On the potential of Idle wages to regulate the relationship between ride-hailing platforms and drivers

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1 INTRODUCTION

A central, timely, and controversial question in ride-hailing systems is about the work status classification of drivers in the platform. Are drivers independent agents, or should they be classified as employees? The answer is non-trivial, as driving for a ride-hailing platfom entails significantly more freedom compared to atraditional job, for example, drivers have the flexibility of selecting when to work (Ramezani *et al.*, 2022). However, the price of each trip, the assigment of drivers to trip requests, and the drivers' subsequent earnings are defined by the company.

From a policy perspective, this debate has been on the agenda of many countries and states, and different measures have been taken (Fielbaum *et al.*, 2023). On the one hand, the original situation in which the drivers are regarded as independent contractors has had several negative consequences in terms of working conditions, including the wage level and transparency (Fielbaum & Tirachini, 2021, Fielbaum *et al.*, 2023, Ashkrof *et al.*, 2020). On the other hand, a strict regulation might worsen the situation: for example in Spain, after a new law was introduced, some delivery companies left the country, while others required drivers to bargain against each other, which in total seems to be leading to reduced earnings[1].

In this context, a novel alternative for the ride-hailing industry, that we term *Idle Wage*, was proposed in Chile when discussing a bill aim to address drivers' earning concerns. The basic idea behind Idle Wage is to **provide a fixed payment to drivers while they are logged into the driver app but not transporting any passenger**. This idea was borrowed from the general labour legislation, where it deals with situations in which workers are available but not performing any task because, among other causes, the employer has not assigned them one. In the case of ride-hailing, there is another argument to consider that being idle is working: The

[1] See https://www.wired.com/story/spain-gig-economy-deliveroo/, accessed on 18/04/2024

platform benefits when more drivers are connected, as the users' waiting times are reduced if more idle drivers are available (Castillo *et al.*, 2022). In this paper, we formalise the idea of Idle Wage, and propose a stylised model to capture and quantify its effects.

2 METHODS

2.1 Single-period scenario

Ours is a macroscopic model, where we assume steady conditions and find the economic equilibrium between supply and demand. We extend the well-known model by (Castillo *et al.*, 2022) to include the Idle wage. Let us first introduce the relevant notation in Table 1.

Table 1 – *Basic notation of the model*

Symbol	**Meaning**	**Range**
p	Price per trip charged to the users	$[0, \infty)$
Q	Trips served per time unit	$[0, \infty]$
t	In-vehicle time to serve a user	Constant
T	Waiting time	$(0, \infty]$
L	Supply size	$[0, \infty)$
τ	Percentage of the fare kept by the company	$[0, 1]$
I	Number of idle drivers	$[0, \infty)$
D	Demand function	$[0, \infty)$
ℓ	Supply function	$[0, \infty)$
J	Idle wage	$[0, \infty)$

Here we assume the platform maximises its profit. In the full version of the paper we include welfare as another possible objective function. The problem solved by the company is:

$$
\begin{aligned}
\max_{\mathbf{x}=(p,J,\tau,I,L,Q)} \quad & \tau p Q - JL \\
s.t \quad & \begin{cases} Q = D(p, T(I)), \\ L = I + (t + T(I))Q, \\ L = \ell(\frac{(1-\tau)pQ}{L}, J), \\ \tau \in [0,1], p, J, I, L, Q \geq 0 \end{cases}
\end{aligned} \tag{1}
$$

The objective function is just the profit of the company, i.e., what it obtains for every trip served minus what it spends due to the idle wage. Note that we assume the idle wage is being paid at a constant rate for all the connected drivers[2]. The first constraint represents the equilibrium on the demand, i.e., the number of served trips equates the passengers willing to travel at the corresponding price p and quality of service measured through the waiting time T; note that T is a (decreasing) function of the number of idle drivers I. The second constraint implies that every driver is either idle, serving a passenger, or on its way to pick up a passenger. The third constraint represents equilibrium on the supply; the function ℓ is discussed in more detail below.

