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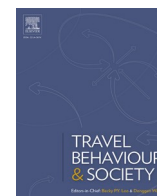
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The job of public transport, ride-hailing and delivery drivers: Conditions during the COVID-19 pandemic and implications for a post-pandemic future

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ABSTRACT

Transport workers were among the most affected by the COVID-19 crisis. In several countries, public transport and delivery drivers were considered essential workers during the pandemic, while the demand changed dramatically. In this context, little is known about the actual effects of the pandemic on the lives of drivers, and whether those effects depend on the type and formality of the corresponding job. In this paper, we analyse the impact of the pandemic on the daily jobs of public transport, ride-hailing, and delivery app drivers: we study changes on working time and income, pandemic-related concerns, and deterioration of job satisfaction, through a survey applied to drivers during the first peak of the pandemic in Santiago, Chile. Probit regressions on job satisfaction identify the main COVID-related experiences that explain variations in subjective perceptions.

We then discuss the implications for post-pandemic job relationships, drivers' working conditions and urban mobility. We show that the unstable characteristics of app-based jobs sharpened during the pandemic: Public transport drivers have kept their jobs, with a similar income as in the pre-pandemic situation and keep their social security, whereas ride-hailing and delivery app drivers do not have social security. Several ride-hailing drivers lost their jobs without any compensation, while delivery drivers earn less money per hour, are more exhausted, and express the greatest concerns and largest decrease in their job satisfaction. The COVID-19 crisis has emphasized that the sustainability of post-pandemic passenger and delivery on-demand services needs to rely on formal job regulation and worker protection.

1. Introduction

1.1. Research motivation

COVID-19 is a contagious respiratory disease caused by the transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) among human beings (Gorbalenya et al., 2020). The first case of coronavirus was identified in December 2019. More than 45 million people were infected, and more than 2 million died due to COVID-19 during the first year of the pandemic. The virus spread rapidly, taking advantage of the hyper-mobility of the 21st century: By the end of May

2020, the virus had reached almost all countries on the globe (Budd and Ison, 2020).

Strict measures were taken to control the spread of the pandemic, limiting travel and movements in general (De Vos, 2020). Many started to work from home, schools and universities switched to online teaching, and public transport was restricted, among other measures, which reduced mobility to a minimum, affecting approximately 90 % of the world's population (Gössling et al., 2020; Wielechowski et al., 2020; Tirachini and Cats, 2020). Thus, between April and August 2020 almost the entire world population faced workplace closure policies. By April 2020, full or partial lockdown measures were affecting around 2.7

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billion workers around the world, i.e., about 80 % of the world's workforce according to the International Labour Organization (ILO, 2020). Beyond global trends, there were variations in the impact of the pandemic on the economy and employment among countries, which depended strongly on two factors: the different waves of cases and intensity of spread and contagion faced at different times across continents and subregions (Dutta, 2022); and the fiscal capacity of states to protect the workforce and industry (ILO, 2020). Hard-hit sectors included informal workers with limited access to healthcare and social protection, particularly in low- and middle-income countries (ILO, 2020).

Transport companies that are based on new technologies were significantly affected. The demand for ride-hailing companies, such as Uber and Lyft, fell down due to the sharp reduction in mobility and the need for physical distancing (Luan et al., 2021). The COVID-19 outbreak caused severe operational disruption for the ride-hailing service providers (Beck and Hensher, 2020; Morshed et al., 2021). Early studies into the impacts of COVID-19 on modal preferences found a reduced willingness to use modes where there is the potential for encounters with strangers over the course of the trip, such as public transport modes (Kucharski et al., 2020; Abdullah et al., 2021; Eisenmann et al., 2021; Das et al., 2021), producing a reduction on the demand of public transport and ride-hailing, with users travellers switching to individual automobile (Arimura et al., 2020; Beck et al., 2020; Fatmi, 2020; Xu et al., 2022) and active modes (i.e., walking and bicycling) (Molloy, 2020; Sung and Monschauer, 2020). At the same time, e-commerce faced an unprecedented surge in its demand, as it enabled buying groceries and goods while fulfilling the stay-at-home requirements (Beckers et al., 2021; Abdelrhim and Elsayed, 2020; Bhatti et al., 2020).

In this context, drivers have been among those more affected by the pandemic as the nature of their working conditions changed. On the one hand, the demand changed dramatically, with a significant decrease in people's mobility and a boost in the need to move goods. On the other hand, the working experience itself also became different, as transport drivers were deemed "essential" and were tied with the unavoidable interaction with other people, implying risks of contagion, particularly if sanitary measures for virus contention were not properly implemented. This situation was more worrisome in the early stages of the pandemic when COVID-19 vaccines were still not available.

Even though there are several studies about the travel behavior impacts of the COVID-19 pandemic, little is known about the actual effects of the pandemic on the work experience of drivers, and whether the emergent app-based jobs faced specific consequences. In this article, we analyse the effect of the first peak of COVID-19 on the jobs of public transport drivers, ride-hailing (ridesourcing) drivers, and delivery drivers (app-based, i.e., riders) in Santiago, Chile. We study working conditions (e.g. type of contract, working time, wage, risk situations faced, social security), job satisfaction, and subjective well-being at work, including fears related to the pandemic and sanitary measures implemented at work. We complement the descriptive statistics with probit regressions that model the changes in job satisfaction, considering the type of driving job and COVID-related experiences, so we can study in more detail the effect of these two main features.

These analyses are relevant both to understand what happened during the worst months of the pandemic, and to assess which measures can be taken so that drivers are better prepared for a post-pandemic scenario, assuming that other unexpected situations might occur in the years to come.

We recognise two main distinctions to analyze the different impacts of the pandemic, as depicted in Table 1. On the one hand, standard and non-standard working conditions (i.e. regular and full-time versus part-time and temporary contracts) imply different levels of social security and labour rights (Kalleberg, 2001), that can even mask labour informality situations. On the other hand, the pandemic affected people and goods mobility in very different ways, as the former decreased while the latter faced a boom (Irawan et al., 2021), and the exposure to infection is expected to be higher in close contact with people. Note that the

Table 1

Relevant features of the three types of jobs studied in the paper.

	Standard working conditions	Non-standard working conditions
Passenger travel	Public transport	Ride-hailing apps
Transport of goods	–	Delivery apps

implementation of lockdowns sharpened this difference, as people can no longer move, so they might require someone else to do their regular shopping or to deliver goods.

1.2. Local context: The COVID-19 pandemic

The COVID crisis in Santiago, Chile, had its first peak during the months of May, June and July in 2020 (first wave), when there were more than 4000 new infections and 100 deaths attributable to COVID during most days. During that first wave of the virus, Chile's COVID outbreak (adjusted by population) was one of the worst around the world (Tariq et al., 2021). The urban consequences of that situation were fostered by the public health (non-clinical) measures adopted by the Chilean government in order to contain the virus spread, adopted at the end of March 2020: curfews and prohibition of massive events and agglomerations, sanitary checkpoints, and quarantines (Villalobos et al., 2021). In a more detailed view, the most relevant measures included the closure of most public places, including schools and universities, a strict lockdown in which people could only leave their houses for shopping a couple of times a week, and teleworking was imposed for everybody who could do it (Tariq et al., 2021; Villalobos et al., 2021).

In this context the Chilean labor market, following the prevailing global trend, experienced a major contraction due to the pandemic: between March and July 2020, the unemployment rate rose from 10 % to 13 % (Ruiz Encina and Ruiz Bruzzone, 2022). Furthermore, the growth in unemployment was accompanied by an absolute contraction of the occupational market during the reference period of this study (between May and August 2020, see Section 2): in contrast to some other countries, the fall in employment in Chile occurred in both the formal and informal sectors of the economy, with the transport sector suffering a contraction of approximately –20 % inter annually (Montt et al., 2020).¹ Although there are no reliable indicators to quantify the evolution of the number of workers via apps,² there are some indirect data that points to a radical change in demand for urban transport services during 2020. CEOs of digital platforms informed to the public that the demand for goods orders increased by 250 % between March and June 2020 (compared to 2019), while they projected a decrease in the number of app-services for passengers. Therefore, during the same period, ride-hailing platforms incorporated goods delivery and courier services (Asenjo and Coddou, 2021). Moreover, records from public agencies indicated that during the first ten months of 2020 the number of consumer complaints against digital platforms (specifically Rappi, PedidosYa, UberEats and Cornershop) had a relative increase of 250 %, relative to 2019 (Morris, 2021). On the other hand, smartcard data reveal that in some areas in Santiago, the demand reduction for public transport was as high as 90 % (Gramsch et al., 2022). In that scenario,

¹ Due to the general contraction of the labor market, including the transport sector, it does not seem possible to assume that the transport sector has become a kind of refuge for the unemployed population. Moreover, as shown in Table 2, only 10% of our study sample worked in a non-transport sector before the pandemic.

² As shown by Jirón et al. (2021), Asenjo & Coddou (2021), and Morris (2021), it is impossible to determine the number of app workers in Chile. This is because there is no public registry provided by the companies and the prevailing employment measurement instruments are insufficient to register this segment of the working population.



