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Competition Effects of the Sharing Economy in Brazil:

Has Uber's entry affected the cab-hailing app market from 2014 to 2016?

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Executive Summary

This paper assesses the competition effects of Uber's entry into the incumbent cab-hailing app market. A fixed-effects model was applied to a panel data set of 590 municipalities and 36 months, covering the 2014-2016 period. The paper is split into five sections. After an introduction that covers the literature review, the second section brings considerations on the ridesharing market in Brazil, presenting the current market structure for both taxi and ride-sharing apps as well as the legislation in the sector. The third section describes the methodology and the source of the data used. The fourth section presents findings on the effects of Uber's entry into the market that taxi drivers operate. Finally, the fifth section shows conclusions and practical implications of the study.

Applying the sample to the 590 municipalities, the results showed that Uber's entry into the market resulted in an average reduction of 56.8% in the number of rides from cab-hailing apps in the cities where the platform operates; additionally, every 1% increase in the number of Uber rides represented a 0.09% decrease in the number of cab-hailing app rides. These figures, together with some descriptive information on the dynamics of the number of rides of companies in the sector, show that Uber not only competed with cab-hailing apps and attracted part of their users, but also attracted new users who were not cab-hailing apps' customers. It has also been verified that, in most municipalities, taxi apps did not react to the increase in competition, for example, by offering discounts on rides.

On the other hand, when investigating the competition effects of Uber's entry taking into account only Brazilian capitals, the magnitude of the effect of Uber's entry decreases (36.9% in the number of taxi rides), an indication that the competitive effect tends to be smaller (in percentage terms) in cities where the market is larger. It was also found that there is an important spatial heterogeneity in the competition effects of the platform when comparing the markets of the capitals of the North and Northeast regions with the capitals of the South, Southeast and Central West regions. This may be explained, to some extent, by when Uber entered in those regions. In the group of capitals of the North and Northeast regions, a late entry of the Uber app is observed (between March and December 2016), whereas the entries began in May 2014 for the group of capitals of the South, Southeast and Central West regions.

In this regard, it is possible to compare the results of the effects of a recent entry (less than a year ago) of Uber vis-à-vis an entry that occurred more than two years ago. It is noteworthy that when only capitals of the South, Southeast and Central West regions are examined, the effect of Uber's entry on cab rides is less intense (reduction of 26.1%) than in the North and Northeast regions (reduction of 42.7%). This evidence indicates that, initially, Uber's entry can have a huge effect, substantially reducing the number of cab rides, but, over time, a gradual recovery in the number of rides of the incumbent sector takes place.

The results suggest that only in the group of capitals of South, Southeast and Central West regions was detected that Uber's entry caused a reduction in taxi fares (reduction of 12.1%). This result indicates that the cab-hailing app sector reacted, offering discounts in fares after a longer period of exposure to a competitive environment. In this regard, it is possible to verify a growing rivalry over time between the two types of apps, where Uber's entry causes a reduction in the

number of cab rides, reactions via price reductions through discounts and, finally, a recovery in the number of cab-hailing app rides.

Finally, it is important to note that, in addition to generating benefits to consumers and encouraging the entry of suppliers in the ridesharing market, such innovations resolved some market issues in the sector, making the current regulation of taxi services outdated. The recently enacted Federal Law 13,640/2018, which outlines how ridesharing services operate in the country, was parsimonious in that it included safety rules but did neither impose major regulatory barriers to entry nor restrictions to pricing freedom. In the same regard, municipal entities should avoid measures that hinder the operation of such services via apps. In a complementary way, it is necessary to improve the debate towards a gradual deregulation of taxi services, especially on issues related to barriers to entry and pricing freedom. Such deregulation can be thought of, for example, only for the radio taxi segment via Internet apps. Thus, it would be possible to encourage more competitive business models for apps, bringing benefits for the consumer in terms of more innovative services, with improved quality and security, lower prices and more options.

Keywords: Sharing economy, ridesharing service, competition policy, taxi, Uber.

1. Introduction

In recent years, there has been a sharp growth in the sharing economy[1], a business model that dissociates the use of a particular good or service from its acquisition. In other words, there is sharing between the holder and third parties. Despite it being an old practice, since it has always been possible to rent or lend consumer goods, the model has been strengthening due to the introduction of technology platforms that facilitate the interaction between consumers and suppliers (Codagnone, Biagi & Abadie 2016). These platforms are known as peer-to-peer or P2P and provide a virtual environment where consumers have access to information about products they want to use temporarily, while suppliers have greater access to the consumer market.

It is noteworthy that, in general, the architecture of the sharing economy platforms follows the logic of two-sided markets (2SM) or multi-sided platforms (MSP)[2]. Schor (2017) argues that sharing economy activities are split into four broad categories: (i) recirculation of goods (for example, eBay and free exchange sites), (ii) a more intensive use of durables goods and other assets (for example, Airbnb and Uber)[3], (iii) exchange of services (timebanking)[4], and (iv) sharing of productive assets or spaces in order to enable production, rather than consumption (for example, co-working spaces or communal offices). The recent success of sharing economy is clearly associated with the development of new technologies – including smartphones, global positioning systems (GPS), online payment and rating mechanisms – and the popularization of Internet (Crespo 2016; Wallsten 2015).

Numerous technology platforms can be cited as examples of mechanisms to boost the sharing economy. The most successful ones are Airbnb and Uber. Airbnb allows individuals willing to rent their vacant rooms or properties to find individuals that need a temporary accommodation. The company was founded in 2008 and is currently present in more than 65,000 cities and 191 countries. Uber, a technology company founded in 2009 in California, allows a real-time connection between private-vehicle drivers and potential passengers. It is present in approximately 633 cities from 82 countries and is considered world's most valuable startup, with a valuation of approximately US$ 70 billion (The Economist 2016).

Sharing economy can benefit both consumers and suppliers. Consumers benefit from the temporary use of certain goods, with a greater range of options and generally lower prices. In this

[1] This paper does not aim to give a precise definition of what sharing economy is; in fact, this would be virtually impossible. In the recent book of Zanatta et al. (2017), which is a compendium of fourteen chapters written by various authors, theoretical discussions on the issue and practical case studies are presented.

[2] See Rochet & Tirole (2003) and Evans & Schmalensee (2007).

[3] In the transportation sector, there are several cases such as carpooling (BlaBlaCar), ridesharing (Uber, Cabify) and bike sharing (Tembici).

[4] According to Schor (2017, p. 25-26), "*time banks are community-based, non-profit and multilateral exchange sites in which services are exchanged using units of time as currency, following the principle that the time of each member has the same value. Compared to other platforms, time banks did not grow rapidly, partly due to the demanding nature of maintaining an egalitarian conversion rates. There is also a series of exchange services based on money such as TaskRabbit and Zaarly, which connect users who need to get tasks done with people who can do them, even though also these services have encountered expansion problems*".

regard, Cohen et al. (2016) found that, in 2015, Uber generated a consumer surplus[5] of about US$ 6.8 billion in the North American market. As for suppliers, they can access the consumer market more easily, more efficiently and can also reduce significantly the idleness of their goods; reducing, therefore, transaction costs and related inefficiencies, and creating value for the entire economy. In a recent study, Cramer e Krueger (2016) showed that drivers affiliated to Uber achieve an efficiency greater than that of cab drivers, since the former spend more time and drive a greater proportion of the daily distance with passengers in their respective vehicles. Another benefit from the sharing economy is the deceleration of unbridled consumerism because the access to the product is only temporary. Thus, in the long run, the sharing economy tends to reduce the pressure on natural resources (Heinrichs 2013).

Despite those benefits, the expansion of the sharing economy may reduce the revenue of traditional economic sectors due to the increase in competition. The rise of P2P platforms encourages the entry of new suppliers because there is a reduction in transaction and entry costs. In principle, those new suppliers would compete with the incumbent companies. In the individual passenger transport market, for example, there is conflict between ridesharing apps[6] (Uber and Cabify, for example*)* and the traditional taxi service[7]. On the other hand, it is also suggested that P2P platforms do not necessarily operate in the same market for traditional sectors (such as hotel, taxi and industries); therefore, their consumers are mainly individuals that were out of those markets. In this regard, it is possible to argue that Uber might have conquered, to a large extent, new customers that did not use taxi services[8] (The Economist 2015).

In the midst of these divergences, there are very few empirical studies investigating the effects of the entry of P2P ridesharing platforms on the incumbent market. Wallsten (2015) analyzes the individual passenger transport market in New York City and Chicago and shows that the popularization of Uber is correlated with the reduction in the number of taxi rides in New York City and with the drop in taxi license prices in Chicago. In addition, Wallsten (2015) also shows that Uber's popularity is associated with the reduction in the number of taxi-related complaints in both cities, suggesting that greater competition encourages incumbents to increase the quality of their service and, therefore, benefits even consumers who did not join the new service. On the other hand, Berger et al. (2017) assessed the impacts of Uber on the labor market for taxi drivers in metropolitan areas of the United States. The authors detected that the introduction of the app did

[5] Consumer surplus is the gain that consumers obtain when they buy/rent a good or service by less than they were willing to pay.

