Department of Economics, University of Warwick

Monash Business School, Monash University

as part of

Monash Warwick Alliance

Price dispersion in the rideshare industry: a study of the Mexico City market

Tom Sullivan

Warwick-Monash Economics Student Papers

September 2022 **No: 2022-40**

ISSN 2754-3129 (Online)

The Warwick Monash Economics Student Papers (WM-ESP) gather the best Undergraduate and Masters dissertations by Economics students from the University of Warwick and Monash University. This bi-annual paper series showcases research undertaken by our students on a varied range of topics. Papers range in length from 5,000 to 8,000 words depending on whether the student is an undergraduate or postgraduate, and the university they attend. The papers included in the series are carefully selected based on their quality and originality. WM-ESP aims to disseminate research in Economics as well as acknowledge the students for their exemplary work, contributing to the research environment in both departments.

"*We are very happy to introduce the Warwick Monash Economics Student Papers (WM-ESP). The Department of Economics of the University of Warwick and the Economics Department at Monash University are very proud of their long history of collaboration with international partner universities, and the Monash Warwick Alliance reflects the belief in both Universities that the future will rely on strong links between peer Universities, reflected in faculty, student, and research linkages. This paper series reflects the first step in allowing our Undergraduate, Honours, and Masters students to learn from and interact with peers within the Alliance.*"

Ben Lockwood (Head of the Department of Economics, University of Warwick) and Michael Ward (Head of the Department of Economics, Monash University)

Recommended citation: Sullivan, T. (2022). Price dispersion in the rideshare industry: a study of the Mexico City market. *Warwick Monash Economics Student Papers* 2022/40.

[1] Warwick Economics would like to thank Lory Barile, Gianna Boero, and Caroline Elliott for their contributions towards the selection process.

Price dispersion in the rideshare industry: a study of the Mexico City market

Tom Sullivan*

Abstract

Nascent and highly dynamic industries such as the rideshare industry have disrupted traditional industries and business models. The use of technology has allowed firms like Uber and Didi to compete over both consumers and workers on an increasingly sophisticated level. This paper explores the use of algorithmic pricing strategies employed by the rideshare industry and the impact of such strategies on the overall level of competition in the market. It uses the Mexico City, Mexico, rideshare industry as a case study. The paper shows that specific firms target specific consumers based on whether those consumers are informed or uninformed about other options in the market, and do so at specific times based on the level of demand in the market. The findings of the paper are relevant for both economic understanding of such markets as well as policy responses.

Keywords: Rideshare; Uber; algorithm; pricing; competition; consumer

JEL codes: D4; L1

* Contact information: sullivantomf@gmail.com

1. Introduction

In the early days of e-commerce in the 1990s, much speculation existed that the internet would lead to the 'law of one price' and near-perfect competition. However, nearly three decades of empirical evidence has proven this not to be the case. Instead, e-commerce today is largely dominated by a small group of some of the world's most iconic 21st Century companies. Firms such as Amazon, Ebay and a host of others exercise significant degrees of market power and market share over the e-commerce industry.

The rise of these giants has been accompanied by new forms of consumption, exploiting technology and data to give consumers a new customer experience. With this new form of consumption and production has also come new forms of pricing and competition strategies. Whereas traditional brick-and-mortar retailers face a range of challenges in their ability to rapidly respond to changes in supply and demand, and consumer sentiment, e-commerce firms have the ability to use algorithmic price-setting strategies that can almost instantly respond to such changes.

Perhaps the best example of this new phenomenon is Uber. Founded in 2009, Uber was the first-mover in the now multibillion-dollar rideshare industry. Having initially enjoyed complete control of the market as it was the only existing firm, there is now a slew of other rideshare firms, with some of the most notable being Didi, Cabify, and Lyft. The nascent state of this industry, however, means that economic inquiry into the nature of rideshare markets and firms is relatively underdeveloped.