Fig. 1. Agglomeration of delivery riders during the pandemic in Santiago, Chile (Retrieved from <https://twitter.com/srmolina2010/status/1266091374216187905>, accessed on 22/09/2022).

some specific critical situations involved transport workers, such as the agglomeration of delivery riders barely protected during the “hamburger’s day” (May 28th, 2020, see Fig. 1), or one public transport agency reporting more than a hundred workers infected already in May 2020.³

1.3. Public transport, ride-hailing and delivery apps operation

Public transport in Santiago is organised in Transantiago, a system launched in 2007 that integrates Metro (subway) and buses by means of a unique fare collection system (Munizaga and Palma, 2012). There are approximately 20,000 bus drivers, working for six different private companies whose routes are coordinated by the local public transport authority. The pandemic influenced public transport both in demand and supply: according to the mobility reports provided by Google,⁴ the usage of public transport decreased by about 44 %, while bus frequencies were first reduced by around 18 %, as a response to the decrease in the number of passengers. Moreover, night services were suspended due to the curfew applied over the city (from March 2020 until September 2021). Astroza et al. (2020) show a general reduction of demand for all transport modes in Chile at the beginning of the pandemic in Santiago, with public transport and ride-hailing suffering the largest demand reductions.

Ride-hailing companies started operating in Chile when competing platforms, Cabify and Uber, arrived in 2012 and 2014, respectively (Tirachini and del Río, 2019). The path followed by these companies in Chile is similar to the disruptive schemes from ride-hailing platforms that have been reported in London (Dudley et al., 2017) and San Francisco, Paris and Mexico City (Goletz and Bahamonde-Birke, 2019). Ride-hailing companies started operations unregulated by Chilean law, quickly becoming popular among users and drivers. Although the exact number of drivers has never been known, the companies had constantly reported it to be increasing before the beginning of the pandemic.⁵ During the COVID-19 pandemic, ride-hailing drivers were particularly affected, as the lockdowns imposed in several cities plus the fear of infections significantly reduced the demand for ride-hailing.

Delivery apps have existed in Chile since 2013, beginning with

PedidosYa, which focuses on meals. Nowadays, other relevant delivery companies are Cornershop (that brings products from shops, mostly supermarkets), Rappi (the most flexible app regarding what to deliver) and UberEats (also focused on the delivery of meals). Before the pandemic, it was estimated that more than one hundred thousand people were working for these apps, either as drivers or as riders⁶; and, in the last three to four years these companies have experienced a surge in demand,⁷ and recent labor conflicts have scaled up to the formal judicial system.⁸ Although these companies are also unregulated, just as ride-hailing, their services were officially recognised as essential by the Chilean Government during the pandemic, as these platforms allow people to stay in their homes instead of going out for shopping.⁹

The Chilean labor market shows high levels of flexibility, and strong legal deregulation of employment relations (Ruiz and Boccardo, 2014; Ugarte, 2014), showing advantageous opportunities for the fast growth of unregulated app-based ride-hailing and delivery jobs. Consequently, in terms of labor regulation at the time of this study, the digital platforms considered their drivers or deliverers as commercial service providers (not as dependent workers). Due to the fact that during 2020 there was no specific regulation on the matter (Álvarez and Weiden-slauffer, 2020; Morris, 2021), this segment of the labor market was outside the rights established in the Chilean labor law (Asenjo and Coddou, 2021). Thus, during the period of this study, there were no regulatory transformations. The sharp changes in the demand for app-based services due to the COVID-19 pandemic is the only direct factor that could have produced major modifications in the quantity and dynamics of this type of employment.

1.4. Related works

Studies about the health and working conditions of public transport drivers have a long history, as described by John et al. (2006) who surveyed 50 years of research on that topic. The literature distinguishes three types of health effects: physical, psychological and behavioural (alcohol, drugs and tobacco consumption). Studies show that besides the direct problems for drivers, these health issues cause relevant organisational problems, due to work absenteeism and increased risks of provoking traffic crashes. The last decades have witnessed new causes of labour stress, such as congested traffic conditions and passengers’ violence. In this context, the COVID-19 pandemic can be seen as yet another source of stress for public transport drivers. This type of analysis has also been carried out on Chilean Transantiago drivers, showing a high prevalence of the so-called *burn-out*, i.e. chronic work stress (Olivares-Faúndez et al., 2013). More recent studies have focused on some specific features and consequences of these workers’ stress, such as *driving anger* and traffic sanctions (Montoro et al., 2018) and, again, tobacco consumption (Useche et al., 2018).

The body of literature that discusses the aspects of driving jobs under the so-called sharing economy has snowballed during the past few years, recognising a tension between economic efficiency and labour conditions (Rogers, 2015). On the one hand, Chen et al. (2019) argue that there is a relevant increase in drivers’ surplus thanks to deciding when to

³ See <https://medium.com/@davidalejandrovsm99/carencias-sanitarias-el-transporte-p%C3%BABlico-en-tiempos-de-coronavirus-5fbaaedc4574>, accessed on 22/09/2022.

⁴ See https://www.gstatic.com/covid19/mobility/2020-09-11_CL_Mobility_Report_es-419.pdf, accessed on 22/09/2022.

⁵ See <https://segreader.emol.cl/2019/03/07/A/BG3IHK7/light?gt=173001>, accessed on 22/09/2022.

⁶ See <https://www.publimetro.cl/cl/noticias/2019/03/25/febre-las-apps-radiografia-los-trabajadores-las-plataformas-digitales.html>, accessed on 22/09/2022.

⁷ See <https://www.latercera.com/tendencias/noticia/boom-del-deliver-y/376891/>, accessed on 22/09/2022.

⁸ See <https://www.latercera.com/pulso/noticia/juzgado-del-trabajo-de-concepcion-reconoce-vinculo-laboral-entre-pedidos-ya-y-repartidor-y-abre-fuer-te-debate/WHWA5UWSTNHE7FWZHWNBWY5A/>, accessed on 22/09/2022.

⁹ This paradoxical situation has been analysed by some opinion pieces (in Spanish). see <https://palabrapublica.uchile.cl/2020/11/03/apps-de-transporte-y-delivery/> and <https://www.ciperchile.cl/2020/04/02/la-otra-primera-linea-covid-19-y-trabajadores-de-plataformas-digitales/>, accessed on 22/09/2022.

work, as Hall and Krueger (2018) and Mäntymäki et al. (2019) show that this flexibility of schedules is highly valued by drivers; on the other hand, Wells et al. (2018) showed that Uber drivers are encouraged to take debts and are frequently exposed to risky situations. All of this happens in Santiago, Chile, as shown by Fielbaum and Tirachini (2021), who found that ride-hailing drivers also appreciate the working time flexibility but present concerning facts such as very long working times and a high prevalence of risky situations while driving. Only a few papers have conducted their analyses without depending on the mediation of the ride-hailing companies (such as Fielbaum and Tirachini, 2021; Peticca-Harris et al., 2020; Chen, 2018; and Glöss et al., 2016).

Regarding delivery riders, recent analyses suggest similar issues as the ones described in ride-hailing, but sharpened. Ivanova et al. (2018) and Veen et al. (2020) focus on the autonomy aspects of the job, finding that information asymmetries (also reported in ride-hailing by Calo and Rosenblat (2017) and companies' control through technologies restrain the drivers' autonomy, which is limited only to decide when to work. Del Bono (2019) focuses on the Argentinian case, finding that working conditions are extremely flexible, including variation in wages and a lack of social security, questioning the very idea of "sharing" in this relationship. The case of Santiago has been studied by Asenjo and Coddou (2020), Boccardo et al. (2022), Gutiérrez-Crocco and Atzeni (2022), and Fairwork (2021). Asenjo and Coddou (2020) point out that most riders consider this job as their primary or exclusive source of income, implying extremely long workdays that compromise riders' health and safety. They also found that riders appreciate the flexibility and ease of starting work, especially for migrants. Boccardo et al. (2022) show that the flexibility and autonomy offered by these companies is combined with hybrid control practices and young people willing to work for low salaries and high workload. Gutiérrez-Crocco and Atzeni (2022) focus on two companies in Chile and Argentina and conclude that the companies have shifted the costs of the COVID crisis to the drivers. Fairwork (2021) reports relevant problems regarding transparency, wages' level, and the chance of workers to organize.

1.5. Contribution, limitations and structure of the paper

The major contributions of this paper are twofold: First, we study a relevant impact of the COVID-19 outbreak to the transportation sector that has not been analysed yet, namely the working conditions of different types of drivers; second, we contribute to the body of literature about new transport modes, by studying the consequences of the lack of formality when sudden changes occur. This is done by analysing app-based drivers and riders, and comparing them to a more traditional job in the same sector such as public transport drivers.

We do this by producing primary COVID-related information about urban transport jobs, through the design and administration of a driver survey that characterises changes in working conditions, experiences, job satisfaction, and COVID-related concerns. We use descriptive statistics to identify the most relevant changes faced by the three types of workers and to compare them, and then we estimate probit models to uncover how the objective aspects of the work (such as earnings, working times, and COVID-related situations) have reshaped the subjective perceptions of drivers due to COVID (such as exhaustion due to work or the desire of changing jobs). Following our analyses, we propose how to regulate app-based transport services so that their workers are better protected for external shocks such as a pandemic.