[6] With the enactment of Federal Law 13,640/2018, the item X of the article 4 of Federal Law 12,857/2012 is now in force with the following wording: "*X – paid private individual passenger transport: paid passenger transport service, not open to the public, for individual or shared trips requested exclusively by users previously registered in apps or other network communication platforms"*. This paper uses the term "ridesharing apps" to represent apps like Uber, Cabify, 99pop (Amon others, see section 2.2) that differ from cab-hailing apps like EasyTaxi and 99Taxis. It is noteworthy that 99 started its operation in 2012 having only taxis in its platform (99Taxis) but, in 2016, it also opened to private vehicles (99pop).

[7] It is noteworthy that the existence of this conflict or dispute is not consensual since, in a recent analysis, 99 concluded that after the convergence of the platform offering the option of cabs and private vehicles for users, "99pop does not makes taxi unfeasible; in fact, it boosts its use". See https://medium.com/para-onde-vamos/como-os-carros-particulares-aumentam-a-demanda-por-t%C3%A1xis-ba5337984d88 (accessed on 12/25/2017).

[8] Esteves (2015b) suggests that Uber generated a new demand. It is possible to argue that not all Uber passengers would have entered a taxi for a trip even if Uber did not exist. Some could have gone by subway, bus, walking, cycling or stayed at home.

not reduce the demand for taxi drivers, despite generating an increase in the income of self-employed taxi drivers, which is partially counterbalanced by the reduction in the income of wage-employed taxi drivers. For the Brazilian case, the studies that exist so far have corroborated the hypothesis that Uber conquered mostly new customers and, therefore, did not rival the taxi segment. In this regard, Esteves (2015b) indicates that the number of cab-hailing app rides was not immediately affected by Uber's entry in the cities of São Paulo, Belo Horizonte, Brasília and Rio de Janeiro. More recently, Oliveira & Machado (2017) found that the emergence of the P2P platform did not change the hourly income of taxi drivers. Hence, these results show that there is no consensus in the empirical literature regarding the competitive effects caused by ridesharing apps.

In this context of growth of the sharing economy and doubt about the real effects of P2P platforms on the incumbent markets, this paper investigates whether there has been any type of competitive effect (basically on price and quantity) after Uber entered the individual passenger transport market[9]. Fixed-effects regression models with panel data containing monthly data (from 2014 to 2016) of 590 Brazilian municipalities and metropolitan areas were run in order to assess the impact of Uber's entry on the number of cab-hailing app rides and on the average value of the rides of the incumbent sector[10]. Thus, we seek to contribute to the empirical literature by using a data set that covers a larger number of cities and a longer time period. Additionally, we obtained evidence yet unpublished for Brazil regarding the effects of the increase in competition on the fares charged by the cab-hailing app segment.

In addition to being directly linked to the aforementioned literature, this study is also connected with works that assessed the effects of the emergence of Uber on different socioeconomic aspects. There is evidence that the platform was able to reduce traffic congestion and carbon dioxide emissions in urban areas of the United States (Li, Carey & Zhang 2016), change the use of public transportation (Nelson & Sadowsky 2017; Babar & Burtch 2017), facilitate the access to paid individual transport service on rainy days (Brodeur & Nield 2016) and, also, affect the number of alcohol-related fatal traffic accidents (Brazil & Kirk 2016; Dills & Mulholland 2017).

This study is split into four more sections. In the second section, some considerations on the individual passenger transport market in Brazil are made, presenting the current structure of the taxi industry, the legislation that regulates the sector and the evolution of the dynamics of the market after the emergence of ridesharing apps. The third section presents the methodology and the data – in this section, we discuss potential definitions of the relevant market to the scope of this study, the details of the empirical strategy and the information and data collected. Fourth section presents the results of the assessment of the impact of ridesharing apps on the taxi industry. Finally, fifth section discusses the conclusions and the practical implications of the study.

[9] Hence, this work seeks to complement Esteves (2015b), who made this analysis when Uber launched its operation in Brazil. His results – that Uber does not compete directly with cab-hailing apps – might have been influenced by the period analyzed.

[10] It is noteworthy that this study is based only on information from cab-hailing app rides (99Taxis and EasyTaxi). This limitation is due solely to the difficulty in obtaining data from the traditional (non-digital) taxi services.

2. Considerations on the individual passenger transport market in Brazil

This section describes the current stage of the individual passenger transport market in Brazil. Thus, section 2.1 briefly describes the taxi market and subsection 2.2 presents the recent evolution of the market after the entry of the ridesharing apps. Finally, subsection 2.3 discusses some recent regulatory issues.

2.1. The taxi market in Brazil

In Brazil, the taxi service is regulated by local laws and is considered a public utility service as defined by the National Policy on Urban Mobility (Federal Law 12,587/2012)[11]. Thus, the local public authority issues authorizations for the taxi supply[12]. According to the Survey of Basic Municipal Information (Munic) conducted by the Brazilian Institute of Geography and Statistics (IBGE) in 2012, 4,645 (83.5%) municipalities had taxi services. According to Esteves (2015b), the Brazilian taxi market is split into three tiers: (i) cabs that seek passengers on the streets; (ii) cabs that stand on points predetermined by the local authority (taxi stands); and (iii) cabs that meet the demand directly through calls or apps (radio taxis).

Although taxi legislation varies between municipalities, a common characteristics of the market is the excessively rigid legislation (Dias 2007). There is both the entry regulation (through the limitation of new licenses) and the pricing regulation, which establishes fixed[13] or maximum fares and sets fixed percentages for late night fees[14]. In some municipalities, there is also quality regulation, which establishes safety and quality standards such as the requirement of professional qualification of drivers and the model, color and year of manufacture of the vehicle.

The regulation of the taxi service is based on the idea that the individual passenger transport market has two major market failures: asymmetrical information and negative externalities (Esteves 2015a). The former occurs because consumers do not have prior knowledge about the type and the quality of the service they will hire and have also little ability to negotiate fares. Hence, a cab ride can be classified as a credence good because the passenger can only ascertain the quantity and the quality of the services after consuming it (at the end of the ride). This information asymmetry could

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[11] The article 4, item VIII, of the mentioned Law defined individual public transportation as "*paid passenger transport service open to the public by means of rental vehicles for individual trips*". In addition, in its article 12 it states that "*The public individual passenger transport services must be organized, disciplined and supervised by the municipal authority based on the minimum safety, comfort, hygiene and quality standards and on the previous fixation of maximum fares*".

[12] The Second Panel of the Federal Supreme Court (STF), on 06/30/2017, decided that the taxi business does not need to participate in public biddings, since it cannot be included in the category of public service for it is a public utility service, and may be allowed with the permission of the municipality: *"(...) in view of the understanding of this Court – exposed above – the premise adopted by the judgment under appeal that the taxi service is a public service, what would demand public bidding, is not supported. This occurs because, as it has been exhaustively demonstrated, the taxi service is a public utility service rendered in the exclusive interest of its holder with the authorization of a public authority"*. (AWAITS REGISTRATION IN THE EXTRAORDINARY APPEAL 1.002.310 SANTA CATARINA, RELATOR: MINISTER GILMAR MENDES). Available on: http://www.juscatarina.com.br/wp-content/uploads/2017/10/T%C3%81XI.pdf (accessed on 02/26/2018).

[13] In Brazil, municipal regulations opted for the imposition of fixed fares and, in most municipalities, the concession of discounts on the final value of the ride is allowed.

[14] Colloquially referred to as "Bandeira 2".

encourage the taxi driver to take a route longer than necessary, charge abusive fares or drive an unsafe vehicle (Harding, Kandlikar & Gulati 2016). The second failure occurs because the individual passenger transport market affects economic agents that are out of the market due to either traffic congestion or to air and noise pollution. Hence, free entry can be characterized as a tragedy of the commons: the free access to the resource (taxi market) causes an accumulation of negative externalities that ends up destroying the resource (Harding, Kandlikar & Gulati 2016). In addition, the entry of new suppliers may cause an immediate reduction in the profits of incumbent taxi drivers (Shreiber 1975).

While minimizing the aforementioned market failures, regulation also generates high social costs. The establishment of fixed fares may prevent the possibility of discounts and, consequently, price competition. The limitation of licenses inhibits the entry of new drivers in the taxi market, which may cause supply shortage and, consequently, a weakening of the market (Bekken & Longva 2003). In addition to this rigid regulation, another characteristic of the Brazilian taxi market is that the number of new licenses does not usually follow the growth of the cities. In the Federal District, for example, the number of licenses have not increased since 1979 even though the population has grown more than 142% between 1980 and 2015 (Farias 2016). Table 1 shows the relationship between number of cabs[15] and population for each Brazilian capital in 2015.