As these firms now make up some of the world's biggest corporations and are at the forefront of exploiting personal data and technology to re-imagine traditional markets, they have attracted growing academic interest and attention. Not only is such investigation into these firms warranted from a purely economic perspective but also from a broader societal perspective. This is due to the impact that they are having on so many aspects of modern life. Indeed, Uber and other rideshare firms make claims to not just be acting in the economic interests of their shareholders, but also to be contributing to social goods. These claims include helping to reduce traffic congestion in urban centres; making car ownership no longer a necessity; and allowing for the growth of small businesses through their food-delivery arms like UberEats.

The literature shows that the validity of these claims is mixed. Whilst services like UberEats played a crucial role in allowing many small businesses to remain open during the COVID-19 pandemic and consequently providing jobs and a source of income for many low-paid workers, their contribution to reducing traffic congestion is less clear. Furthermore, there are undeniable, deleterious effects that rideshare firms are having on labour markets, at least from the point of view of workers. Given rideshare firms in most jurisdictions hire their workers as independent contractors as opposed to their own employees, the industry is contributing to the precarisation of labour markets. Consequently, rideshare workers are responding. Legal disputes have occurred or remain ongoing in many countries on the question of rideshare workers' legal employment relationship to rideshare firms.

In this context, this paper hopes to contribute to the literature on pricing strategies and competition more generally in the rideshare sector. As will be explained in subsequent

sections, the paper collected data from the rideshare sector in Mexico City, Mexico, in late 2020 and early 2021. In this particular market, there exists four rideshare firms: Uber, Didi, Cabify, and Beat. The most important conclusion from the data is that the market has essentially been divided into two different groups of firms. Uber and Didi constitute one group targeting the uninformed consumers who will generally take the first price they see and are unwilling to incur search costs; Cabify and Beat constitute another group that target the informed consumers, who will generally consider all their options and choose the cheapest one.

As the literature review will show, these types of markets are not uncommon in the e-commerce space. Their prevalence is yet further evidence that the increased accessibility of market information that the internet offers consumers does not necessarily come accompanied by an increase in market competition.

In addition to providing evidence for this type of market, the paper will also show evidence and provide economic reasoning to explain other important observations from the data, such as the price elasticity of demand in the market, and how the supply of drivers impacts pricing. The paper is arranged in the following structure: the following section will provide a review of the relevant literature; the third section will explain the data collected for the paper; the fourth section will provide the results and offer analysis; and the fifth section will conclude.

2. Literature review

The relevant literature for this area of study is quite wide-reaching. It encompasses the history of the rise of e-commerce, the relevant economic theory on pricing strategies and online markets, online consumer patterns, the market impacts of technological advancements, and the literature on the rideshare industry.

Salop and Stiglitz (1977), in an important paper, demonstrate how if a market exists in which consumers have heterogeneous search costs to obtain necessary information, the potential exists for firms in that market to target consumers differently. Some firms will sell at a higher price to the uninformed consumers, whilst other firms will sell at a lower (more competitive) price to informed consumers.

As mentioned in the previous section, there existed a widely shared belief in the early days of the internet that e-commerce would lead to the law of one price. That belief was presented in a widely cited article by Bakos (1991) arguing that online markets would reduce consumer search costs to such an extent that unprecedented levels of market efficiency would be unleashed with resulting changes in consumer behaviour. That market efficiency would be observed in prices tending towards the perfectly competitive market price. It did not take long, however, for the evidence to present an alternative scenario. Instead of e-commerce markets automatically increasing market efficiency and driving down prices, many of the factors that contribute to a lack of competition in non-online markets also existed in online markets.

Refuting the central theory of Bakos (1991) and building on Salop's and Stiglitz's (1977) theory, Carlton and Perloff (2000) proposed the "tourist-native" theory. Simply, the theory was that uninformed consumers are like tourists who arrive in a new city. As tourists they are unfamiliar with prices in the new city and unwilling to incur the search costs of finding the

cheapest prices. Natives are from the city and understand local prices and are willing to incur the search costs of going to a different store if the price is cheaper. If there are sufficient tourists in the market, some firms will set their prices at the higher price, knowing that they will lose natives but will be compensated for this loss by selling to tourists at the higher price. Other firms will sell at the lower price to win the natives, but also a portion of the tourists who randomly enter their store.

