*, 2018)¹⁷, whereas others like New York, apart from taxes, have recently set temporary caps on the quantity of ride-hailing licences¹⁸. Usually, a perceived increase in traffic and/or the need to raise revenues (in the case of price instruments) are provided by city officials as paramount reasons to set these types of price or quantity regulations.

In order to get a feeling of users' perceptions about regulation in Santiago, two specific questions were added to the survey. The first one is a general question on how relevant the respondent thinks that official regulation of ride-hailing is, the answer to be presented on a 1 to 7 Likert scale. A large majority (70%) considered relevant (6) or very relevant (7) to regulate ride-hailing services, with an average score of 5.6. In contrast, only 10% of respondents think that regulation is not relevant at all (Figure 12).

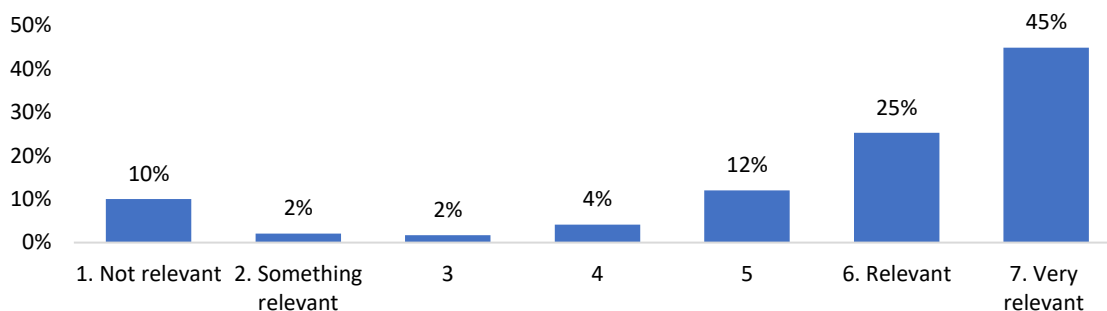


Figure 12. Perceived relevance of regulating ride-hailing

In addition, a second question on specific aspects of regulation was asked, in which respondents could prioritize different regulatory aspects as presented in Figure 13, indicating a maximum of three priorities out of 6 possibilities in total, namely (i) security and personal protection, (ii) labour regulations, (iii) tax regulations, (iv) personal data protection, (v) user responsibilities, (vi) environmental protection. For survey respondents, the priority aspects to regulate are, in descending order of relevance, safety and protection of the consumer, labour regulation of drivers

¹⁶ https://www.washingtonpost.com/news/dr-gridlock/wp/2018/06/26/d-c-councils-vote-to-increase-ride-hailing-tax-will-likely-mean-higher-uber-and-lyft-fares-to-support-metro/?utm_term=.da487d65d0e1, accessed August 16th, 2018.

¹⁷ See also <https://www.citylab.com/solutions/2016/01/sao-paulo-uber-traffic-congestion-mileage-fee/433764/>, accessed August 16th, 2018.

¹⁸ <http://time.com/5361998/new-york-city-uber-lyft-cap/>, accessed August 16th, 2018.

and tax regulations. This finding coincides with the results of a previous survey presented by Tirachini (2017), where in an open question about the use of Uber in Chile, several respondents complained about previous experiences travelling with drivers that were inexperienced or too young. The bill to legalise ride-hailing in Chile, currently under discussion in the Chilean Parliament, seeks that ride-hailing drivers should have a professional driving license (which is obtainable not before 2 years of use of the basic driving license and after passing further tests), with the aim of protecting both drivers and users.