As it can be seen in Table 1, there is an average of one taxi for each group of 376 inhabitants, considering only capitals. This ratio varies substantially between cities, mainly due to different urban characteristics. There are both capitals that are relatively well served by cabs, like Recife (one taxi per 265 inhabitants), Rio de Janeiro (one taxi per 197 inhabitants) and Porto Velho (one taxi per 135 inhabitants), and capitals whose ratio is much higher than the average, like Florianópolis, Campo Grande and Palmas.

[15] The taxi fleet of Brazilian capitals is available on the website of Association of Taxi Fleet Companies of the Municipality of São Paulo (ADETAX): http://www.adetax.com.br/index.php/category/taxis-de-frota/ (accessed on 08/31/2017).

Table 1 - Population and the number of taxis in the Brazilian capitals in 2015

Macroregion	Municipality	Number of Taxis	Population	Ratio Population/Taxi
North	Belém	5,383	1,446,042	269
North	Boa Vista	374	326,419	873
North	Macapá	950	465,495	490
North	Manaus	4,021	2,094,391	521
North	Palmas	136	279,856	2,058
North	Porto Velho	3,800	511,219	135
North	Rio Branco	610	377,057	618
Northeast	Aracaju	2,080	641,523	308
Northeast	Fortaleza	4,392	2,609,716	594
Northeast	João Pessoa	1,442	801,718	556
Northeast	Maceió	3,080	1,021,709	332
Northeast	Natal	1,010	877,662	869
Northeast	Recife	6,125	1,625,583	265
Northeast	Salvador	6,996	2,938,092	420
Northeast	São Luís	2,300	1,082,935	471
Northeast	Teresina	1,200	847,430	706
Southeast	Belo Horizonte	6,576	2,513,451	382
Southeast	Rio de Janeiro	33,000	6,498,837	197
Southeast	São Paulo	33,922	12,038,175	355
Southeast	Vitória	472	359,555	762
South	Curitiba	2,252	1,893,997	841
South	Florianópolis	470	477,798	1,017
South	Porto Alegre	3,918	1,481,019	378
Midwest	Brasília	3,400	2,977,216	876
Midwest	Campo Grande	490	863,982	1,763
Midwest	Cuiabá	604	585,367	969
Midwest	Goiânia	1,470	1,448,639	985
	Brazilian Capitals	**130,473**	**49,084,883**	**376**

Source: DEE / CADE elaborated with data from the Association of Taxi Fleet Companies of the Municipality of São Paulo (ADETAX) and the Brazilian Institute of Geography and Statistics (IBGE). Data for the year 2015.

Finally, it can be noted that cab-hailing apps have grown in number and scope throughout the country. The precursors that occupied the market in several Brazilian cities were EasyTaxi and 99[16], which started their operations in 2011 and 2012, respectively (see Table A.1 in Annex A). Many other taxi apps have emerged with only local coverage (present in only one municipality). Apps like 99Taxis and EasyTaxi, which worked exclusively in the intermediation of taxi services, started operating also in the intermediation of private drivers and, thus, launched 99pop (in September 2016) and EasyGo (in July 2016)[17], respectively. In addition, more recently some strategic alliances have occurred between the companies of the sector. In Brazil, the alliance between Cabify and EasyTaxi (now Easy) has been signed in June 2017. In this case, both companies decided to continue to offer their services complementarily and to operate separately. On the other hand, 99, which d in 2012 had

[16] The company's corporate name, initially *99 Taxi Software Development Ltd.*, was changed in 2017 to *99 Technology Ltd*. Therefore, throughout the text the company will be referred to as 99 – when it comes to the taxi service it will be referred to as 99Taxis; when it comes to the private vehicle service, 99pop.

[17] The operation of the private vehicle service of EasyTaxi, EasyGo, ended on September 2017.Available on: https://exame.abril.com.br/blog/primeiro-lugar/easy-deixara-de-operar-carros-particulares-no-brasil/ (accessed on 02/26/2018).

only cabs in its app, opted for another business model in 2016, opening its platform to private vehicles (see footnote 7). In January 2018, one year after joining the administrative board of 99, Chinese transportation company Didi Chuxing announced its acquisition of 99[18]. In the next subsection, the entry of ridesharing apps in Brazil is detailed.

2.2 The entry of ridesharing apps in Brazil

In Brazil, Uber was the first technology company in the ridesharing market, launching its operations in Rio de Janeiro in May 2014 and starting to serve new municipalities continuously over time. After the rapid growth in the popularity of Uber, a series of new competitors[19] started to operate in the segment in mid-2016. Both international ridesharing companies (such as Spain-based Cabify and India-based WillGo) and national startups (T81, Femitaxi and TeLevo) decided to exploit the sector, quickly dynamizing the competition in the ridesharing market[20]. As shown in Table A.1 (Annex A), new players have gradually been entering the sector. In this regard, it can be suggested that 2017 and the beginning of 2018 may face dynamics very different from the period covered by this study, which goes from January 2014 to December 2016. Such dynamics will be discussed in the Results section.

Graph 2 shows the popularity evolution of Uber, EasyTaxi and 99Taxis in Brazil through the Google Trends tool. Google Trends is a free tool made available by Google that enables monitoring the evolution of the number of searches in the Google search engine for a particular keyword or subject over time. According to Choi e Varian (2012), Google's trend research can be used as a real-time approximation of the dynamism of the related economic activity.

Analyzing Graph 1, we note that Uber only started gaining popularity in the second semester of 2015, which indicates that its acceptance was not immediate after its launch. In addition, it can be seen that the growth of the platform is correlated with a reduction in the popularity of platforms that work in the taxi segment, suggesting the existence of substitution and competition. In the fourth section of this paper, this competitive effect will be examined in more depth, seeking to find a relationship between the emergence of ridesharing apps and the number of rides of cab-hailing apps.

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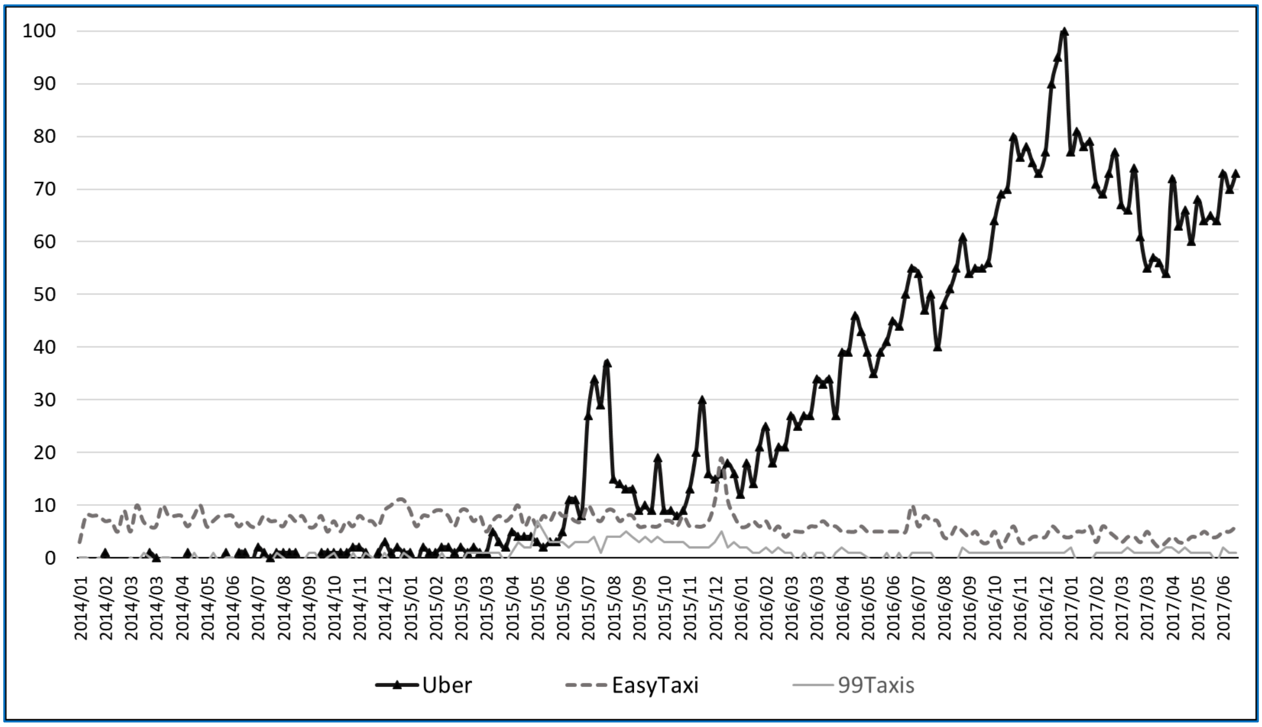
[18] In addition to 99, Didi invested in the North American company Lyft; in Indian Ola; in Grab, from Syngapore; in Taxify, from Estonia; and in Careem, from the Middle East. Available on: https://exame.abril.com.br/negocios/99-confirma-compra-pela-chinesa-didi-chuxing/ (accessed on 02/26/2018).

[19] In the Table A.1 of the Appendix, the main taxi and ridesharing companies in Brazil are listed together with information on when they launched their operations, number of cities served and number of app downloads.