Employing this theory, Bayliss and Perloff (2002) considered online retail markets for digital cameras and scanners. Having ranked the firms each week from highest price to lowest price, the authors point to the fact that there was great consistency in the firms' price positions and little observed change over the course of the study. They use this fact to reject the idea that this e-commerce market was an "immature market" still in the process of adjusting towards a competitive price equilibrium. Instead, their conclusion is consistent with the theory of a heterogeneous set of consumers in the market with different levels of willingness to incur search costs and, consequently, firms exploiting this by targeting these two sets of consumers with different prices.

Whilst the debate has largely been settled that online markets do not automatically tend towards the law of one price, there is still a broad literature investigating the pricing systems of such markets. Indeed, as the price-changing ability of online retailers and firms has become increasingly advanced through the use of algorithmic pricing, a body of literature has focused on how the ability to adjust prices over large geographical (multiple countries) jurisdictions instantly is impacting pricing strategies of firms. Cavallo (2018), in what he calls the "Amazon effect", shows how algorithmic pricing strategies employed by firms such as Amazon and Walmart have led to a high degree of price flexibility and a rise in price uniformity across geographies. Furthermore, these firms have made prices on a national level more sensitive to shocks, such as changes in energy prices.

Contrastingly, Aparicio, et al. (2021) consider the online grocery market in the US. Their findings suggest that compared to offline retailers, online retailers actually have less uniform pricing. Their paper argues that algorithmic pricing capabilities allows online retailers to personalise and discriminate their prices based on geographic location, which actually reduces, rather than increases, price uniformity. Therefore, it is clear that amongst the recent literature on algorithmic pricing there is far from a consensus on what its effects are on a range of questions.

Finally, there is also a growing literature specifically focused on the rideshare industry. Nowag (2016) raises the issue of algorithmic pricing and the highly sophisticated use of data for competition within the market. He argues that companies like Uber are developing the ability to personalise prices to extreme levels. For example, there is evidence that the applications can understand when a user checks the price and then closes the application. This is assumed by the application that the user is checking the prices of other companies. When the user then returns to the original application (possibly only a matter of seconds later), the price will have changed based on other companies' prices.

Another issue for competition law has been raised by Pandey and Caliskan (2021). In their study they find evidence of racial bias in the pricing strategies of rideshare firms. Citing

evidence taken from the Chicago rideshare market, the authors find that firms such as Uber and Lyft, tend to raise their prices in areas with high African-American populations.

Therefore, with a clear motivation of social welfare and economic interest this paper helps to contribute further to the growing literature on the rideshare industry. As will be shown in the results section of this paper, the rideshare market in Mexico City appears to be a market consisting of two consumer groups: informed consumers and uninformed consumers.

3. Data

The data was collected over a five-month period from October 2021 to February 2022. Using each firms' application, data was collected every two hours from 10am to 8pm on the price and wait time of each firm for a defined route. That route was from the Plaza of the Constitution to the Torre Mayor in Mexico City. This route was chosen because it is in a busy, business and tourist area of Mexico City and is subject to significant variation in variables such as busyness.

In addition to collecting price and wait time data from the firms' application, data on the busyness of the pick-up destination was also collected from Google Maps. Google Maps has a feature that provides real time data on the busyness of destinations through using live user location data. The busyness of a certain destination at any given time receives a non-numerical ranking (for example "not busy", "not too busy", "very busy", etc.). The qualitative ranking system was then converted into numerical data by ranking it from one (the least busy measure) to seven (the most busy measure).

This collection process resulted in a set of data amounting to over 3500 data points. Each data point included the firm, the time, the busyness at the pick-up destination, the wait time, and the price. The price is always in Mexican pesos.