Our results are based on an innovative survey that has been directly delivered to the drivers, without the mediation of their companies, to analyse the drivers' working conditions, in a field of study in which quantitative information is scarce. Because in Chile there is no public record on the number of app-based workers (because the companies have no obligation to share this data), it is impossible to determine the universe of app-based workers in the country, and therefore, to design a probabilistic survey sampling method. We resorted to an online convenience sample, which imposes some limitations to our analysis, as we

cannot guarantee that our sample is representative of the total universe of drivers during the pandemic (which is further discussed in Section 2). Whereas all ride-hailing and delivery drivers work with smartphones and have internet connections, this is not true for public transport drivers, so it is likely that the sampling method imposes a larger bias on public transport drivers than on app-based drivers. This sampling limitation is shared by related studies, as this type of online sampling method has been previously used to analyse the jobs of drivers in several papers (e.g., Waheed et al., 2018; Holtum et al., 2021; Hill et al., 2021; and Fielbaum and Tirachini, 2021; Hasegawa et al., 2022).

The rest of the paper is organised as follows. Section 2 describes the survey, the data collected and the most relevant sociodemographic characteristics of the respondents. Section 3 focuses on the effects of the pandemic on drivers' working conditions, such as wages, workdays and labour mobility. Section 4 analyses drivers' pandemic-related concerns. Section 5 uses probit models to discuss changes in job satisfaction. Section 6 discusses the impacts of our findings on the regulation of app-based companies during and after the pandemic. Finally, Section 7 synthesises the most relevant findings and concludes.

2. Data description and collection

Our analysis of working conditions and pandemic impacts on the job of driving for ride-hailing apps, delivery apps, and public transport in Santiago, Chile, is based on a voluntary online and self-administered survey. It was distributed between May and August 2020, during the first wave pandemic peak in Santiago, when the first and strongest containment measures were implemented. The survey was applied to both current and former drivers, targeting public transport drivers, ride-hailing app drivers, and delivery app drivers. The situation before and during the pandemic was surveyed for relevant topics.¹⁰ The survey contains five groups of questions:

1. Socio demographics characteristics: age, gender, nationality, education level, current and pre-pandemic occupation, and educational activities.
2. Transport workers' characteristics: transport sector before and during the pandemic.
3. Working conditions: type of contract, working time (specifically, the weekly average number of working hours), wage, additional job (if any), risky situations lived at work, social security, continuity of complementary employment during the pandemic, and circumstantial incentives to work.
4. Job satisfaction: subjective well-being at work and satisfaction level with the driving job in general and with specific elements of the job, before and during the pandemic, for all the three transport sectors.
5. Impacts of the pandemic: self-declared health status, reasons for abandoning the transport sector, fears of the pandemic, sanitary (health) measures and protocols implemented at work.

The universe of ride-hailing and delivery app drivers is unknown and unreachable. Therefore, it is not possible to make a random sampling strategy, meaning that all the results are only valid for the respondents of the survey. However, we do report survey statistics with other sources of information where appropriate. For our research, drivers were contacted mainly through two strategies: i) Facebook and Whatsapp groups created by the drivers themselves to share information; ii) we also contacted associations and unions of drivers, which distributed the

¹⁰ The start of confinement and restriction of movement in Chile due to the pandemic began on 26 March 2020. Therefore, the date 25 March 2020 was explicitly used in the questionnaire so that respondents could clearly distinguish when a question was asked about their occupation prior to the pandemic. The questions that dealt with the situation during the pandemic referred to "the current situation".

Table 2
Descriptive statistics sample.

Variable	Category	Count	Percentage
Nationality	Chilean	302	94.4 %
	Venezuelan	9	2.8 %
	Others	9	2.8 %
Gender	Male	251	78.4 %
	Female	68	21.3 %
	Other	1	0.3 %
Age	18–20	4	1.3 %
	21–25	17	5.3 %
	26–30	43	13.4 %
	31–35	50	15.6 %
	36–40	55	17.2 %
	41–50	79	24.7 %
	51–60	50	15.6 %
	60+	22	6.9 %
Driving status			
During pandemic	Public transport	87	27.7 %
	Ride-hailing apps	85	27.1 %
	Delivery apps	95	30.3 %
	Does not work in transport	47	15.0 %
Pre-pandemic	Public transport	93	29.2 %
	Ride-hailing apps	138	43.3 %
	Delivery apps	54	16.9 %
	Does not work in transport	34	10.7 %
Education			
Educational level	Without studies completed	5	1.6 %
	Elementary School	6	1.9 %
	Secondary School	120	37.5 %
	Technical studies	94	29.4 %
	University studies	78	24.4 %
	Postgraduate studies	17	5.3 %
Currently studying	Yes	39	12.2 %
	No	281	87.8 %
Total sample		320	100.0 %

survey to their members. A similar approach for the analysis of working conditions of ride-hailing drivers in Chile (pre-pandemic) was implemented by Fielbaum and Tirachini (2021). No monetary reward was provided to survey respondents. The survey was implemented on the platform Qualtrics. No IP (Internet Protocol) address could complete the survey more than once.

The general attributes of the sample, as well as the driving status, are reported in Table 2. These results show a masculinized occupational segment in our sample, with 78.4 % of the sample being male, and 94.4 % declaring Chilean nationality. In comparison, the survey made by the National Productivity Commission to ride-hailing drivers in Chile (CNP, 2019) shows that around 8 % are women and between 4 % and 8 % are migrants. In relation to age, one out of four drivers in the sample (24.7 %) is between 41 and 50, while approximately one out of three drivers in the sample (32.8 %) is between 31 and 40. Prior to the pandemic, ride-hailing app drivers accounted for 43.3 % of the sample, while public transport and delivery app drivers accounted for 29.2 % and 16.9 % of the sample, respectively. This situation changed during the pandemic, as the three jobs concentrate a similar number of cases: public transport, ride-hailing, and delivery drivers are 27.7 %, 27.1 % and 30.3 %, respectively. This change is explained by the surge in demand for online delivery services and the reduction of demand for ride-hailing services during the pandemic. Concerning education levels, 58.9 % of the drivers have completed post-secondary studies, and 12.2 % are currently studying.

Table 3
Working conditions.

Variable	Category	Public transport	Ride-hailing apps	Delivery apps
Contract	Working contracts	100 %	4.2 %	2.5 %
	Service	0 %	14.1 %	55.6 %
	Contracts	0 %	69 %	30.8 %
	Doesn't know	0 %	12.7 %	11.1 %
Weekly hours worked	Pre-pandemic: mean	48.5	44.5	37.8
	Pre-pandemic: variation coefficient	26 %	45 %	53 %
	During pandemic: mean	33.3	25.4	34.9
	During pandemic: variation coefficient	36 %	86 %	59 %
Hourly average wage in USD	Pre-pandemic	4.9	5.1	3.6
	During pandemic	5.3	4.9	3.4
	Change	0.4	−0.2	−0.2
Pre-pandemic: additional non-transport job	Yes. Full time	21.8 %	20 %	23.2 %
	Yes. Part-time	13.8 %	20 %	32.6 %
	No	64.4 %	60 %	44.2 %
During pandemic: additional non-transport job continuity	Yes. From home	6.9 %	21.4 %	9.1 %
	Yes. At workplace	79.3 %	25 %	15.9 %
	No longer continues	13.8 %	53.6 %	75 %

3. COVID-19 effects on different types of drivers

This section describes the different impacts that the pandemic had on the transport workers in Chile. We analyse the working conditions of drivers, looking at variations in the situation before and during the pandemic. A detailed analysis is made of labour mobility during the pandemic, as well as the main reasons for stopping working in the transport industry. Indicators are also presented regarding employers' interventions to ensure the supply of work during the pandemic. Finally, the implementation of both sector-specific and general industry sanitary measures is reported, noting the relative effort that companies in each sector have made to ensure compliance with measures that contribute to reducing the spread of the Sars-Cov-2 virus.

3.1. Working conditions

Descriptive statistics in relation to the working conditions of drivers, plus our estimation of wage rates before and during the pandemic, are shown in Table 3. First, we analyse standard and non-standard contracts. We distinguish three main categories:

- (i) Work contracts, which provide the most stable working conditions, based on recognising drivers as workers employed by a company.
- (ii) Service contracts,¹¹ in which drivers have fewer labour rights and no compulsory social security contributions. These contracts suppose that the driver is providing a temporary service to a third company, with no long-term responsibilities.
- (iii) Informal working arrangements, as those between app-based companies and several drivers that do not have any written contract (a kind of labour informality).

Only in the public transport sector work contracts prevail. In ride-hailing apps, informal mechanisms with no type of written contract predominate (69.0 %). In delivery apps, there is a greater prevalence (55.6 %) of service contracts, whereas 30.8 % of the drivers from delivery apps have no contract whatsoever. These figures confirm the usefulness of the classification proposed in Table 1, i.e., that app-based jobs are non-standard.