[20] To mention some international operation we have, in 2017, the investment of Google in Lyft and, in Europe, the acquisition of MyTaxi, Hailo and Taxibeat by Daimler. It is also noteworthy the movement of companies , in Brazil and abroad, to expand their business to the air taxi industry.

Graph 1 - Evolution of Uber, EasyTaxi and 99Taxis popularity in Brazil, 2014-2017



Source: DEE / CADE Elaboration with data obtained through Google Trends for searches of the term "Uber", "EasyTaxi" and "99Taxis" in the period from January 2014 to July 2017, in the travel category. The popularity scale ranges from 0 to 100 and is relativized.

Finally, Graph 1 indicates that Uber's popularity has been growing significantly in the country, peaking in December 2016. This was also the last month with data available for this paper. From 2017 on, Uber's popularity drops, corroborating the existence of a very dynamic market scenario. Several factors help explain the success of the platform, including efficiency in connecting passengers to drivers, facility to pay for rides, diffusion of smartphones and low prices. It is noteworthy that the great advantage brought by ridesharing apps is the reduction in transaction costs, which increases the number of economic agents in the market and, consequently, the popularity of the app. Platforms also helped reduce information asymmetry related to the individual passenger transport market (Esteves 2015a; Harding et al. 2016). This was possible because consumers started to have access to ride information on price forecast, suggested route, ride length, driver rating and vehicle type and model, before the ride.

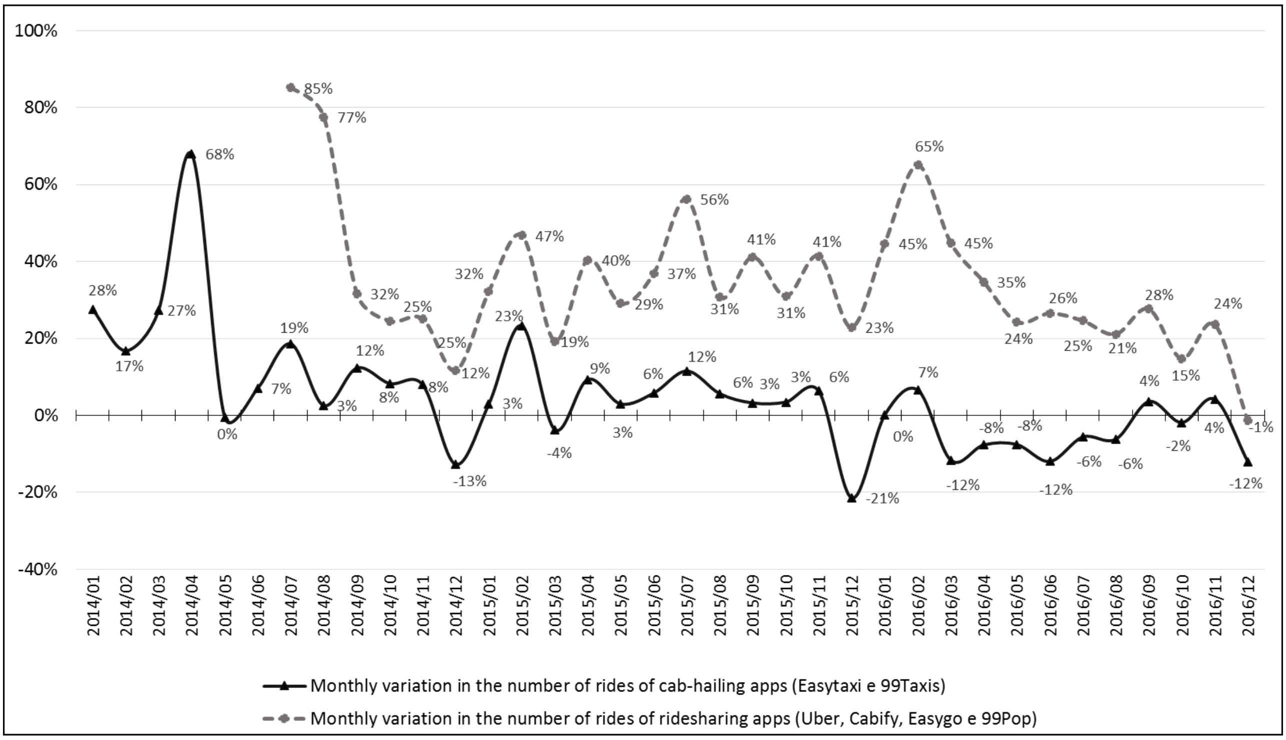
Further, it is possible to state that the pattern of dynamics between the platforms observed in Graph 1 is very similar when we analyze the data set available for rides until December 2016. Since such data set was used exclusively for the econometric analyses, we opted to present these data aggregated by the two types of transportation (cab-hailing and ridesharing apps), analyzing their monthly variation rate[21].

Thus, Graph 2 presents the monthly variation in the number of rides by type of transportation (EasyTaxi, 99Taxis v. Uber, Cabify, EasyGo and 99pop). It can be observed that the

[21] Hence, given the confidentiality of the information reported by companies, this paper will report descriptively only Graph 2, since the aggregation performed makes it difficult to identify the information on the competitors. In addition to this graph, the only values reported throughout the study will be the estimates of the coefficients of regression models presented in section 4.

growth rates of the number of rides of ridesharing companies were always higher than those of cab-hailing apps. Between January 2014 and December 2016, the average monthly growth[22] of cab-hailing app rides was of 5%, against 34% for ridesharing app rides since Uber's entry.

Graph 2 - Monthly variation of the number of rides (cab-hailing apps vs. ride-sharing apps)



Source: DEE/CADE elaboration with data obtained through official request to EasyTaxi, 99, Uber and Cabify.

It is interesting to note that the growth rates of cab-hailing app rides can be separated into two moments. Between January 2014 and November 2015, the average monthly growth of cab-hailing app rides was of 10%, against a reduction of 5% between December 2015 and December 2016. This describes a fact already analyzed by Esteves (2015b): at first, there was a growth in the number of rides of both cab-hailing and ridesharing apps. The information set used by the author goes until the first semester of 2015. In this regard, this paper seeks to go further, investigating a second moment of the entry of Uber-like apps until December 2016. Furthermore, this paper investigates in an unprecedented way the behavior of cab-hailing app fares after Uber's entry.

2.3. Recent regulatory issues

In the previous subsections, some regulatory issues have already been discussed. In addition, other papers and documents analyze such issues exhaustively. For instance, Seae (2016) discusses in detail historical justifications for the individual passenger transport market regulation. In addition, while making a literature review, the author analyzes potential solutions under a more flexible regulation. Esteves (2015a) examines the regulation considering competitive, regulatory and urban planning aspects. The author states that there are not economic elements that justify regulations

[22] Arithmetic mean of the monthly variation rates.

that prohibit or hinder the entry of new providers of individual transport services. Moreover, he concludes that the economic elements suggest that, from a competitive and consumer perspective, the entry of new agents tends to be positive. Thus, this section aims to highlight some recent developments of regulation in the sector.

In the midst of a huge national discussion[23] on the regulation of apps like Uber and Cabify, with regard to their public or private nature, besides tax and safety/quality issues and the possibility of municipal regulation, among other subjects, Federal Law 13,640/2018 was enacted, amending Federal Law 12,857/2012 to regulate the ridesharing market. The enacted Law defines this type of transportation as private, allows the collection of municipal taxes and establishes the requirement of contracting Passenger Personal Accident Insurance (APP) and the Compulsory Road Traffic Insurance (DPVAT) and the driver's registration as an individual Brazilian Social Security (INSS) taxpayer.

In addition, the Law states that, in the municipalities that opt for its regulation, only drivers who fulfill the following conditions will be authorized: *I – hold a National Driver's License in category B or higher that contains information that they engage in a paid activity; II – drive a vehicle that meets maximum age requirements and the characteristics required by the transit authority, the municipal authority and the Federal District; III – issue and maintain the Vehicle Registration and Licensing Certificate (CRLV); IV – present a criminal clearance certificate*.

Another topic of the approved regulation clarifies that "*only the municipalities and the Federal District can regulate and supervise the ridesharing service present in item X of the article 4 of this Law within their territories*". Currently, few Brazilian municipalities have municipal regulations. When there are municipal rules, most are very recent. Out of the 26 regulations found, 23 emerged from 2017 on[24]. On the one hand, the municipality of São Paulo, for instance, has been very active on the regulation of these apps, having already published, in addition to the Decree 56,981/2016, sixteen resolutions referring to several operation aspects of the segment such as public prices, use of the road, data availability, requirement for driver registration, requirement that the municipality of registration and circulation of the vehicle be the same, among others. On the other hand, it would be desirable that the municipal regulation of the apps were more parsimonious – like the one approved by the Federal Law – in order not to over-regulate the sector, which could result in a significant restriction in the supply of available vehicles[25], increasing fares with the respective deleterious effects on consumer welfare. Such task is not trivial since, together with these competitive aspects, the municipal regulations should be coordinated with other aspects of urban planning and mobility policy and investment, environmental issues, among others.