One issue with the data came from Cabify's provided wait time. Cabify never gave a wait time above six minutes. Whilst it is theoretically possible that the wait time never exceeded six minutes, it is unlikely that this was the case. It would appear that Cabify had set a limit on its wait time at six minutes. Consequently, this impacts Cabify's data. However, there was still considerable variation within its wait time data even considering this limit. Whilst it is not ideal for the purposes of the study, it does not present a major problem.

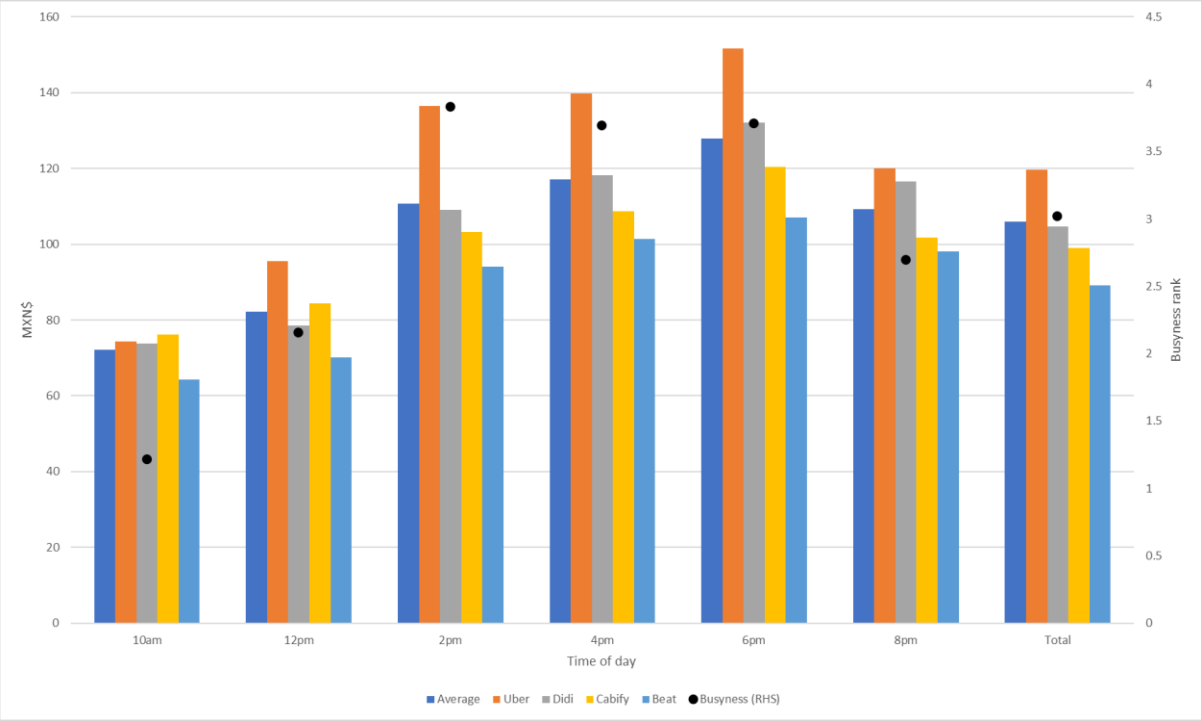
Results

Before presenting the results, it is important to deal with the question of homogeneity of products. This paper assumes that all four firms are providing a homogenous service to the market. Whilst there may be some differences in aspects of the service, such as the quality of the application, refund policies, customer services, there is no evidence that these factors have significant impacts on consumer choice in the market. The core of the service – transporting users from one destination to another through an application – is fundamentally the same amongst all four firms. Therefore, it is acceptable to treat the services provided by the four different firms as homogenous.

This section will provide results from the data as well as evidence for the assertion that the rideshare market in Mexico City is as described above - a dual consumer market. In order to prove this assertion it has to be shown that the four firms in the market employ different pricing strategies that target different consumer groups.