Average working time decreased in all groups during the pandemic. Delivery drivers show the smallest drop in working time, from 37.8 to 34.9 h per week on average (7.7 % drop). It is followed by the public transport group, with a fall of 15.1 h per week on average, from an average weekly of 48.5 h to 33.4 h (31.1 % drop). Finally, the group with the greatest variation is the ride-hailing apps, with an average drop of 19.1 h per week, from 44.5 h to 25.4 h per week (42.9 % drop). The two main jobs' features are relevant to explain these figures: Those who work with passengers now work fewer hours, because fewer passengers travel. However, this effect is softened in public transport due to the existence of fixed contracts and the decision to keep bus service frequency at a high level. On the other hand, the non-standard job arrangements for delivery and ride-hailing allow for a closer match between demand and supply.

We estimated drivers' hourly wages before and during the pandemic, which could be directly calculated as the respondents reported their monthly income and the number of hours worked per week. Our estimation of hourly wage rates in Table 3 shows that wages did change because of the pandemic, and that the variation was different depending on the type of job. Before the pandemic, ride-hailing drivers presented the highest hourly wage, followed by public transport drivers. Noteworthy is that app drivers have expenses (such as fuel, maintenance and depreciation of the vehicle) that are not included in this estimation. The estimation for ride-hailing, when translated into the local currency, coincides with the estimation of Fielbaum and Tirachini (2021). The pandemic caused different effects: whereas wage rates in public transport increased, app workers slightly reduced their wages. In the case of public transport (standard working conditions job) this can be explained because of an insufficient number of available drivers, which is covered with extra hours (that are quite common in Santiago's public transport system). The demand for ride-hailing dropped severely, which explains the decrease in those drivers' hourly wage. Delivery apps, on the other hand, have faced a boom in their sales: why this yields lower hourly wages might relate to a higher number of riders, to the salary policies of the respective companies or to the loss of nightly deliveries due to curfews (or a combination of all of them).

Finally, the prevalence of extra jobs that are additional to those in the transport industry should be noted. Prior to the pandemic, the delivery sector had a greater relative concentration of cases with simultaneous employment in other sectors, with 23.2 % in full-time mode and 32.6 % in part-time mode. In ride-hailing, 40 % of cases had an additional job, distributed equally between full-time and part-time. As expected, the

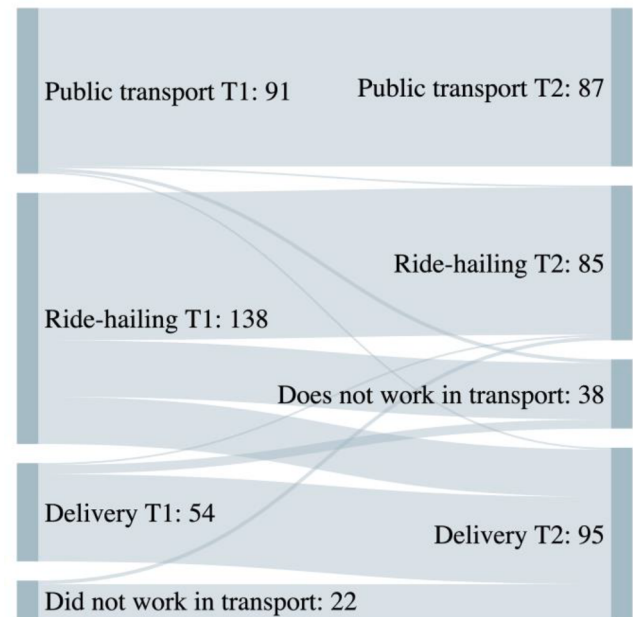


Fig. 2. Labour mobility among different transport sectors, from T1 “before the pandemic” to T2 “during the pandemic”.

public transport sector is where the least prevalence of other employment was observed (35.6 %), with 21.8 % declaring other employment in full-time mode and 13.8 % in part-time mode. During the pandemic, those extra jobs were largely lost: 75.0 % of delivery drivers and 53.6 % of ride-hailing drivers, who had a second job before, lost it during the pandemic. Therefore, our findings show that in the wake of a large economic shock such as the COVID-19 pandemic, these types of non-standard job arrangements become the single source of income for several drivers, significantly increasing their relevance as job generators compared to the pre-pandemic situation.

3.2. Labour mobility due to the pandemic

Fig. 2 shows a Sankey diagram of labour mobility due to the pandemic among the different groups. This mobility was very different depending on the group. The ride-hailing group was the largest before the pandemic, and it became the smallest during the pandemic (among those that still work in transport), mostly because ride-hailing drivers switched to delivery (26 respondents) or they do not work in transport anymore (31 respondents). Most of the drivers that were doing deliveries before the pandemic remained in that job, only 5 delivery drivers stopped working. Most of the new transport workers during the pandemic (20 respondents) started to work in delivery. The public transport group remained mostly unchanged during the pandemic.

These changes can be explained as follows. Working in public transport is a standard working condition job, so it is less affected by this crisis. The other two jobs are non-standard, and the delivery sector has become much more in demand than the mobility services. Working for the delivery apps became an alternative source of income for people whose regular jobs were lost or reduced.

Reasons to quit are depicted in Fig. 3, which shows that different situations can be observed according to the sector. In the ride-hailing group (the one with more people that do not work anymore in transport), the main reasons to quit their jobs are lockdowns (9 respondents), having to take care of someone else (8) and fear of contagion (6). Only 5 people from the delivery group and 2 from the public transport group stopped working in transport, which is explained by dismissals (2 and 1, respectively), fear of contagion (2 and 0), having to take care of someone else (0 and 1), and lockdowns (1 and 0). Noteworthy is that the fear of

¹¹ These contracts have become massive in the last decades in Chile (Ruiz and Boccardo, 2014), where the whole labour market is quite flexible. Ride-hailing and delivery drivers can be seen as an extreme case of this generalized flexibility.

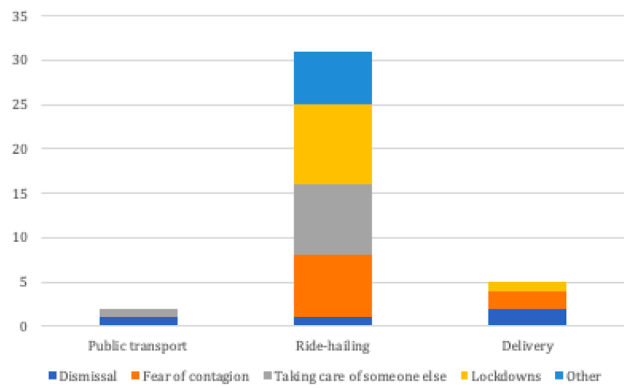


Fig. 3. Reasons to quit the transport job.

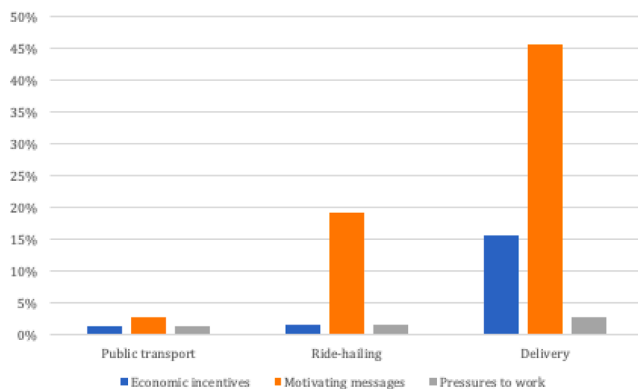


Fig. 4. Circumstantial incentives to work.

contagion appeared to be more relevant for the ride-hailing group, because they are directly carrying passengers in a small vehicle, which might be yet another explanation for switching towards the delivery group. Something similar happened with the lockdowns that prevented ride-hailing drivers from being able to work at all, leaving delivery drivers largely unaffected as they were considered essential workers during lockdowns.

3.3. Extra incentives to work

In order to analyze the relationship between the companies and the drivers during the pandemic, we asked the respondents to report if they received some type of employer's intervention to ensure labour participation during the pandemic, using a Likert-type scale: never, almost never, sometimes, almost always, or always. The relative number of cases that are always or almost always is depicted in Fig. 4. The highest prevalence is observed in delivery apps where 15.7 % of drivers received economic incentives to work, and 45.7 % received motivating messages to work; the same category reaches 19.4 % in the ride-hailing group, which might be a reflection of the different demand patterns for both services during the pandemic. Public transport drivers reported almost no incentives or pressure. This difference between public transport and apps-based jobs can be related to the standard or non-standard working conditions, as those that work for apps can choose whether to work and when.

3.4. Sanitary measures and employer role during the pandemic

We now analyse the health measures adopted in the transport industry during the pandemic. Table 4 reports on the prevalence of certain sector-specific measures, as well as how general health measures were implemented.