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[23] In the international scenario, there are several stances on the regulation of Uber-like apps. For instance, the London transport authority did not renew Uber's license in 2017, but the app appealed and still operates in the city. In general, the European Union has been more rigid towards services via applications. On the other hand, in the United States, several cities already regulated such apps with less restrictive laws. Available on: https://www.theguardian.com/technology/2017/dec/20/uber-european-court-of-justice-ruling-barcelona-taxi-drivers-ecj-eu (accessed on 02/26/2018).

[24] For more detail about these regulations, see Table A.3 (Annex A).

[25] Vehicle supply restriction can be directly imposed via maximum vehicle quantity or indirectly via, for example, requiring that the circulation of vehicles used by app drivers occur exclusively in the city where the vehicle is registered.

In this regard, it should be noted that some of the failures identified in the individual passenger transport market (taxi and private vehicles) are eliminated (at least mitigated) through the use of platforms[26]. Therefore, it makes sense, at the present moment, to regulate the ridesharing market less than the taxi market has ever been regulated. Indeed, Federal Law 13,640/2018 brought safety standards (that can be further developed by local authorities) beneficial to the consumer and did neither impose major regulatory barriers to entry nor restrictions to pricing freedom. On the other hand, it is important to expand the debate towards the gradual deregulation of taxi services, especially about barriers to entry and pricing freedom. Such deregulation may be thought of, for instance, only for the cab-hailing app segment[27]. Thus, it would be possible to encourage more competitive business models in terms of more innovative services, with improved quality and security, lower prices and more options, increasing consumer welfare.

3. Data and methodology

Initially, this section discusses potential definitions of a relevant market for ridesharing apps, without the ambition of defining it for the present paper. In addition, we discuss the method and the data set used for the empirical analysis.

3.1. Potential relevant market definitions and scope of the study

The notion of relevant market is used in the identification of competing products and companies. Therefore, it can be said that it is the market where competition takes place (CADE 2016). The relevant market has two dimensions: the product dimension, which regards goods and services that can be considered as substitutes; and the geographic dimension, which corresponds to the maximum area where competing firms tend to react to any change in the level of prices, quantities, quality (among other factors).

First, it should be noted that defining a relevant market in the case analyzed in this study is extremely complex, since the sector is characterized by a high degree of dynamism and recent innovations[28] (see section 2.2). It can be argued that the relevant market (at the product dimension) involves the following substitutes: cab-hailing apps, traditional taxi cabs (street and stand), public transportation and private vehicles. However, this encompassing definition is not consensual. For

[26] In this regard, Esteves (2015a, p. 23) states that: *"the technological developments of apps for smartphones, which include the possibility of viewing driver profile, declining the ride, rating services, monitoring the vehicle through GPS technology, know the fare ex ante, and also pay online in the platform itself, have indeed addressed seeral of the concerns that historically motivated taxi regulation".*

[27] In this respect, it should be noted that an amendment (not approved as of yet) to PLC 28/2017 elaborated by Senator Pedro Chaves proposed that "*in the hiring of radio taxi cabs via Internet applications, pricing will be free as long as it is accurately informed to the passenger at the time of the request*".

[28] It should be noted that such technological innovations can be considered disruptive. According to OECD (2015, p. 2-3): "*First, disruptive innovations disrupt, which is to say they drastically alter markets. They are not incremental technological developments [...]. Instead, they are breakthroughs that bring radical changes which were unforeseen by the market and occur irregularly. [...]. Second, disruptive innovations include not only new products and manufacturing processes, but new business models, as well. Disruptors in the sharing economy like Airbnb and Uber, for example, are not new technologies so much as they are new business models that leverage the Internet and smartphones to match excess capacity in private durable goods with demand*".

example, the Urban Mobility Survey of the National Confederation of Transport (CNT 2017)[29] shows that, in 2017, 2.1% of the passengers who stopped taking buses replaced it with Uber and Cabify services. The survey also shows that buses have been replaced by taxi services in the same magnitude. In addition, Clewlow & Mishra (2017) found a decrease of about 6% in the use of subway services and of 4% in the use of buses associated with the use of Uber-like apps in seven metropolitan areas of the United States. On the other hand, other existing evidence regarding public transportation shows that diffusion of P2P apps can both increase and decrease their use, depending on the type of transportation (bus, van or subway), the urban structure of the location and the period post-entry of the apps (Nelson & Sadowsky 2017; Babar & Burtch 2017). Rayle et al. (2014) bring interesting results for the case of San Francisco, in the United States. Evidence suggests that ridesharing services serve a latent demand for urban trips from users generally younger and educated that look for a fast point-to-point service, avoiding the inconveniences of driving like parking and having to drink and drive. The authors also suggest that, despite ridesharing services compete with public transportation, they often seem to serve as a complement.

Due to the complexity of the theme and the difficulty of building a data set that contains all possible substitutes, this paper does not aim to determine the relevant market for ridesharing apps, but to examine the competitive pressure (in terms of number of rides and respective fares) that ridesharing apps exert on cab-hailing apps.

With respect to the geographic dimension, it is believed that competition tends to take place in the limits of the municipality or the metropolitan area. A neighborhood or district dimension is not feasible, since the easy mobility of vehicles between different regions ends up inhibiting non-transitory price increases in these locations. In this regard, this paper used the geographic dimension of municipality or, when necessary[30], metropolitan area.

Finally, with respect to the scope of the study, the empirical analysis will be limited to considering only Uber rides (as a representative of ridesharing apps) and 99Taxis and EasyTaxi rides (as representatives of cab-hailing apps). The choice of using Uber data in the econometric exercise is due to the fact that the company was the first to operate in the country and is the major representative of the sharing economy, besides being object of several academic researches as observed throughout this paper. In addition, the entry of competitors such as Cabify, EasyGo and 99pop took place at the end of the analyzed period[31], what limits an analysis of the effect of their entry. With respect to the limitation of analyzing only cab-hailing app rides, it is solely due to the difficulty in obtaining data on the number of rides of traditional (non-digital) taxi services, since no public agency or company carries out this type of measurement in a comprehensive way for a large number of cities.

[29] The sampling plan of the survey considered the distribution of 3,100 interviews in 35 municipalities with more than 100 thousand inhabitants in Brazil (out of a total of 309 municipalities). Besides reporting their own information, the respondent provided summary information on the travel habits of all residents in their household who were 15 years old or more.

[30] See subsection 3.3 for further detail.

[31] The competitors (*Cabify*, *Easygo* e *99Pop*) started providing ridesharing services only in the second semester of 2016.

3.2. Empirical strategy

In order to assess the impact of Uber's entry on the incumbent market of cab-hailing apps, a fixed-effects regression model with panel data is used. The main purpose of using panel data is its ability to reduce the omitted-variable bias problem, which is very frequent in cross-section regressions. Using panel data models enables controlling for the omitted variables that are constant over time in the form of individual fixed effects. The specification used in this paper to assess the effects of Uber's entry on cab-hailing apps refers to traditional panel data models, following Greene (2003). It is noteworthy that the specification with fixed effects and time fixed effects is similar to a difference-in-differences model for multiple periods (Angrist & Pischke 2009).

Initially, Equation 1 tests the significance of the treatment effect (Uber's entry) in relation to the logarithm of the number of cab-hailing app rides in municipality *i* in period t. This paper also analyzes the effect of Uber's entry on the log of the average fare paid per kilometer in cab-hailing app rides. In addition, we added some control variables that tend to affect, at the same time, Uber's entry in a certain location and the number of cab-hailing app rides[32].

$$\log(Y_{it}) = \alpha + \beta Uber_{it} + \gamma X_{it} + \mu_i + \varepsilon_{it} \quad (1)$$

where α is the constant, β is the treatment effect coefficient and ε_{it} is the random term. On the other hand, μ_i stands for the fixed effect, which enables capturing the unobservable characteristics of the cities that do not vary over time (fixed), the geographic characteristics, the preference for types of transportation, the taxi fleet – which is generally stable, and the different local laws and institutions. Y_{it} is the dependent variable for city *i* in month-year t. Throughout the paper, two distinct dependent variables are used: the number of cab-hailing app rides as Esteves (2015b) and the fare paid per kilometer in cab-hailing app rides. $Uber_{it}$ is the treatment variable and can be defined as a dummy variable that takes value 1 if city *i* in month-year *t* is served by Uber and 0 if not. Also, specifications where $Uber_{it}$ is a continuous variable (log of the number of Uber rides in city *i* in month/year *t*) are estimated. In this case, the elasticity between the number of Uber rides and the number of cab-hailing app rides is estimated.