Figure 1 shows how the firms' pricing strategies respond to changes in demand. It shows the average price for each firm and the average busyness rank at different times of the day. The first observation to be made is that the behaviour of each firm and the resulting market prices are in line with economic theory. That is to say, when demand is lower, there is less price dispersion (as defined by the percentage difference between the cheapest and most expensive price), and when demand is higher there is more price dispersion. At 8am, where demand is at its lowest, there is a price dispersion of 15 percent. However, at 2pm, where demand is highest, the level of price dispersion increases three-fold to 45 percent. The price dispersion across the entire market (regardless of time of day) is 34 percent.

Figure 1: Average firm price and average demand at time of day



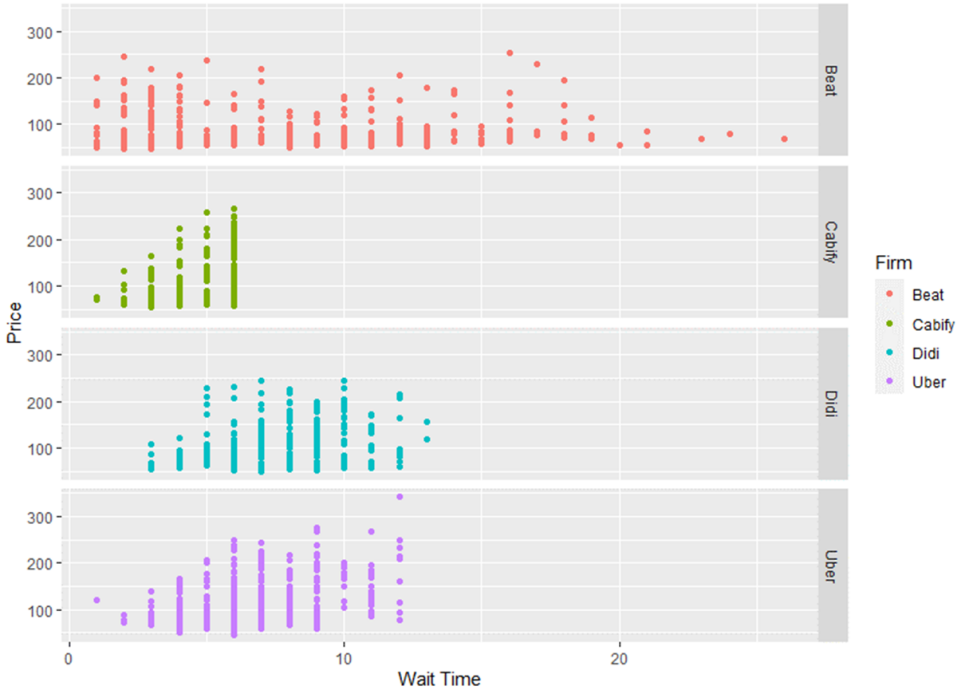
It can, therefore, be seen that the level of demand has a clear effect on the degree of price dispersion in the market. It is also necessary to show how market prices respond to changes in supply. Figure 2 plots the price of each firm against the wait time. Recalling that a higher wait time indicates less drivers and therefore a lower supply, it is clear that firms respond in a heterogeneous manner to changes in supply. Firstly, it can be seen that there appears to be a floor price at $50, below which the price falls only sparingly.

Uber and Didi appear to be the only two firms where even a slight trend in line with economic theory can be observed. As the wait time increases (supply decreases) the price increases for these two firms. Although even at the higher wait times there is still a wide range of prices. Indeed, Didi still has data points close to the floor price of $50 at the higher levels of wait time. Uber, on the other hand, does not. At and beyond the 10-minute wait time, Uber's price clearly

increases in a way that Didi's does not. This indicates that Uber has at least a degree of market power to raise prices above its main competitor when supply is low.

It is difficult to draw any inferences from Figure 2 about Cabify and Beat given how spread out Didi's data is and with the previously mentioned caveat of Cabify's wait time data never going beyond six minutes.