If J is fixed to be equal to 0, then Problem (1) is exactly the same formulation by Castillo *et al.* (2022), where the function ℓ has only the first argument. In our case, J reduces the objective function through the term $-JL$, and also changes the number of available drivers. Now the function ℓ receives two arguments. The first one is the expected income due to the trips (equal

[2] In this paper, we assume that drivers comply with the trips proposed by the platform. Otherwise, a strategic behaviour could arise, where riders connect while doing a different job just to earn the Idle wage. Strategic behaviour in general is regarded as a relevant direction for future research.

to the total income received by the drivers, divided by the number of drivers), which we denote $e = \frac{(1-\tau)pQ}{L}$. The second one is the income through J. Our main assumption is that drivers are risk-averse. The income via e has a random component, namely, how many of those trips will be assigned to me? On the other hand, the income through J is predictable. We represent this situation through the following mathematical assumption: For every $e, J \geq 0$, we have

$$\frac{\partial \ell}{\partial e}(e, J) \leq \frac{\partial \ell}{\partial J}(e, J) \tag{2}$$

With mild assumptions on the differentiability and asymptotic behaviour of the functions involved (described in the full version of the paper), our main results in the single-period case are:

Theorem 1: For any p, J, τ, there exist I, L, Q such that the equilibrium conditions of Problem (1) are fulfilled.

Theorem 2: Problem (1) admits at least one solution with $\tau = 1$.

Theorem 3: Assume $\ell(e, J) = A\rho(e, J)$, where A is the maximum number of drivers and ρ a function taking values in $[0, 1]$. For a given A and τ, denote by $J^*(A, \tau)$ the resulting optimal J when solving Problem (1) with exogenous τ. Then $J^*(A, \tau) \xrightarrow{A\to\infty} 0$.

The proofs are in the full version of this manuscript. Three comments are noteworthy:

1. The "true" decision variables of the company are p, J, τ, as the rest is exogenous. Theorem 1 ensures that whatever combination the company decides, an equilibrium exists.
2. The reason why it is optimal to provide $\tau = 1$ is risk-aversion. The core of the proof is that, if $\tau < 1$, it is possible to increase τ and compensate via increasing J.
3. Theorem 3 is a negative result. Assuming $\tau < 1$ makes sense when the problem becomes multi-period (see next section). This theorem provides insights on why platforms might be reluctant to introduce the idle wage, particularly when there is a large population of potential drivers (a situation that helps them strive, de Ruijter *et al.* (2024)); namely, because they could attract too many of them.

2.2 Multi-period model

The demand for transport presents strong fluctuations along the day. This is why ride-hailing companies have introduced *surge pricing*, so that pricing can be a tool to match demand and supply (Yan *et al.*, 2020). In the context of J, having it dynamic might contradict its ultimate purpose of providing the drivers with a more predictable income. In the multi-period model, we consider that the day is divided in $\mathcal{T}$ periods of the same length, and the demand function $D(p, T)$ is different in each of them. We assume the platform can change the price p in each of these periods. Regarding J we study three policies in terms of how much can it change, and now summarise our main findings in each of them:

- **Fully flexible** J: If J can be defined per period, the multi-period model is equivalent to having $\mathcal{T}$ independent single-period models. Thus, all previous theorems remain valid.
- **Single** J: The extreme opposite of the previous policy is that a single J has to be decided for the whole day. In this case, $\tau = 1$ is not always optimal. That is, in this context it is convenient for the company to pay the drivers using both mechanisms. This illustrates a fundamental trade-off: **Idle wage has the virtue of being better received by the drivers, but it is less adjustable to face the flexibility of the demand.**

- **Double-interval minimum wage constraints:** A reasonable condition is that if a person drives during a normal working day (e.g., 8 hours), they should receive a guaranteed income through J. Which 8 hours should they work? We propose a model to capture that those 8 hours should permit a reasonable time to perform other activities, through following constraint: $\exists I_1, I_2$ continuous and disjoint intervals, both of length 4 hours, such that $\sum_{h \in I_1} J_h + \sum_{h \in I_2} J_h \geq M$, where M is an exogenous value, e.g., the daily minimum wage. Note that this condition is always feasible thanks to Theorem 1. However, the profit could diminish because of attracting more drivers that will receive J[3]. Quantifying this reduction is a complex combinatorial problem, and we develop a specific heuristic to solve it.