The matrix X_{it} includes three control variables. The first refers to the size of the population of city *i* in month/year *t* and captures the differences between the sizes of the individual passenger transport markets of the cities analyzed. The second control measures the density of private vehicles (vehicle fleet divided by the number of inhabitants) of city *i* in month/year t e captures both the type of urban structure of the city (places with more spreading tend to encourage the use of the car) and the degree of local economic dynamism, since the number of cars per inhabitant of a region tends to grow monotonically with the income level (Nishitateno & Burke 2014). The third variable included is the average wage of formal employees in city *i* in month/year t and captures the shifts in the demand given the local income and the economic cycle. All the variables were included in their logarithms so that their coefficients could be interpreted as elasticities. On the other hand, Equation 2, more robust, includes controls that capture time fixed and specific trend effects. This specification is equivalent to a difference-in-differences model for multiple periods.

[32] In this regard, in the absence of control variables, Resende (2014) states that it is unlikely that such estimates bring a reliable value for the treatment effect coefficient, given the omission of relevant variables in the model.

$$\log(Y_{it}) = \alpha + \beta Uber_{it} + \gamma X_{it} + \delta Trend_{it} + \omega_t + \mu_i + \varepsilon_{it} \quad (2)$$

where ω_t is the time fixed effect, which enables controlling for variables that are common to all cities and that vary over time such as macroeconomic shocks and the monthly seasonality of the demand for transportation. Thus, it was included a dummy time variable for each month/year of the analyzed period. In addition, we included a variable that captures the time elapsed since Uber's entry in each specific municipality, $Trend_{it}$, which takes rising values (0, 1, 2, 3 ... *n*), where 0 means that it has not entered yet and *n* is the last month of the sample in which Uber served the municipality. This variable controls for unobservable specific characteristics that may be associated with the time of exposure to the competition pressure exerted by ridesharing apps. All the results using both specifications are presented in the Results section with emphasis on Equation 2, which is the most complete. Finally, it should be noted that there are alternative impact evaluation strategias such as instrumental variables, matching and propensity score techniques (Khandker, Koolwal & Samad 2010). It is important to emphasize that, although matching techniques using matching and propensity score are attractive, these approaches are based on the same conditional independence assumption that is necessary to provide a causal interpretation of regression coefficients. Thus, it can be said that both matching (and propensity score) and regression techniques are control strategies (Angrist & Pischke 2009. In this regard, these authors argue that:

> "[...] *since the core assumption underlying causal inference is the same for the two strategies, it is worth asking whether or to what extent matching really differs from regression. Our view is that regression can be motivated as a particular sort of weighted matching estimator, and therefore the differences between regression and matching estimates are unlikely to be of major empirical importance*" (Angrist & Pischke 2009, p. 69).

As an alternative to such matching techniques, this paper focuses on fixed-effects regression because it enables controlling for both observablse and unobservables that do not vary over time.

3.3. Data

The information required to estimate the competitive impacts of Uber's entry on the incumbent cab-hailing app market was requested[33] directly to companies (*EasyTaxi*, *99Taxis*, *Uber e Cabify*[34]) by the Department of Economic Studies (DEE) of the Administrative Council for Economic Defense (CADE). The following variables were made available at the municipal level[35] by each company: number of rides month and year each city started being served, average fare in Brazilian Real (R$) and average distance traveled. As dependent variables, the number of rides made by cab-

[33] In the process SEI/CADE nº 08700.000924/2017-87 all the requests are listed.

[34] The Cabify data were used only in Graph 2 and in Table A.2. Such data were not used the econometric analyses as previously explained.

[35] In municipalities where there is conurbation, the geographic unit comprises the entire metropolitan area, since vehicles can move freely in adjacent regions. In the rest of the paper we use the term city for simplification, although this term may mean municipality or metropolitan area.

hailing apps and the average fare paid per kilometer[36] were used. The variables are monthly and cover the January 2014-December 2016 period. Since not all Brazilian cities are served by individual passenger transport apps, the sample is restricted to those where at least one cab-hailing app operates. After all the restrictions, the final sample is a panel of 590 cities observed in 36 months. During this period, Uber's entry occurred sometime in 41 municipalities or metropolitan areas[37].

The monthly periodicity of the analysis makes it difficult to add control variables to the estimation since most are measured annually and, to some extent, lagged. For example, the Gross Domestic Product (GDP) of municipalities is calculated annually by IBGE and the last edition of the study released the GDP of 2015. In spite of this, the following explanatory variables were used at the municipal level with monthly periodicity: total population, vehicle density, average wage of formal employees, a trend variable and time dummies. Population is measured annually by IBGE and, in order to add it to the empirical model, it is assumed that the monthly population growth rate is constant over the respective year. Vehicle density is obtained by the ratio between total vehicle fleet in the municipality and local population. Vehicle fleet is calculated monthly and made available by the National Traffic Department (DENATRAN). The average wage of formal employees at the municipal level comes from the Annual Social Information Report (RAIS)[38] issued by the Ministry of Labor. In order to smooth the monthly municipal series of wages and filter its noise, we used the 12-month moving average.

4. Results

This section is divided into two subsections. Subsection 4.1 presents the econometric estimations that were performed using the data set with all 590 municipalities and metropolitan areas available between January 2014 and December 2016. On the other hand, subsection 4.2 analyzes the effects of Uber's entry on the cab-hailing app market only in capitals. Such an exercise is interesting because it also enables analyzing the effects of Uber's entry separately in the capitals of the North and Northeast regions (where Uber's entry, when it occurred, was only in 2016) vis-à-vis the capitals of the South, Southeast and Central West regions (where Uber's entry was in May 2014). It should also be noted that, according to Table A.2 (Annex A), the entry of cab-hailing apps had occurred before 2014 and in similar moments for both groups of capitals. This fact is important to avoid biases in the coefficients of the estimations.

[36] To construct this variable, the average ride fare in Brazilian Real (R$) was divide by the respective average distance traveled. The values were converted to constant prices of December 2016 using the IPCA.

[37] Metropolitan area (MA) was defined here by the data received from Uber. They aggregated the data from some municipalities in MAs. According to these data, the company operated in 122 municipalities/districts in 2014-2016. Part of these municipalities was grouped to compose the MAs where Uber operated. In this regard, the MA referred to in this study is always a definition of Uber itself, which listed the municipalities of each MA, what enabled the aggregations required to match the spatial scale of the analysis of EasyTaxi and 99Taxis. The MA of São Paulo, for instance, is composed of 20 municipalities and the MA of Belo Horizonte is composed of 6 municipalities. On the other hand, the municipalities of Aracaju and João Pessoa, for example, were not aggregated with any other.

[38] Wages are in R$ in constant prices of December 2016, using a consumer price index (IPCA).

4.1. All municipalities

Initially, Table 3 shows the results in columns 1 and 2 of the estimation of the respective Equations 1 and 2 discussed in subsection 3.2. Such estimations aimed to identify the effects of Uber's entry on the number of cab-hailing app rides. The treatment variable is dichotomous, taking value 1 only in the cities and months Uber operated and 0 where it did not. The dependent variable and the other explanatory variables are in logarithms. Column 1 of Table 3 presents the specification controlling for the fixed effects of the municipalities and with the inclusion of explanatory variables and, finally, column 2 displays the results of the full specification, with the inclusion of time fixed effects and the trend variable.

According to Table 3, the effects of Uber's entry on cities served by the app are negative and statistically significant in both specifications. The coefficient that captures the effect of the entry in the most complete specification (column 2) is -0.8397, indicating that Uber's entry in the market caused a reduction in the number of cab-hailing app rides of about 56.8%[39]. In addition, the estimated model (column 1) has a lower explanatory power, presenting a coefficient of determination[40] (R^2) of 0.371, when compared to the more complete model (column 2), which presents an R^2 of 0.554[41]. Since this also occurs in the other estimates, the next tables will present only the analyses for the most complete model, which are always reported in the second column of the following tables.

It is interesting to note that the coefficient of the variable "(logarithm of) population" becomes statistically insignificant in the second specification, when the time dummies are included. The other control variables, in column 2, are positive and statistically significant at 5%. This means that, the larger the total vehicle fleet per inhabitant (vehicle density) and the higher the average wage, the higher the number of cab-hailing app rides in the municipalities analyzed.

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[39] It should be noted that, since it is a regression in the logarithms of the dependent variable, the coefficients (β) estimated for the dummy variable of Uber's entry should be interpreted as (exp(β)-1)*100. Hence, the following calculation was made for all the Uber's entry coefficients: (exp(-0,8397)-1)*100 = 56.8%. For small values of β, there is not much difference between the usual interpretation ($\beta * 100$) and the correct transformation, (exp(β)-1)*100. However, the difference grows when the absolute value of β moves away from zero.

[40] The coefficient of determination is the most used measure to analyze the goodness of fit of a regression curve. Such coefficient measures the proportion or percentage of the total variation of the dependent variable (Y) explained by the regression model (Gujarati 2000). The R^2 varies between 0 and 1 and indicates, in percentage terms, how much the model is capable of explaining the observed values. The higher the R^2, the better the fit.

[41] For instance, if R^2 is 0.554, this means 55.4% of the dependent variable can be explained by the explanatory variables.