Figure 2: Firm price and wait time



Notes: Wait time in minutes, price in MXN$

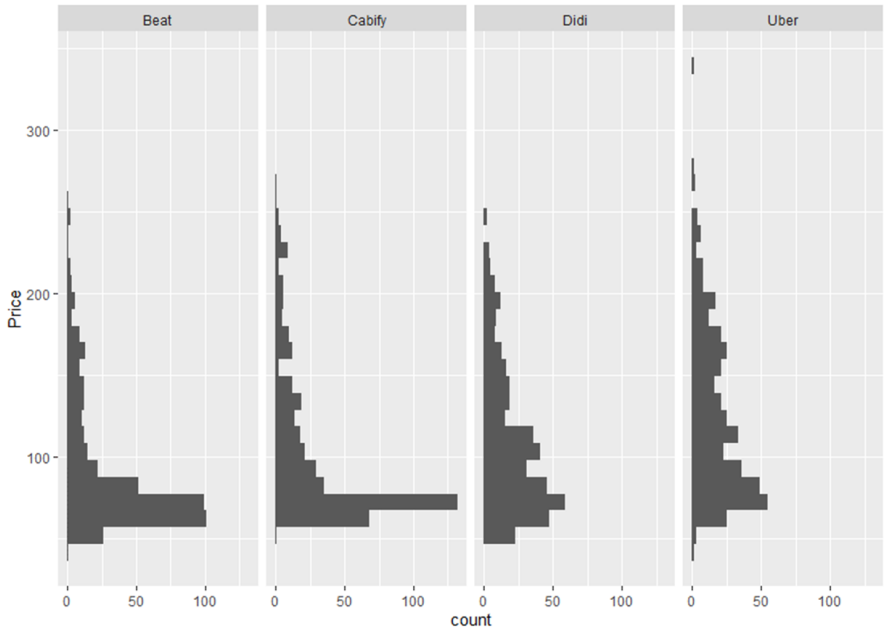
The distribution of price frequencies further illustrates the different pricing strategies of the firms. Figure 3 shows histograms of each firms' price frequencies. Considering the modality of the histograms helps to differentiate the pricing strategies. The histograms of Beat and Cabify have a very similar shape, whilst the histograms of Uber and Didi also share a similar shape. Beat and Cabify both set the majority of their prices between $60 and $80. At prices higher than $80, there is a significant drop in the frequency. Above $100, the frequencies become even lower. Interestingly, there is a drop in both at $150 and then a slight uptick at $160 and smaller but still elevated uptick at $170.

The conclusion to be drawn from this is that Cabify and Beat constitute the group of firms targeting the informed consumers. Cabify and Beat, by setting the majority of their prices at the lower rate, are in competition with each other over the consumers who have a better understanding of the market and are willing to search for a lower price. These consumers incur higher search costs, but, by checking all four applications, will find a cheaper service.

Uber and Didi clearly have different pricing strategies to Cabify and Beat. It is clear that they do compete at times for the informed consumers against Cabify and Beat, but the distribution of their prices is far more even. Whilst the distributions of Cabify and Beat appear unimodal, the distributions of Uber and Didi appear to be trimodal. Uber and Didi do have peaks at the

informed consumer price (approximately $70) but considerably smaller. They then have a peak at approximately $110 that Cabify and Beat do not have. This price is not a competitive price across the entire market. It indicates that Uber and Didi target those consumers who are either uninformed about the market or who are unwilling to incur the additional search costs of finding a cheaper service.

Figure 3: Histogram of each firms' prices[1]



Notes: Price in MXN$

Despite Uber and Didi falling into the same broad category of targeting the uninformed consumers, there is considerable difference in their distributions. For example, both firms have a small third peak but at different prices. For Didi, there is a slight rise in the frequency around $130. However, for Uber this third peak is far more pronounced and at a higher price of approximately $160. This difference between Uber and Didi is not dissimilar to the difference presented in Figure 2. Figure 2 showed that Uber, at the higher levels of wait time, was able to increase its prices in ways that Didi could not. Figure 3, therefore, is likely a representation of the same phenomenon. Clearly, Uber has a certain degree of market power above Didi.