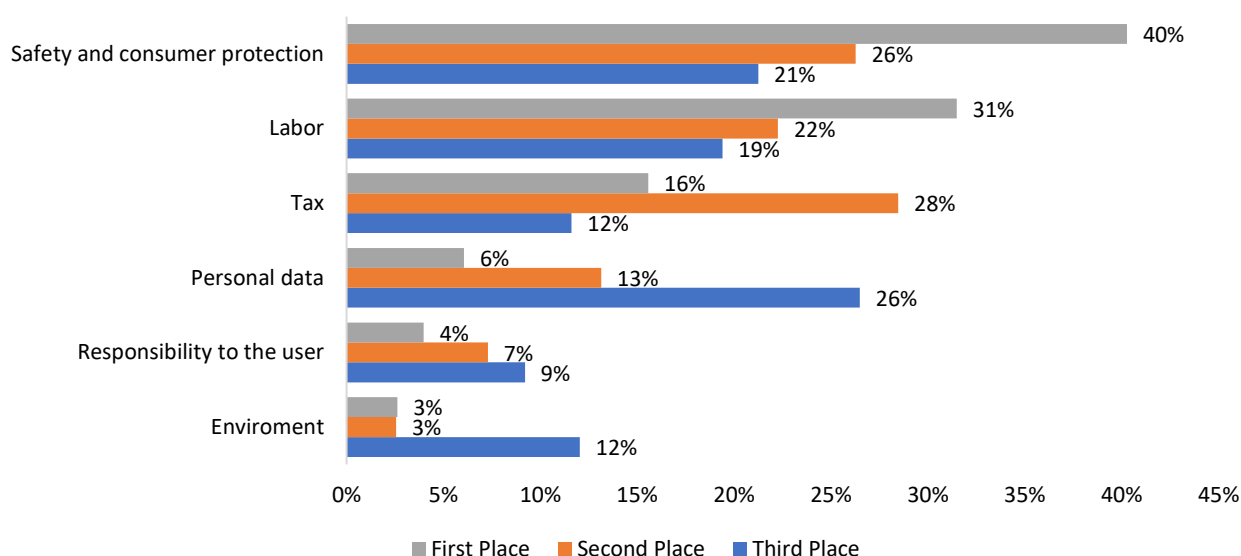


Figure 13. User preferences on topics for the legal regulation of ride-hailing

Finally, the evidence in Section 2.4 reinforces the conclusions of Tirachini and Gómez-Lobo (2018), who with a Monte Carlo simulation model estimate a very likely increase in traffic in Santiago due to ride-hailing, mainly given by the large substitution of public transport trips and to a lower extent by induced (new) ride-hailing trips. The use of ride-hailing has several quality-of-service benefits for its users, especially in terms of increased comfort and safety/security (see Figure 10). Moreover, some people are able to engage in activities that they would have not performed if ride-hailing did not exist. These social benefits need to be balanced with the social costs incurred, likely in the form of increased traffic externalities like pollution and congestion that this new form of mobility introduced in Santiago. A second-best price regulation (considering that in Santiago there is no road pricing for cars), that applies a fee per kilometre adjustable temporally and spatially according to traffic levels and delays, is a policy that adjusts more precisely to traffic externalities, than caps on

the number of ride-hailing vehicles or drivers. Such kilometre-based fee could be reduced or be zero at night or for trips in which ride-hailing serves as a feeder mode to long-haul public transport services¹⁹. The provision of detailed ride-hailing trip timing and route data by ride-hailing companies is a key to implement such fine-tuned price regulation, therefore anonymised data provision arrangements should be part of the legislation.

5. Conclusions

In this article, a descriptive and econometric analysis was carried out regarding the use of ride-hailing services in the city of Santiago, mainly based on a recent survey conducted by Chile's National Productivity Commission (CNP). When possible, results are compared with the findings from previous studies on ride-hailing, published in the scientific literature.

The most important results are summarized below. Mass public transport remains as the main form of mobility for a majority (more than 60%) of ride-hailing users in Santiago, whereas 3.9% of users stated that ride-hailing is their main mode of transport. We found that ride-hailing occupancy rate (number of passengers per vehicle) tends to decrease with household income of the rider and increase for leisure trips. The modes most replaced by ride-hailing are, by far, taxis and public transport; moreover, it was found that for each ride-hailing rider that combines with public transport (bus or Metro), there are 11 riders that substitute public transport. These results point to likely increase in traffic in the city of Santiago due to ride-hailing, a result that is in line with previous studies on the matter from the United States (Clewlow and Mishra, 2017; Schaller, 2017; Henao and Marshall, 2018; Schaller, 2018).

The monthly frequency of ride-hailing use -categorized in low, medium and high frequency- is larger for younger riders and for high household income groups, as indicated by the estimation of a generalized ordinal logit model. Once controlling for household income and age, car ownership is not significant to explain the frequency of ride-hailing use. A large majority of users agree that ride-hailing should be legally regulated in Chile. The priority areas of regulation for users are safety and protection of the consumer, plus labour and tax areas. The analysis and results presented in this article shed light on the effects of the irruption of ride-hailing platforms in travel behaviour, vehicle

¹⁹ A similar suggestion regarding public transport is made by Gehrke *et al.* (2018) for Boston, in order to encourage the integration of ride-hailing as a first or last mile mode.

occupancy rates and potential impacts on traffic levels. Some findings are relevant for the regulation of the ride-hailing platforms, as discussed in Section 4.

Several venues of further research emerge from the evidence presented in this paper. The inclusion of a sample of non-users would help to expose the drivers of ride-hailing adoption as a mode of transport. Second, the potential effects of ride-hailing on reducing car ownership should be determined in the future. Third, spatial equity effects of ride-hailing in Santiago should also be explored in future research efforts, provided that sufficient data on actual trips made and socioeconomic characteristics of users are available.

Acknowledgements

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References

- Alemi, F., G. Circella, S. Handy and P. Mokhtarian (2018). What influences travelers to use Uber? Exploring the factors affecting the adoption of on-demand ride services in California. *Travel Behaviour and Society* 13: 88-104.
- Alpha & Beta (2017). Rethinking Urban Mobility in Indonesia: The Role of Shared Mobility Services. Consultancy Report.
- APTA (2016). Shared Mobility and the Transformation of Public Transit. TCRP J-11/Task 21, Research Analysis, American Public Transportation Association.
- Beer, R., C. Brakewood, S. Rahman and J. Viscardi (2017). Qualitative Analysis of Ride-Hailing Regulations in Major American Cities. *Transportation Research Record* 2650: 84-91.
- Brown, A. E. (2018). Ridehail Revolution: Ridehail Travel and Equity in Los Angeles. PhD thesis, University of California Los Angeles.
- Circella, G., F. Alemi, K. Tiedeman, S. Handy and P. Mokhtarian (2018). The Adoption of Shared Mobility in California and Its Relationship with Other Components of Travel Behavior Report, National Center for Sustainable Transportation, United States.
- Clewlow, R. R. and G. S. Mishra (2017). Disruptive Transportation: The Adoption, Utilization, and Impacts of Ride-Hailing in the United States. Research Report – UCD-ITS-RR-17-07, UC Davis Institute of Transportation.