Table 3 - Effects of Uber's entry on the rides of cab-hailing apps, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Uber Entry (0/1)	-0.3368***	-0.8397***
	(0.091)	(0.092)
Log (Population)	9.5314***	-0.3391
	(0.418)	(0.480)
Log (Car Density)	28.5121***	2.0054**
	(0.503)	(0.796)
Log (Average Wage)	-0.9456**	2.7202***
	(0.482)	(0.429)
Constant	-62.4377***	-13.8191**
	(7.285)	(6.890)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	Yes	Yes
Time Trend	No	Yes
Number of Observations	6,825	6,825
R^2	0.371	0.554
Number of Municipalities	590	590

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

It is noteworthy that the tables in Annex B present the results considering the treatment variable in a continuous version. Thus, instead of a binary variable, the treatment variable is given by the logarithm of the total number of Uber rides. This type of specification enables obtaining the elasticity of the number of cab-hailing app rides in relation to variations in the number of Uber rides. Similarly to the results found in Table 3, Table B.1 (Annex B) shows that in both specifications the effects are negative and statistically significant. The coefficient estimated in column 2 shows that an increase of 1% in the number of Uber rides reduces, on average, the number of cab-hailing app rides in 0.09%. Together with the analysis of Graphs 1 and 2 (subsection 2.2), this low elasticity corroborates the hypothesis that Uber not only competes with cab-hailing app rides, but may be also affecting, at the same time, other types of transportation. At this point, we must recall the Urban Mobility Survey of the National Confederation of Transport (CNT 2017), which shows that, in recent years, out of the respondents who stopped using buses, 2.1% replaced the bus[42] with ridesharing app rides, what may mean a considerable portion of passengers in absolute terms. In addition, Clewlow & Mishra (2017) showed a drop in the use of subway services (↓6%) and buses (↓3%) associated with the use of ridesharing apps in seven metropolitan areas of the United States. This evidence sheds light on the debate about the definition of relevant market, besides posing challenges for urban mobility managers with respect to a better planning and complementarity of transportation services.

[42] According to CNT (2017, p. 58-59), "*the bus stopped being used by a considerable portion of the population. Among the respondents, 38.2% stopped using the bus as a type of public transportation, out of which 16.1% no longer use it and 22.1% reduced the use. [...] 56.3% still opt for the bus service. In comparison with the 2006 survey, there was a 24.2% increase in the number of Brazilians that reduced the use or no longer use buses. Certainly, the lack of prioritization of public transportation, the fall in the operational speed and the costing of services based solely on fares, which is the policy adopted in most Brazilian municipalities, are the main causes of the loss of demand and migration of users. [...] The reduction in the use of buses is more representative among higher-income Brazilians. For individuals from classes A and B, the bus is either no longer use dor had its use reduced by 47.8% and 43.6%, respectively*".

Considering that the emergence of Uber caused a reduction in the number of cab-hailing app rides, it is important to know if there was some type of economic reaction from the incumbent sector. Although it is not possible to measure changes in the quality of the service or the cars, for example, the data available enable investigating whether the incumbent sector reacted reducing fares (via discounts in the final value of the ride). Thus, Table 4 presents the results of the estimation of the effects of Uber's entry on the average fare paid per kilometer in cab-hailing app rides, with the same specifications of Table 3.

Table 4 - Effects of Uber's entry on the average fared charged by cab-hailing apps (per kilometer), 2014-2016

	Dependent Variable: Log (average fare per kilometer)	
	(1)	(2)
Uber Entry (0/1)	0.0201	0.0026
	(0.028)	(0.032)
Log (Population)	-2.8263**	-2.2565
	(1.291)	(2.418)
Log (Car Density)	-2.5192***	-2.5671**
	(0.665)	(1.182)
Log (Average Wage)	-0.0857	0.4275
	(0.433)	(0.478)
Constant	37.6543*	25.7873
	(19.263)	(32.839)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	1,439	1,439
R^2	0.035	0.080
Number of Municipalities	71	71

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

The results in Table 4 reveal that Uber's entry in the individual passenger transportation market was not capable of affecting cab-hailing app fares, because regardless of the specification, the coefficient of Uber's entry was not statistically significant. Thus, it can be noted that, using the entire sample of municipalities with available data[43], the incumbent sector did not adopt a price reduction strategy as an immediate reaction to the increase in competition. Two facts can explain such a behavior. First, the excessively rigid regulation, which imposed fixed tariffs, tends to make it difficult or prohibit the application of discounts in cab rides. Secondly, it is observed that there has been a huge effort by the incumbent sector in reacting to the intensification of competition by seeking to contest the legality of the apps, which also tends to discourage or postpone the adoption of price reactions.

The results presented so far, which state that Uber affected negatively the number of rides of the incumbent cab-hailing app market, contrast with the evidence from previous studies for Brazil that showed that Uber neither did reduce the number of cab-hailing app rides (Esteves 2015b) nor changed the average income of taxi drivers (Oliveira & Machado 2017). Thus, previous papers exclusively corroborated the hypothesis that Uber conquered mostly new customers who did not use cab-hailing app services.

[43] Due to data unavailability, the size of the sample that contains taxi fares falls to 71 municipalities/MAs.

It is noteworthy that the results of Esteves (2015b) can be explained by the period analyzed in the study (October 2014-May 2015), a period in which Uber was still in the beginning of its operations, consequently presenting a low popularity and a low number of operations (see Graph 1). As for Oliveira & Machado (2017), which evaluate the effects of Uber on the labor market for taxi drivers between April 2014 and September 2016, it can be noted that the income stability of taxi drivers can coexist with the increase in the competition and the reduction in the total number of rides. The increase in competition can encourage some taxi drivers to quit the individual transport market so that the remaining taxi drivers end up capturing a larger share of demand (even if aggregate demand is lower). Thus, this effect ends up offsetting income reductions caused by the emergence of the competition posed by ridesharing apps.

4.2. Brazilian capitals

This section analyzes the effects of Uber's entry on cab-hailing app rides only in the Brazilian capitals.

4.2.1. All Brazilian capitals

A first exercise consists of reperforming the econometric estimations presented in the previous section only for the 27 Brazilian capitals[44], in order to examine any different pattern for Uber's entry in this selection of municipalities. Table 5 reveals, again, a statistically significant negative effect for the estimated models in columns 1 and 2. However, when only capitals are analyzed, the effect of Uber's entry on cab-hailing app rides is lower. In the more complete specification (column 2), the coefficient that measures this effect is -0.4604, suggesting that Uber's entry provoked a reduction of 36.9% in the number of cab-hailing app rides.

Table 5 - Effects of Uber's entry on the rides of cab-hailing apps: all Brazilian capitals, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Uber Entry (0/1)	-0.5468***	-0.4604***
	(0.087)	(0.098)
Log (Population)	7.5304***	2.3517***
	(0.507)	(0.691)
Log (Car Density)	32.9443***	13.4658***
	(1.232)	(2.669)
Log (Average Wage)	-4.2307***	-0.8581
	(0.813)	(0.887)
Constant	-18.0361	2.8643
	(11.910)	(10.987)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	921	921
R^2	0.481	0.602
Number of Municipalities	27	27

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

[44] As previously explained, the capital refer to the municipality or metropolitan area to which it (the municipality) belongs.

After examining the effect on the number of rides, it is important to verify potential impacts of Uber's entry on the average fare paid per kilometer in cab-hailing app rides. Table 6 displays the results of this estimation. Differently from the result verified when all the municipalities in the sample are considered, considering only the capitals we found a reduction of 7.8% in the average fare paid per kilometer in cab-hailing app rides during the analyzed period. These results indicate that the incumbent sector (cab-hailing apps), in Brazilian capitals, reacted to Uber's entry in the period, reducing (via discounts) its fares.

Table 6 - Effects of Uber's entry on the average fared charged by cab-hailing apps (per kilometer): all Brazilian capitals, 2014-2016

	Dependent Variable: Log (average fare per kilometer)	
	(1)	(2)
Uber Entry (0/1)	-0.0257	-0.0814***
	(0.023)	(0.026)
Log (Population)	-5.6268***	-10.6767***
	(1.134)	(2.056)
Log (Car Density)	-0.7499	-4.9475***
	(0.650)	(1.194)
Log (Average Wage)	-0.0781	0.9297**
	(0.352)	(0.366)
Constant	81.9856***	140.4986***
	(17.648)	(28.903)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	705	705
R^2	0.117	0.240
Number of Municipalities	27	27

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

4.2.2 Brazilian Capitals in the North and Northeast regions

Finally, it is worth examining the results using two regional groups of Brazilian capitals. The groups enable exploring an interesting feature found in these two groups. In the group of sixteen capitals from the North and Northeast regions, a late entry of the Uber app is observed. Analyzing Table A.2 (Annex A), we observed that, when the entry occurred, it happened in the last year of the analyzed period, that is, between March 2016 and December 2016. On the other hand, when we observe the group of eleven capitals from the South, Southeast and Central West regions, we verify that entries started in the beginning of the analyzed period. In the MA of Rio de Janeiro, for instance, it occurred in May 2014. In this regard, it is interesting to investigate the effects of Uber's entry in these two groups.