Table 1 demonstrates that at every time of the day except 10am, Uber has a higher price than Didi. Indeed, the average price of Uber is $120 compared to $105 for Didi, or a 14 percent price dispersion rate.

[1] Appendix 1 presents individual histograms of all firms' prices divided into smaller price brackets.

Table 1: Firm prices and market measurements

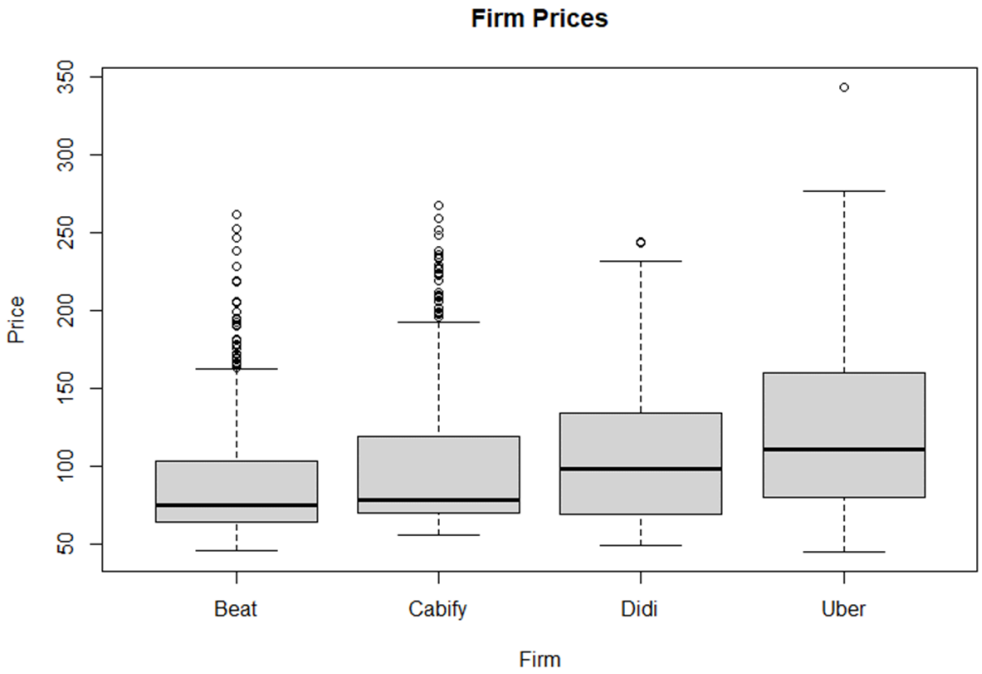
Time	Average ($)	Uber ($)	Didi ($)	Cabify ($)	Beat ($)	Price dispersion (%)	Value of Information (%)
10am	72	74	74	76	64	16	58
12pm	82	96	78	84	70	36	42
2pm	111	137	109	103	94	45	64
4pm	117	140	118	109	101	38	80
6pm	128	152	132	120	107	42	90
8pm	109	120	116	102	98	22	94
Total	106	120	105	99	89	34	70

Notes: Value of information is the percentage difference between the average price and the lowest price. Price dispersion is the percentage difference between the highest and lowest prices. Prices in MXN$.

Evidence of the different pricing strategies can also be found in Figure 4, showing a boxplot of each firms' price. Again, it shows that Cabify and Beat are utilising similar pricing strategies whilst Uber and Didi are using another pricing strategy. Cabify and Beat have an almost identical median price at approximately $75. Contrastingly, Uber and Didi have a median price much higher around $100. Although as has been seen above, once again Uber shows signs of having greater pricing power than Didi, with a higher median price and larger interquartile range.

A further difference is that Uber's 25th percentile is considerably above the other three firms. The other three firms' 25th percentiles essentially show the $60 price floor, which does not apply to Uber. Furthermore, Uber has the largest range of all firms.