In relation to a first body of measures, preventing older workers from driving is reported mainly in the public transport sector (72.1 %), while training on sanitary measures is mostly reported by the ride-hailing apps (58.5 %) and delivery apps (57.6 %) sectors. On the other hand, 32.3 % of the drivers in the public transport sector declare that the installation, improvement or maintenance of a safety cabin that isolates them from the passengers, while 30.2 % of the ride-hailing drivers declare the implementation of rear door passenger entrance.¹² Then, 94.9 % of the delivery app's drivers declared the implementation of a sanitary protocol for delivery.

Now, in a second, more general, set of measures, we can see that companies made different efforts depending on the sector. In the public transport sector, the implementation with company resources predominates: this is the case for 91.8 % of the drivers regarding wearing a mask, 88.5 % regarding hand sanitisers and 70.5 % regarding frequent sanitisation of the vehicle. For the ride-hailing group, "implementation with own resources" is the most common response: this is the case for 68.9 % of the drivers regarding wearing a mask, 70.9 % regarding hand sanitiser usage, and 68.9 % regarding vehicle sanitisation. For the

Table 4
Sanitary measures during the pandemic.

Group	Variable	Public transport	Ride-hailing apps	Delivery apps
General	Training on sanitary measures	39.3 %	58.5 %	57.6 %
	Avoidance of work by older workers	72.1 %	13.2 %	10.1 %
Passport transport	Installation, improvement or maintenance of the safety cabin	32.3 %	17 %	–
	Rear door passenger entrance	23 %	30.2 %	–
Delivery	Sanitary protocol for delivery	–	–	94.9 %
General measures	Type			
	Implemented: company resources	91.8 %	9.8 %	52.5 %
	Implemented: own resources	8.2 %	68.9 %	42.6 %
	Not implemented	0 %	8.2 %	1.6 %
Hand sanitisers usage	Implemented: company resources	88.5 %	8.2 %	55.7 %
	Implemented: own resources	9.8 %	70.5 %	37.7 %
	Not implemented	1.6 %	8.2 %	3.3 %
Vehicle sanitisation	Implemented: company resources	70.5 %	9.8 %	3.3 %
	Implemented: own resources	24.6 %	68.9 %	59.9 %
	Not implemented	4.9 %	8.2 %	34.4 %

¹² Before the pandemic, the usual practice was carrying passengers at the front seat, to avoid conflicts with traditional taxi drivers.

Table 5

Percentage of drivers that have faced the COVID-related risky situation.

	Public transport	Ride-hailing	Delivery
To carry passengers that might have COVID-19	66,7%	63,8%	19,7%

delivery group, mixed situations are observed. Wearing a mask is reported as implemented with own resources by 52.5 % of the riders and implemented with company resources by 42.6 %; hand sanitiser usage is reported as implemented with own resources by 37.7 % of the riders and implemented with company resources by 55.7 %; vehicle sanitisation is the measure with the highest prevalence of implementation with own resources (59 %) as well as the highest rate of non-implementation with 34 % of delivery drivers. A relevant conclusion from these figures is that the existence of a regular employer, providing the necessary resources to implement these preventive measures, increases the chance that such measures do take place.

3.5. Risky situations faced by the drivers

Following Fielbaum and Tirachini (2021), the drivers were also asked about risky situations while driving. Besides the situations already asked in that paper, we asked for an additional COVID-specific issue: have you transported passengers with symptoms that look like COVID-19, without being protected enough?

The rates of drivers that have been exposed to this COVID-related risk are highly dependent on the job type, and are depicted in Table 5, whereas the detailed answers for the rest of the risky situations can be found in Table A.1 in the Appendix. The numbers are very concerning: about two-thirds of those drivers that work with passengers report having lived through this experience, while in the delivery group this proportion is reduced to about one fifth. This difference can be easily explained because public transport and ride-hailing drivers have more direct interaction with passengers. These high numbers are bad news not only for drivers themselves, but also imply that both mobility systems can have a role in spreading the virus when no proper measures are taken, such as the proper use of face masks and ventilation of vehicles while travelling (Tirachini and Cats, 2020). This will continue to be relevant for a post-pandemic scenario, as a main concern is how our societies can better prepare for similar future situations.

4. Drivers' concerns due to the pandemic

The pandemic situation generated different concerns that affect everybody, but that might be particularly strong for transport drivers, as their work implied a greater exposure to the virus through close contact with other people. Concerns were asked to be rated in a 1 to 5 scale, where “high concern”, as shown in Table 6, refers to the ratio of drivers that gave the maximum score 5. The fears are sorted according to this

index, from the highest to the lowest.

All three driver groups express a large level of concern about the health and financial effects of the COVID-19 pandemic. This is especially true for dimensions such as the concern that a relative or loved one is infected and that the driver's income decreases due to the pandemic, which presented over 80 % of maximum concern in all driving workers. The public transport sector stands out for presenting the highest prevalence in dimensions such as the risk of own COVID contagion (81.8 %), passenger crowding or agglomerations in public transport (74.2 %) and the saturation of hospitals (90.9 %). Drivers from delivery apps have fewer concerns about the possibility that a large number of people die due to COVID (77.1 %) and about being infected by the virus (65.6 %). However, delivery workers have a considerable concern about economic issues: 88.5 % are concerned about not being able to pay debts, while 83.6 % are concerned about the fact that the COVID-19 pandemic may cause a large economic crisis in the country. Thus, the main conclusion of this section is that delivery drivers are the group with the lowest perceived health risk, but with a high level of economic vulnerability; the ride-hailing sector is in an intermediate position between the opinions of public transport and delivery drivers in almost all variables, with the exception of their high concern about an income decrease, which might relate to the lack of demand for this service during the pandemic. The fact that both economic and health-related concerns present similar overall values reveals that both types of consequences (fear of the virus itself, and fear of the economic consequences of the general COVID-19 crisis) are affecting drivers.

5. Changes in job satisfaction

As the pandemic impacted the whole daily working experience, the job satisfaction felt by transport workers is expected to change. Job satisfaction refers to the general affective orientation of individuals towards the job roles that a worker currently occupies, whose determinants are multidimensional (Kalleberg, 1977). External and internal determinant factors can be distinguished (Muchinsky, 2000) as well as a comparison between the current job situation and another past or ideal reference, so it is always a relative judgment (Gamero Burón, 2004).

To measure changes in job satisfaction, we took six questions regarding job satisfaction from the First National Survey on Job, Health and Quality of life (MINSAL, 2011): 1) Do you enjoy working? 2) Does your job leave you enough free time? 3) Do the concerns and problems from your job prevent you from enjoying your free time? 4) Do you finish your workday so exhausted that you only want to rest? 5) Does your job make you feel permanently stressed? 6) Have you thought about changing your job due to lousy labour conditions? In addition to these six questions, and considering the impact of the pandemic on wages, we also asked 7) Is your wage enough for your basic and regular needs? All these seven questions were answered in a Likert-type scale (never, almost never, sometimes, almost always, or always, which are coded as 1–5 for the numerical analysis below), and considering the pre-pandemic and the current situation. By these means, we can compare the

Table 6

Drivers that answered the maximum level of COVID-related concerns and fears.

Variable	Category	Overall	Public transport	Ride-hailing apps	Delivery apps
High concern	Insolvency to pay debts	86.1 %	81.8 %	86.2 %	88.5 %
	Relative COVID contagion	85.1 %	87.9 %	82.8 %	85.3 %
	Income decrease	85.1 %	81.8 %	87.9 %	83.6 %
	Health system collapse	84 %	90.9 %	77.6 %	83.6 %
	Economic crisis	82.5 %	78.8 %	82.8 %	83.6 %
	Numerous deaths	82 %	86.4 %	82.8 %	77.1 %
	Own COVID contagion	72.2 %	81.8 %	67.2 %	65.6 %
	Public transport Agglomerations	68 %	74.2 %	67.2 %	60.7 %



Fig. 5. Changes in job satisfaction due to the pandemic. All scales are determined so that a lower value implies a worse situation.

answers to measure their change due to the COVID crisis.

Fig. 5 reports the job satisfaction levels reported by drivers considering the pre-pandemic period and the reference period of the questionnaire (during the pandemic), distinguishing by job type. Note that some questions were written such that the higher the value, the larger the satisfaction, and others were the other way around. To ease the interpretation, in Fig. 5 we mirror the replies to some of the questions, such that value 1 always represents the lowest level of satisfaction, while value 5 represents the highest level of satisfaction. Overall, there was a general decline in job satisfaction at the time of the pandemic (−19.3 %), from a mean of 2.97 to 2.4. This is replicated for all groups, with the most significant variation occurring in the delivery drivers group (−21.7 %).

In a more detailed analysis, the items “Enjoy working”, “Job

concerns during free time”, “Stress due to work” and “Wage in relation to needs” are the ones that present the largest average score reductions, dropping near one point in the satisfaction scale during the pandemic: for the public transport group negative variations are observed with −18.7 %, −28.9 %, −40.5 %, and −22.9 %, respectively; for the ride-hailing group negative variations of −25 %, −22 %, −28 %, and −44.2 % are observed; finally, for the delivery group negative variations of −21.2 %, −33.1 %, −42.1 %, and −24.3 % are observed respectively.