3 NUMERICAL RESULTS

We use specific functional forms and parameters taken from Yan *et al.* (2020), and assume that every dollar earned via J is valued as 1, whereas if earned via trips is valued as β, with $\beta = 0.25, 0.5, 0.75, 1$. Some of the main results are illustrated in Figure 1.

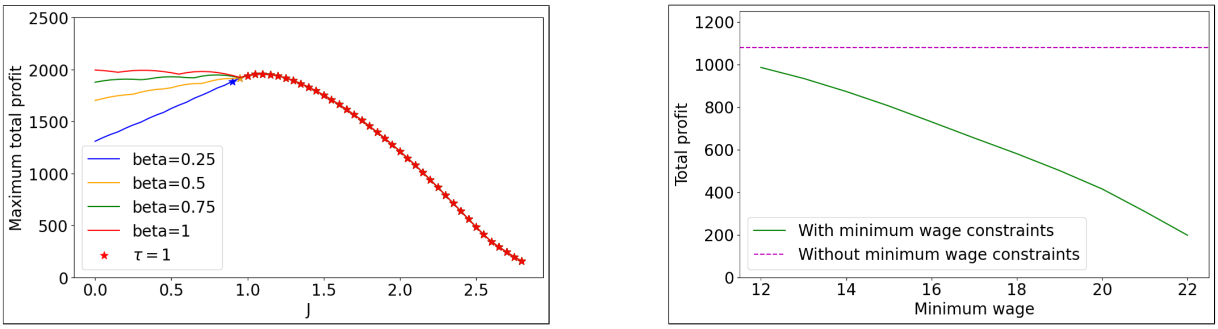

Figure 1 – *Numerical results. In the left, we show the optimal profit achieved for given values of J, marking when the resulting optimal τ is 1. Note that when drivers are risk avert ($\beta < 1$), the optimal solution always requires $\tau = 1$. In the right, using $\beta = 0.5$, we show the profit decrease due to the minimum wage constraint, for different values of the threshold M.*

References

Ashkrof, Peyman, de Almeida Correia, Gonçalo Homem, Cats, Oded, & Van Arem, Bart. 2020. Understanding ride-sourcing drivers' behaviour and preferences: Insights from focus groups analysis. *Research in Transportation Business & Management*, **37**, 100516.

Castillo, Juan Camilo, Knoepfle, Daniel T, & Weyl, E Glen. 2022. Matching in ride hailing: Wild goose chases and how to solve them. *Available at SSRN 2890666.*

de Ruijter, Arjan, Cats, Oded, & van Lint, Hans. 2024. Ridesourcing platforms thrive on socio-economic inequality. *Scientific Reports*, **14**(1), 7371.

Fielbaum, Andrés, & Tirachini, Alejandro. 2021. The sharing economy and the job market: the case of ride-hailing drivers in Chile. *Transportation*, **48**(5), 2235–2261.

Fielbaum, Andrés, Ruiz, Felipe, Boccardo, Giorgio, Rubio, Daniela, Tirachini, Alejandro, & Rosales-Salas, Jorge. 2023. The job of public transport, ride-hailing and delivery drivers: Conditions during the COVID-19 pandemic and implications for a post-pandemic future. *Travel Behaviour and Society*, **31**, 63–77.

Ramezani, Mohsen, Yang, Yue, Elmasry, Jacob, & Tang, Porsiem. 2022. An empirical study on characteristics of supply in e-hailing markets: a clustering approach. *Transportation Letters*, 1–14.

Yan, Chiwei, Zhu, Helin, Korolko, Nikita, & Woodard, Dawn. 2020. Dynamic pricing and matching in ride-hailing platforms. *Naval Research Logistics (NRL)*, **67**(8), 705–724.

[3] If drivers are risk-neutral (i.e. $\frac{\partial \ell}{\partial e} = \frac{\partial \ell}{\partial J}$) the profit will remain unchanged if the threshold is lower than what drivers earn in the optimal solution of the unconstrained problem.