Figure 4: Boxplot of each firms' price



4. Conclusion

This paper has helped to contribute to an understanding of rideshare markets, the pricing strategies of rideshare firms, and the level of competition within these markets. It has shown that in the Mexico City rideshare market, the four active firms can be divided into two groups in which one group (Cabify and Didi) target the informed consumers who incur the search cost of finding the cheapest option, while the other group (Uber and Didi) target the uninformed consumers who do not incur the search cost of looking at different options. It has shown, however, that this is not the case all of the time. When demand is low, which causes the price dispersion between firms to be low also, it is not possible for Uber and Didi to target a different section of consumers. Instead, at the lower levels of demand all four firms generally compete at the lower, informed consumer price.

Additionally, the paper has helped to contribute to the literature more generally by providing further evidence that e-commerce or online markets do not tend towards the law of one price, as was widely predicted in the early days of the internet. Instead, online markets share many of the same factors as non-online markets that contribute to a lack of competition.

The policy implications of the paper have the potential to be wide-reaching. As stated in the introduction, the model that rideshare firms use for labour hiring practices is becoming increasingly widespread. It contributes to a more casualised and less secure labour market for workers. Furthermore, as this paper has shown, the rideshare industry does not necessarily drive down market prices, which would contribute to consumer welfare. Policymakers could use the findings of this paper and further investigation to justify and promote policies that seek to reign in the market power of rideshare firms and put downward pressure on prices. Such a

debate would be particularly pertinent in current times as rideshare firms are currently litigating cases in many jurisdictions on issues such as their labour hire practices.

Finally, it is not just policy that could contribute to greater levels of competition and therefore lower prices in the rideshare market. This paper has argued that one of the key drivers of price dispersion in the market is a lack of information on the part of a section of consumers due to the higher search costs of becoming fully informed. Therefore, easier access to information could contribute to downward pressure on prices. Such tools to achieve this already exist in a wide range of industries, particularly online industries. Price aggregator sites or applications are becoming increasingly common that allow consumers to compare the price of a series of products. Indeed, Google Maps now shows the price of certain rideshare firms when a user looks up a route. Increasing consumer information on rideshare prices and decreasing consumer search costs would be a key way to contribute to a more competitive rideshare market.

References

Akerlof, G.A. (1970). The Market for 'Lemons': Quality Uncertainty and the Market Mechanism. *The Quarterly Journal of Economics*, 84(3), pp.488–500.

Aparicio, D., Metzman, Z. and Rigobon, R. (2021). The Pricing Strategies of Online Grocery Retailers. *SSRN Electronic Journal*. doi:10.2139/ssrn.3819542.

Bakos, J.Y. (1991). A Strategic Analysis of Electronic Marketplaces. *MIS Quarterly*, 15(3), p.295. doi:10.2307/249641.

Baylis, K., & Perloff, J. M. (2002). Price Dispersion on the Internet: Good Firms and Bad Firms. *Review of Industrial Organization*, *21*(3), 305–324. http://www.jstor.org/stable/41799125

Cavallo, A. (2018). More Amazon Effects: Online Competition and Pricing Behaviors. doi:10.3386/w25138.

Diamond, P.A. (1971). A model of price adjustment. *Journal of Economic Theory*, 3(2), pp.156–168. doi:10.1016/0022-0531(71)90013-5.

Nowag, J. (2016). The UBER-Cartel? UBER between Labour and Competition Law. *SSRN Electronic Journal*. doi:10.2139/ssrn.2826652.

Pandey, A. and Caliskan, A. (2021). Disparate Impact of Artificial Intelligence Bias in Ridehailing Economy's Price Discrimination Algorithms. *Proceedings of the 2021 AAAI/ACM Conference on AI, Ethics, and Society*. doi:10.1145/3461702.3462561.

Salop, S. and Stiglitz, J. (1977). Bargains and Ripoffs: A Model of Monopolistically Competitive Price Dispersion. *The Review of Economic Studies*, 44(3), p.493. doi:10.2307/2296903.

Appendix

1. Individual histograms of each firms' prices divided into smaller price brackets