Only for the item “Enough free time”, there is a positive but marginal variation during the pandemic (+4.5 %). This is explained by the fact that the public transport group increased its score by 12.1 %, while the ride-hailing app group increased its score by 5 %. However, for the delivery group, the trend is reversed, as the item’s score (−3.4 %) deteriorated during the period of interest. As discussed above, both the

Table 7

Explanatory variables for the model of fears and concerns.

Variable	Type of variable	Description
1. Explanatory variables		
COVID risk	Dummy	1 = Has carried passengers that seemed to have COVID without enough protection.
Training	Dummy	1 = Participated in some training regarding COVID.
Elderly care	Dummy	1 = The company excluded older adults from working during the pandemic.
Mask	Dummy	1 = Wears a face mask while working.
Hand sanitiser	Dummy	1 = Uses hand sanitiser often while working.
Vehicles sanitisation	Dummy	1 = The vehicle is sanitised more often during the pandemic.
Ride-hailing-ride-hailing	Dummy	1 = Was a ride-hailing driver before the pandemic and continues to do so.
Delivery-delivery	Dummy	1 = Was a delivery rider before the pandemic and continues to do so.
Ride-hailing-delivery	Dummy	1 = Was a ride-hailing driver before the pandemic and is now a delivery rider.
Sociodemographic variables		
Age	Ordinal	–
Sex	Dummy	1 = Woman, 0 = Man.
Tertiary education	Dummy	1 = Tertiary studies completed, 0 = Otherwise.
Working conditions		
Had full-time job	Dummy	1 = If he/she had a full-time job other than transport.
Had part-time job	Dummy	1 = If he/she had a part-time job other than transport.
Lost full-time job	Dummy	1 = If he/she had a full-time job other than transport and lost it due to COVID.
Lost part-time job	Dummy	1 = If he/she had a part-time job other than transport and lost it due to COVID.
Current working time	Intervalar	Weekly hours working in transport.
Current wage	Intervalar	Monthly wage due to transport.
Past working time	Intervalar	Weekly hours working in transport in the pre-COVID situation.
Past wage	Intervalar	Monthly wage due to transport in the pre-COVID situation.

public transport and the ride-hailing groups reported a decrease in their working times during the pandemic.

All-in-all, it is observed that the pandemic has negatively affected the levels of job satisfaction in all interest groups. Together with the increase in stress and fatigue linked to the work process, the levels of enjoyment of the work activity have decreased significantly, as has the satisfaction with wages in relation to needs. Likewise, there is an increase in the concerns about job-related matters during the drivers' free time, and more drivers think of changing jobs during the pandemic.

In order to uncover how the different job types, as well as other working and sociodemographic characteristics, influence differences in job satisfaction before and during the pandemic, we specify ordinal probit regressions to identify the variables that are statistically significant in increasing or reducing the different dimensions of job satisfaction under study. Probit and logit models are frequently used in transport analysis for the analysis of ordinal variables. For instance, Alemi et al. (2019) use an ordinal probit model to estimate the frequency of use of ride-hailing services in California, while Fielbaum and Tirachini (2021), use probit models to study the job satisfaction of ride-hailing drivers in Chile.

We estimated one probit model for each of the seven dimensions of job satisfaction. That is, each of the models is computed for only one of the explained variables. A probit model means that the parameters are estimated assuming that probabilities are given by Eq. (1), where X is the explained variable (any of the seven dimensions of job satisfaction), Φ is the cumulative probability function for a standard normal distribution, Z_k are the explanatory variables, and β_k the parameters to be estimated. The intercepts γ_i refer to the specific probabilities of each category i (Greene and Hensher, 2010). To be precise, the equations governing the probit model are

$$P(X \leq i) = \Phi(\gamma_i + \sum_k \beta_k Z_k) \quad (1)$$

Eq. (1) implies that:

$$\frac{\partial P(X \leq i)}{\partial z_k} = \beta_k \phi'(\gamma_i + \sum_k \beta_k z_k) \quad (2)$$

Eq. (2) implies that

$$\text{sign}\left(\frac{\partial P(X \leq i)}{\partial z_k}\right) = \text{sign}(\beta_k) \quad (3)$$

Let us analyze Eq. (3) by cases. If $\beta_k < 0$, a greater value of z_k will increase the chances of X being small (smaller than any i). That is, a negative β_k means that z_k and X are inversely correlated. The exact opposite situation occurs when $\beta_k > 0$.

How to include the past and present situation in a probit model is not straightforward. Let X_{past} and $X_{current}$ be the dependent variables, and $Z_1, \dots, Z_N$ the independent variables. We are interested in the difference $X_{current} - X_{past}$, which cannot be directly used as the explained variable because the ordered models require the explained variable to be natural (≥ 0). To face this issue, we take X_{past} as another explanatory variable, and consider $X_{current}$ as the dependent variable. By these means, if the pandemic has no effect, all the other variables will be not significant. We can look at it the other way around, i.e., the explanatory variables other than X_{past} will capture only the changes in the explained variable due to the pandemic, which is precisely our purpose.

A set of 9 explanatory variables is selected, which condense the most important characteristics of the respondents regarding the two aspects we study in this paper: their experience with COVID and the type of job. To control for other possible explanations, we include 11 control variables reflecting the sociodemographic and working characteristics, which are known to affect job satisfaction as discussed in Section 1. Note that the mathematical role played by all these 20 variables is equivalent, but the distinction is relevant to focus the subsequent analysis. The variables are fully described in Table 7. The Variance Inflation Factor (VIF) is below 2.7 for all of them, meaning that there is no collinearity (i.e., no problematic correlation among the explanatory variables).

The probit models are estimated using Matlab. The results are exhibited in Table 8, where we show the value of the coefficients and the t -test, marking with one, two or three asterisks when the respective variable is significative for $\alpha = 0.1, 0.05$, and 0.01 , respectively. To read Table 8, recall that in the specification of the probit model we use Eqs. (1)–(3), a negative value of the coefficient means that the respective explanatory variable increases the value of the explained variable (as

Table 8

Value of the coefficients and *t*-test for each of the models explaining changes in job satisfaction. We mark with one, two or three asterisks when the respective variables are significant for $\alpha = 0.1, 0.05$, and 0.01 , respectively.

	Enjoy working		Enough free time		Job concerns during free time		Exhaustion due to work		Stress due to work		Thinking of changing jobs		Wage in relation to needs	
	B	t	B	t	B	t	B	t	B	t	B	t	B	t
Explanatory variables														
Covid risk	1,23***	4.33	0.11	0.44	−0,76***	−2.86	−0,5*	−1.9	−1,06***	−3.87	−1,1***	−3.21	0,8***	3.02
Training	−0.23	−1	0.05	0.24	−0.29	−1.29	0.27	1.2	0.17	0.73	0.25	0.93	0,49**	2.18
Elderly care	−0.18	−0.63	−0,51*	−1.81	0,5*	1.77	0.34	1.22	0,69**	2.35	0,85***	2.59	−0.09	−0.33
Mask	−0.21	−0.26	−0.16	−0.19	0.77	0.9	0.78	0.91	−0.09	−0.09	−0.17	−0.18	−1,68*	−1.81
Hand sanitiser	0.06	0.1	−0.61	−1.02	0	0	0.14	0.23	0.32	0.5	0.16	0.26	0.82	1.29
Vehicles sanitisation	−0.13	−0.35	0.1	0.27	−0.08	−0.21	−0.31	−0.84	−0,72*	−1.9	0.17	0.41	−0.14	−0.36
Ridehailing- Ridehailing	−0,7*	−1.77	0.42	1.12	0.56	1.46	0	0.01	0.42	1.09	−0.23	−0.53	−0.05	−0.13
Delivery-Delivery	1,44***	3.29	0.22	0.51	−0.34	−0.8	−0,81*	−1.84	−0,89**	−1.98	−1,15**	−2.29	0,7*	1.66
Ridehailing-Delivery	0.12	0.29	0.05	0.12	−0.03	−0.06	−0,99**	−2.21	−0.39	−0.86	−0,98**	−2.06	0.27	0.63
PreCovid Satisfaction	−0,4***	−3.14	−0,68***	−6.02	−0.11	−1.22	−0,44***	−4.4	−0,56***	−5.41	−0,69***	−6.07	−0,31***	−3.07
Sociodemographic														
Age	0.97	1.43	0.82	1.2	−0.02	−0.03	−1	−1.47	−0.78	−1.12	−0.65	−0.84	0.24	0.36
Gender	−0,58**	−2.03	−0.42	−1.47	0.03	0.12	0.17	0.6	−0.06	−0.2	1,51***	3.89	−0.27	−0.96
Tertiary education	−0,5**	−1.98	−0.14	−0.56	0.07	0.28	0.17	0.72	0.19	0.75	0.19	0.66	−0,41*	−1.69
Working conditions														
Keeps full-time job	0.41	1.29	0.17	0.55	−0,64**	−1.99	0.27	0.84	−0,63*	−1.84	−0.3	−0.83	−0.46	−1.44
Keeps part-time job	0.09	0.23	0	0	−0.26	−0.75	−0.16	−0.46	−0.24	−0.67	0.18	0.41	−0.58	−1.58
Lost full-time job	0.09	0.21	0.34	0.83	−0.43	−1.05	−0.08	−0.19	−0.16	−0.38	−0.64	−1.38	0.22	0.52
Lost part-time job	0.42	1.1	0,68*	1.79	−0,73*	−1.91	−0.2	−0.54	−0,7*	−1.72	−1,32***	−2.96	0.34	0.88
Current working time	−1,12**	−1.97	1,09**	2.04	1,04*	1.89	−0.83	−1.56	0.82	1.48	0.49	0.83	−1,09*	−2.07
Current wage	−0.96	−1.18	0.1	0.13	−0.68	−0.87	−0.81	−1.04	0.16	0.2	1.08	1.24	−1,98**	−2.48
Past working time	0.14	0.23	−1,24**	−2.09	−1,83***	−3.1	0.67	1.14	−0.95	−1.52	−1,65**	−2.44	1,67***	2.81
Past wage	0.47	0.82	0.29	0.5	−0.14	−0.24	−0.24	−0.41	−0.57	−0.96	1,19*	1.86	1,35**	2.3
Intercepts														
1–2	−0.2	−0.19	0.37	0.35	−0.03	−0.03	0.44	0.42	1.28	1.14	1.14	0.93	−0.26	−0.25
2–3	0.36	0.34	1.54	1.48	0.54	0.53	1.24	1.18	2.03	1.82	1.55	1.27	0.53	0.52
3–4	1.46	1.37	2.49	2.36	1.39	1.35	2.11	1.99	3.01	2.67	3.47	2.75	1.62	1.57
4–5	2.41	2.23	3.53	3.29	2.24	2.17	2.89	2.71	3.94	3.45	4.39	3.42	2.65	2.53