CNP (2018). Tecnologías Disruptivas: Regulación de Plataformas Digitales (in Spanish). Chapter 3: Transport Platforms. National Productivity Commission, Chile, April 2018.

de Souza Silva, L. A., M. O. de Andrade and M. L. Alves Maia (2018). How does the ride-hailing systems demand affect individual transport regulation? Research in Transportation Economics.

Dias, F. F., P. S. Lavieri, V. M. Garikapati, S. Astroza, R. M. Pendyala and C. R. Bhat (2017). A behavioral choice model of the use of car-sharing and ride-sourcing services. Transportation 44(6): 1307-1323.

Feigon, S. and C. Murphy (2018). Broadening Understanding of the Interplay Among Public Transit, Shared Mobility, and Personal Automobiles. TCRP Research Report 195, Transit Cooperative Research Program, National Academy of Sciences.

Gehrke, S. R., A. Felix and T. Reardon (2018). Fare Choices, a Survey of Ride-hailing Passengers in Metro Boston. Report #1, Metropolitan Area Planning Council (MAPC), Boston.

Greene, W. H. and D. A. Hensher (2010). Modeling ordered choices: A primer. Cambridge University Press.

Hall, J. D., C. Palsson and J. Price (2018). Is Uber a substitute or complement for public transit? Journal of Urban Economics 108: 36-50.

Henao, A. (2017). Impacts of ridesourcing –LYFT and UBER– on transportation including VMT, Mode replacement, parking and Travel Behavior. Ph.D. Thesis, University of Colorado.

Henao, A. and W. Marshall (2017). A Framework for Understanding the Impacts of Ridesourcing on Transportation. In: Meyer G., Shaheen S. (eds) Disrupting Mobility. Lecture Notes in Mobility. Springer, Cham.

Henao, A. and W. E. Marshall (2018). The impact of ride-hailing on vehicle miles traveled. Transportation <https://doi.org/10.1007/s11116-018-9923-2>.

INE (2017). Encuesta Suplementaria de Ingresos 2016 (Supplementary Income Survey 2016). . Instituto Nacional de Estadísticas (National Statistics Institute), Chile.

Kickhöfer, B., D. Hosse, K. Turner and A. Tirachini (2016). Creating an open MATSim scenario from open data: The case of Santiago de Chile. VSP Working Paper 16-02. See <http://www.vsp.tu-berlin.de/publications>. TU Berlin, Transport Systems Planning and Transport Telematics.

Li, Z., Y. Hong and Z. Zhang (2016). An empirical analysis of on-demand ride sharing and traffic congestion. Thirty Seventh International Conference on Information Systems, Dublin.

Pew Research Center (2016). Shared, Collaborative and On Demand: The New Digital Economy. Report.

Rayle, L., D. Dai, N. Chan, R. Cervero and S. Shaheen (2016). Just a better taxi? A survey-based comparison of taxis, transit, and ridesourcing services in San Francisco. *Transport Policy* 45: 168–178.

Rodier, C. (2018). The Effects of Ride Hailing Services on Travel and Associated Greenhouse Gas Emissions. White Paper, National Center for Sustainable Transportation, United States.

Schaller, B. (2017). UNSUSTAINABLE? The Growth of App-Based Ride Services and Traffic, Travel and the Future of New York City. Report.

Schaller, B. (2018). The New Automobility: Lyft, Uber and the Future of American Cities. Report, Schaller Consulting.

SECTRA (2014). Encuesta de Origen y Destino de Viajes Santiago 2012 (in Spanish). Report and database available at www.sectra.gob.cl.

Tirachini, A. (2017). Plataformas ridesourcing (tipo Uber y Cabify) en Chile: impactos en movilidad y recomendaciones para su regulación. ISCI Seminar (in Spanish), presentation available at [https://www.researchgate.net/publication/318429681 Plataformas ridesourcing tipo Uber y Cabify en Chile impactos en movilidad y recomendaciones para su regulacion](https://www.researchgate.net/publication/318429681_Plataformas_ridesourcing_tipo_Uber_y_Cabify_en_Chile_impactos_en_movilidad_y_recomendaciones_para_su_regulacion).

Tirachini, A. and A. Gómez-Lobo (2018). Does ride-hailing increase or decrease vehicle kilometers traveled (VKT)? A simulation approach for Santiago de Chile. *International Journal of Sustainable Transportation*, accepted for publication.

Williams, R. (2006). Generalized ordered logit/partial proportional odds models for ordinal dependent variables. *The Stata Journal* 6(1): 58-62.