done in Matlab¹³ 2020a). Here we do not mirror the values of any variable, so for the columns corresponding to positive aspects “Enjoy working”, “Enough free time”, and “Wage in relation to needs”, a positive sign implies that drivers are worse, whereas the contrary happens in the other columns because the questions refer to negative things.

Our models are significant, as the explanatory variables play indeed a relevant role in determining how job satisfaction diminished due to the pandemic. Only two of the dimensions (“Enough free time” and “Job concerns during free time”) present almost no significant explanatory variables, and depend mostly on working conditions; others (such as “Enjoy working” or “Exhaustion due to work”) are explained (almost) only by the variables we highlight in this paper, whereas the remaining dimensions are affected by both types of variables. In other words, COVID-related measures and the type of transportation job are variables that are required to understand the changes in job satisfaction in this context. Moreover, the previous job satisfaction is significant at the highest level for all the dimensions but “Job concerns during free time”. That is, in general, our approach to model the changes correctly captures the relationship between satisfaction before and during the pandemic. The unique status found for the dimension of job concerns during free time suggests that the impact of COVID has been particularly strong regarding this concern.

Let us first analyze the role of the type of work. App-based drivers have been more affected in general than public transport (which is the base case). First, those that remain as delivery drivers report a stronger degradation in enjoying their jobs, stress, exhaustion, a desire of changing jobs, and receiving enough income, revealing how working as a rider has become much more demanding due to the surge in the utilization of this type of service, without a sufficient monetary compensation. Second, those who worked in ride-hailing but switched to delivery during the pandemic report a sharper increase in exhaustion and a desire to change jobs. The exhaustion is related to the increase in the demand for delivery services, but also to the fact that some delivery riders use a bicycle to move, which requires more physical effort than driving a car as in ride-hailing. Moreover, for such a group, working as a delivery driver is probably a temporary solution because their previous job in ride-hailing is not available anymore, so that the desire of switching jobs is easy to interpret. Only those that remain in ride-hailing report little impacts. In other words, the type of job that became predominant during COVID in our sample (delivery riders) is exactly the one in which the job satisfaction was degraded to a higher extent.

COVID has not only affected because of the changes in the demand and the chance of working when there are lockdowns. The direct effect of having transported someone who looks like having COVID sharpens the degradation of several dimensions of job satisfaction, which is very relevant as this was a very common situation for those that transport passengers (as shown in Table 5). On the other hand, sanitary measures such as using masks, hand sanitizers, and vehicle sanitization have little to no effect. The only measure affecting job satisfaction is preventing elderly from working because they are at risk, which softens the negative changes.

6. Implications for the regulation of app-based driving jobs in a post-pandemic scenario

In the past years, there has been an intense debate about how to regulate Transportation Network Companies (TNC), and in particular, the role of their drivers. While the companies have defended that drivers are ‘partners’ that make autonomous decisions (such as when to work) that are different from standard employer-employee relationships, drivers’ unions have been created worldwide, which generally demand an explicit recognition of a labour relationship and access to workers’ rights. This discussion has been recently taken to several Parliaments

and Courts, as we exemplify in the next paragraph, in a growing debate that is far from settled. Therefore, it is fundamental to have independent research available on the situation of drivers, so that all the evidence can be taken into account by policymakers.

In Europe, Spain and England have already decided to classify drivers as employees, and the European Commission is planning a regional reform.¹⁴ In the US, the government supports similar ideas,¹⁵ although California has recently decided in the opposite direction.¹⁶ Some countries in Latin America have regulated these companies, without considering drivers as employees,¹⁷ which has been a source of conflict.¹⁸ In Chile, during 2020 and 2021 three bills were discussed in the Parliament to regulate these platforms (Asenjo and Coddou, 2021; Morris, 2021), which differ in this crucial aspect¹⁹; in the meantime, during 2021 a local court has claimed that there exists an employment relationship in the case of delivery riders.²⁰

Our study reveals that the pandemic has affected standard and non-standard jobs differently. Public transport drivers have kept their jobs, with similar wages, and the same level of social security. They also report having received more measures to protect them from the virus, which has yielded a softer degradation of their job satisfaction. Non-standard jobs such as ride-hailing and delivery app drivers do not have social security, with specific impacts depending on the (app-based) type of job: several ride-hailing drivers have suddenly lost their jobs without any support or compensation, a situation that becomes more dramatic for those who have gotten into debt to buy their vehicles, which was already identified as problematic even before the pandemic (Agarwal et al., 2019); Delivery riders, on the other hand, are also earning less money per hour, are more exhausted, and express the greatest concerns and largest decrease in their job satisfaction. Therefore, they continue working because they need to, but also suffer the lack of protection as they cannot opt to stop working (or to do it from home), which coincides with the findings from Del Bono (2019) for delivery drivers in Argentina.

All these troublesome situations were directly related to the lack of formal protection. In traditional dependent jobs, when external conditions lead to a reduction in the demand for a certain good, workers do have some protection, such as severance payments or formal duration of the contracts. Similarly, wages and work requirements cannot change unilaterally, and a minimum level of salary has been guaranteed during extremely exceptional situations such as the pandemic. In other words, the negative consequences of the non-standard working conditions of this type of job, as our results show, have sharpened with the pandemic.

As such, the first implication of our study is the need to regulate these jobs to ensure that they count with the same social security provisions as regular jobs, i.e., to recognize that drivers are working for the respective companies. Even in a post-pandemic scenario, unexpected situations can always occur, so it is not sustainable to maintain working conditions in which drivers are as unprotected as now. As shown by Boccardo et al.

¹⁴ See <https://www.cnbc.com/2021/04/12/europe-could-be-seeing-the-end-of-its-gig-economy-deliveroo-uber.html>, accessed on 22/09/2022.

¹⁵ See <https://www.reuters.com/world/us/exclusive-us-labor-secretary-says-most-gig-workers-should-be-classified-2021-04-29/>, accessed on 22/09/2022.

¹⁶ See <https://www.theguardian.com/us-news/2021/may/16/uber-lyft-drive-rs-california-prop-22>, accessed on 22/09/2022.

¹⁷ See <https://www.paraguay.com/internacionales/las-regulaciones-a-uber-e-n-paises-de-latinoamerica-190060>, accessed on 22/09/2022.

¹⁸ See <https://www.lanacion.com.ar/economia/paro-repartidores-trabajadores-reclaman-mas-ingresos-mejores-nid2356876/>, accessed on 22/09/2022, for the case of Argentina.

¹⁹ See <https://www.larepublica.co/globoeconomia/debate-sobre-regulacion-de-apps-de-transporte-en-chile-bajo-presion-tras-el-fallo-contra-uber-3129834>, accessed on 22/09/2022.

²⁰ See <https://www.df.cl/noticias/economia-y-politica/laboral-personas/corte-de-concepcion-da-espaldarazo-a-exrepartidor-de-pedidosos-y-recalca/2021-01-16/091001.html>, accessed on 22/09/2022.

¹³ See <https://www.mathworks.com/help/stats/multinomial-models-for-ordinal-responses.html>, accessed 22/09/2022.

(2022), the current operation of these systems rests on having a large number of drivers willing to work regardless of the low income and lack of social security, which reinforces the idea that formal regulation is required.

The positive aspects of the flexibility of these jobs have also played a role during the pandemic. The ease of beginning work as a delivery rider, combined with the increased demand for these services, seems to have become a relevant opportunity for many people who lost their regular jobs. Moreover, the chance of deciding when to work has always been defended by the companies, but is also appreciated by the drivers (Fielbaum and Tirachini, 2021). Therefore, when recognizing the labor relationship between the companies and the drivers (i.e., that drivers are actually employees), it is crucial to allow for these specific types of flexibility. Note that increasing regulation in such a way that drivers are still able to decide when to work would increase companies' costs, which might be compensated with higher prices or lower profit (or a combination of both). It is worth commenting that some non-profit initiatives have been trying to find such a balance, such as RideAustin (a former cooperative ride-hailing company in Austin, Texas), The Drivers Cooperative in New York, or PídeloEnCleta, a delivery service that was recently launched by the municipality of Renca (that is part of Santiago). The cooperative aspect of these initiatives can also help avoid some unexpected harmful consequences of the proposed type of regulation. For instance, after the regulation introduced in Spain, at least one big company left the country²¹ to prioritize more lucrative markets, whereas another one asked the riders to bargain the prices they would offer²² to circumvent the new regulation and keep the non-standard working conditions.

There are also implications regarding the sanitary measures, which are valid while the pandemic is not fully overcome, and are necessary to be better prepared for future similar crises. As reviewed by Tirachini and Cats (2020), an extensive body of literature has been built to understand the measures to reduce or prevent the spread of the virus in public transport systems, which include the use of masks, ventilation, sanitisation, and even the requirement of passengers not talking to each other. However, our study reveals that, in Chile, the measures to prevent the virus from spreading are less common in app-based transportation services (both ride-hailing and delivery), which is a natural consequence of their non-regulated working status. Regulating these platform-based services entails other aspects than their drivers (e.g., how to price or tax these services), most of which are out of the scope of this study (see Tirachini and Del Río, 2019), but the pandemic has revealed that countries need to be able to require these companies to implement specific measures (e.g., sanitary) as a response to unexpected external conditions. Finally, it is worth highlighting that the flexibility offered by on-demand systems played a crucial role in the delivery of basic products during lockdowns, and can also increase the resiliency of public transport in future unexpected upheavals (Auaed et al., 2021), so that transport authorities should study the incorporation of on-demand technologies for the mobility of both people and goods.

7. Synthesis and conclusions

The health and economic crisis provoked by the COVID-19 pandemic has had a strong impact on the transport sector, where its drivers have been particularly affected both because of the risks of catching the virus while working and by the changes in the demand for their services, with profound implications for job satisfaction and related concerns that go well beyond job-related matters. In this paper, we analyze these issues and compare the situations lived by different types of driving jobs, by

studying a survey applied to drivers working in public transport, ride-hailing and delivery companies during the first wave peak of the pandemic in Chile (2020).

Our results confirm that the magnitude of the COVID-19 impact has been quite large for all these jobs, and that the negative effects are stronger for those that work (or used to) for app-based companies, many of whom have changed jobs (mostly leaving ride-hailing and/or joining delivery) and whose hourly wages have been reduced, a fact that is very relevant because many complementary jobs (other than transport) have also been lost. The reduction in people's mobility induced a decrease in working times for ride-hailing and public transport drivers. Everybody showed high concerns regarding the health and economic repercussions of the pandemic, and a deteriorated perception of their job satisfaction.

App-based jobs have rapidly emerged in the past few years, and the consequences of their non-standard working conditions have been thoroughly discussed: on the one hand, highlighting that drivers have the ability to decide when to work, while on the other hand expressing concerns about the lack of labour rights and protection. All these characteristics were sharpened by the pandemic.

The lack of regulation during pandemic, however, has other relevant effects on public health, as public transport drivers report the highest use of preventive measures (such as masks or hand sanitiser gel), which responds to the fact that those measures were mostly implemented by their employers, whereas app workers, deemed as "independent partners" by the companies, had to implement them mostly using their own resources. This conclusion is reinforced by the fact that almost two-thirds of public transport and ride-hailing drivers report that they have carried passengers with symptoms that look like COVID-19, so the lack of appropriate protection can have very adverse consequences both for the drivers and the rest of the passengers.

How these situations will affect a post-pandemic scenario remains unknown and depends on several factors other than the working conditions themselves, such as the trend of working from home, which reduces the demand for travel (although might increase the distances that are travelled, as shown by Caldarola and Sorrell, 2022), or if the surge of delivery services remains. Internal factors are also relevant, like the willingness to acquire vehicles for these jobs under uncertain conditions, and the result of several judicial processes that are taking place in Chile and abroad, to regulate the labor relationship between employees and employers in ride-hailing and delivery apps. In any case, one might expect that the situation for transport workers after the pandemic is not going to return to the pre-pandemic era. Such an uncertain scenario, together with our findings that the pandemic had stronger effects on app-based drivers due to their non-standard working conditions, reinforces the need for a regulation of these services that relies on formal jobs and worker protection.

Due to the impacts of the pandemic on this type of employment, a debate on the labor regulation of digital service platform workers in Chile began in earnest. Although, as noted above, there have been as many as three different legislative proposals (Morris, 2021) over the past three years, it was not until early 2022 (two years after the time of data production for this study) that a bill was passed, which seeks to incorporate app workers into some aspects of labor legislation. The bill allows the formalization of these workers, either through an employment contract or a contract for the provision of services: that is, it seeks to legalize these occupations by guaranteeing a common basis of minimum conditions of social security, governmental inspection, access to information on the algorithmic determination of wages and working hours, and enabling the possibility of union organization, although without the right to strike or legal labor privileges (SUBTRAB, 2022). Despite these advances, academic observers have pointed out that it leaves open the discussion on whether these workers are considered *a priori* dependent or independent, a matter that is subject to a judicial determination within the current legislation. The bill legalizes for the so-called *independent workers* a contract of a "non-labor" nature that implies consolidating a step backwards in conditions of precarious labor flexibility, by

²¹ See <https://www.20minutos.es/tecnologia/aplicaciones/deliveroo-cierra-definitivamente-su-negocio-en-espana-4896847/>, accessed on 22/09/2022.

²² See <https://www.businessinsider.es/glovo-rectifica-nuevo-sistema-asignacion-pedidos-916955>, accessed on 22/09/2022.

letting them outside the protection of labor laws (Leyton et al., 2022).

Thus, beyond current regulatory efforts, the debate is open due to the factual labor dependence that exists in this type of work (Asenjo and Coddou, 2021). Especially considering the algorithmic control that characterizes this type of productive activities mediated by digital platforms: as the literature points out, although there can be no direct coercion, this type of digital mechanisms can intensify the experience of subordination of workers (Boccardo and Ruiz Bruzzzone, 2021).

Therefore, the most relevant questions for future research are related to gaining a more comprehensive understanding of the new working realities brought by app-based driver jobs. On the one hand, understand the evolution of these jobs, that are increasing their numbers and that have become representative of the so-called sharing economy, and modifying the working conditions of multiple workers across the globe: as other research has pointed out (Asenjo and Coddou, 2021; Morris, 2021), the digital platform workforce is difficult to classify with traditional labor market measurement instruments (Jirón et al., 2021). Likewise, as we have explained in this research, this difficulty of classification means that there is no reliable monitoring of the number of people employed in this type of work or of the specific attributes of their work processes. On the other hand, the pandemic crisis have increased the need for proper regulation, able to keep those features that are best evaluated by drivers, like the flexibility to decide when to work, while providing more labor stability and social security: it is pending an exhaustive evaluation of current regulation efforts on digital platform mediated transport work around the globe. Moreover, while many scholars have identified the need for studying how to integrate these on-demand services with public transport because it might lead to an improved transit network and a reduction in private mobility (therefore, in congestion and emissions), our findings suggest yet another reason for this integration, namely providing similar working conditions for all those that work in transport. This discussion, that has been mostly had regarding people's mobility, shall also include the delivery of goods.

CRedit authorship contribution statement

Andrés Fielbaum: Conceptualization, Data curation, Formal analysis, Methodology, Software, Writing – original draft, Writing – review & editing. **Felipe Ruiz:** Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Giorgio Boccardo:** Conceptualization, Data curation, Formal analysis, Methodology, Software, Writing – original draft. **Daniela Rubio:** Conceptualization, Formal analysis, Methodology, Writing – original draft. **Alejandro Tirachini:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Jorge Rosales-Salas:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

(See Table A1).

Table A1

Risky situations faced by the drivers.

	Public transport	Ride-hailing	Delivery
Drive in unsafe places	56,1%	72,4%	62,3%
Taxi drivers' threats or attacks	24,2%	19,0%	14,8%
Passengers' threats or attacks	54,5%	17,2%	13,1%
Being assaulted by a passenger	28,8%	53,4%	23,0%
Being assaulted by someone else	21,2%	27,6%	37,7%
Accident with injuries	15,2%	10,3%	19,7%
Accident without injuries	15,2%	20,7%	31,1%
None of the above	9,1%	5,2%	14,8%

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