Table 7 shows a statistically significant negative effect for the estimated models in columns 1 and 2. However, when only capitals of the North and Northeast regions are analyzed, the effect of Uber's entry on cab-hailing app rides is stronger than when compared with the results for all capitals (Table 5). In the specification of column 2, the coefficient that measures this effect is -0.5568, indicating that Uber's entry in the capitals of the North and Northeast regions caused a reduction of 42.7% in the number of cab-hailing app rides.

Table 7 - Effects of Uber's entry on the rides of cab-hailing apps: North and Northeast capitals, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Uber Entry (0/1)	-1.0545***	-0.5568**
	(0.149)	(0.248)
Log (Population)	13.0095***	7.4361***
	(1.271)	(1.918)
Log (Car Density)	39.6245***	25.7247***
	(1.644)	(5.380)
Log (Average Wage)	-0.9503	1.6390
	(1.574)	(1.872)
Constant	-97.7071***	-64.0367**
	(27.768)	(30.297)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	525	525
R^2	0.574	0.612
Number of Municipalities	16	16

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

On the other hand, Table 8 displays the results of Uber's entry on the average fare paid per kilometer in cab-hailing app rides in this same group of capitals. Differently from the result verified for all capitals, by restricting the sample to only capitals of the Northeast and Northeast regions we verify that the incumbent sector did not adopt a price reduction strategy as an immediate reaction to the increase in the competition. One hypothesis is that, since the analyzed period ends in December 2016, it was not possible to verify a reaction from the cab-hailing apps right after Uber's entry. Perhaps the reaction via discounts have occurred only in 2017.

Table 8 - Effects of Uber's entry on the average fared charged by cab-hailing apps (per kilometer): North and Northeast capitals, 2014-2016

	Dependent Variable: Log (average fare per kilometer)	
	(1)	(2)
Uber Entry (0/1)	-0.0466*	-0.0228
	(0.024)	(0.036)
Log (Population)	-6.4187***	-1.7503
	(1.359)	(2.266)
Log (Car Density)	-1.8376**	0.7908
	(0.757)	(1.448)
Log (Average Wage)	0.3685	0.4740
	(0.316)	(0.345)
Constant	85.4641***	24.0367
	(21.109)	(31.614)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	399	399
R^2	0.331	0.430
Number of Municipalities	16	16

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

4.2.3. Brazilian capitals in the Southeast, South and Central West regions

In this last set of results, we examine the effect of Uber's entry on the group of capitals of the South, Southeast and Central West regions. As previously emphasized, this group is composed of capitals where Uber entered in the beginning of the analyzed period. In this regard, it is possible to compare the results of the effects of recent entries (less than one year for capitals of the North and Northeast regions) of Uber vis-à-vis entries that occurred more than two years ago.

Analyzing Table 9, it possible to verify the effects of Uber's entry on the number of cab-hailing app rides in the capitals of the South, Southeast and Central West regions. The effects were negative and statistically significant for the model estimated in column 2. It should be noted that when only capitals of the South, Southeast and Central West regions are examined, the effect of Uber's entry on cab-hailing app rides is weaker than when compared to the results for all capitals (Table 5) or only capitals of the North and Northeast regions.

Table 9 - Effects of Uber's entry on the rides of cab-hailing apps: South, Southeast and Midwest capitals, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Uber Entry (0/1)	-0.0716	-0.3032***
	(0.092)	(0.072)
Log (Population)	4.6760***	-0.5962
	(0.491)	(0.487)
Log (Car Density)	20.1167***	-1.9606
	(1.667)	(2.040)
Log (Average Wage)	-3.2205***	0.7653
	(0.823)	(0.693)
Constant	-11.6313	12.6588*
	(11.349)	(7.428)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	396	396
R^2	0.370	0.784
Number of Municipalities	11	11

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

In the specification of column 2, the coefficient that measures this effect is -0.3032, suggesting that Uber's entry in the capitals of the South, Southeast and Central West regions reduces in 26.1% the number of cab-hailing app rides. This evidence is interesting because it suggests that, initially, Uber's entry has a strong effect, substantially reducing the number of cab-hailing app rides, but over time there is a gradual recovery in this number.

Finally, we must check the effects of Uber's entry on the average fare paid per kilometer in cab-hailing app rides in the capitals of the South, Southeast and Central West regions. We found that there was a reduction of 12.1% in the average fare paid per kilometer in cab-hailing app rides in the analyzed period. Differently from the results for the capitals of North and Northeast regions, we verify that the incumbent sector reacted via discounts in the final value of the rides when a longer time period is considered. It is interesting to emphasize that in this group of capitals it was possible to capture a reaction from the cab-hailing apps via price reduction, since the entry in the capitals started May 2014. Therefore, in this sample of municipalities the price reaction was captured. In this regard, it can be expected that the cab-hailing app markets in the North and Northeast regions react via price reduction over time, following the example of the capitals of the South, Southeast and Central West regions.

Table 10 - Effects of Uber's entry on the average fared charged by cab-hailing apps (per kilometer): South, Southeast and Midwest capitals, 2014-2016

	Dependent Variable: Log (average fare per kilometer)	
	(1)	(2)
Uber Entry (0/1)	0.0106	-0.1294***
	(0.041)	(0.047)
Log (Population)	-2.5968	-23.7297***
	(1.919)	(3.875)
Log (Car Density)	-0.6315	-9.9964***
	(1.179)	(2.213)
Log (Average Wage)	-3.0046***	1.7240
	(0.993)	(1.422)
Constant	63.0094**	329.6057***
	(29.059)	(54.045)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	306	306
R^2	0.052	0.240
Number of Municipalities	11	11

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

5. Conclusions

The rise of the sharing economy and the emergence of P2P platforms have brought significant changes to the competitive environment of several traditional economic sectors. One of the most affected sectors was the individual transport market which, due to technological developments and the popularization of Internet, experienced the emergence of apps that started to do the intermediation between drivers and potential passengers.

In this regard, several apps that operate in the ridesharing market, such as Uber and Cabify, started to operate in Brazil, generating structural changes in the competitive environment of the individual transport market and, consequently, reactions from the incumbent sector of cab-hailing apps. The market as a whole grew significantly in a short time period: the monthly average growth of ridesharing app rides was of 34% until December 2016.

This paper aimed to assess the competitive impacts of Uber's entry on the incumbent market of cab-hailing apps. Thus, using a fixed-effects regression model with panel data and a dataset of 590 municipalities and 36 months, covering the 2014-2016 period, we observed that Uber's entry generated, on average, a reduction of 56.8% in the number of cab-hailing app rides in cities where the platform was operating and, additionally, we verified that a 1% increase in the number of Uber rides represented a 0.09% reduction in the number of cab-hailing app rides. This evidence set, together with some descriptive information on the dynamics of the number of ridesharing apps, suggest that, in addition to conquering users from other types of transportation that did not use cab-hailing app services, Uber also competed with the cab-hailing app services, attracting part of their users. Moreover, using the sample that comprises all 590 municipalities, we verified that, on average, the taxi segment did not react to the increased competition, not offering discounts in the final value of the ride.

By investigating the competitive impacts of Uber considering only Brazilian capitals, it can be noticed that the magnitude of Uber's entry falls to -36.9%, an indication that the competitive effect tends to be lower (in percentage terms) in cities where the market is larger. In addition, it was observed that there is also an important spatial heterogeneity in the competitive effects of the platform by comparing the markets of the capitals of the North and Northeast regions and the capitals of the South, Southeast and Central West regions. This may be explained, to some extent, by the moment of entry of the platform in these regions. In the group of capitals of the North and Northeast regions, a late entry of the app is observed (between March 2016 and December 2016). On the other hand, when the group of capitals of the South, Southeast and Central West regions is observed, we verify that the entries began in May 2014.

Thus, it is possible to compare the results of the effects of recent entries (less than a year) vis-à-vis entries that occurred more than two years ago. It is noteworthy that, when only capitals in the South, Southeast and Central West regions are examined, the effect of Uber on cab-hailing app rides is weaker (a reduction of 26.1%) than when compared to the results for the capitals of the North and Northeast regions (a reduction of 42.7%). This indicates that, initially, Uber's entry in a municipality may have a strong effect, substantially reducing the number of cab-hailing app rides but, over time, there is a gradual recovery in the number of rides of the incumbent sector.

The results suggest that only for the group of capitals of the South, Southeast and Central West regions it has been detected that Uber's entry reduced cab-hailing app fares (a reduction of 12.1%). This indicates that the cab-hailing app sector reacted via discounts in their fares after a longer period of exposure to a competitive environment. In this regard, it is possible to verify a rising rivalry between the two types of apps, where Uber's entry provokes a reduction in the number of cab-hailing app rides, reactions via price reductions and, finally, a recovery in the number of cab-hailing app rides. Such empirical results applied to the antitrust policy corroborate the hypothesis that the services provided by Uber would serve the same relevant market that the cab-hailing apps (EasyTaxi and 99Taxis) serve. This evidence does not exclude the possibility that other types of transportation also compose this same relevant market.

Our results should be interpreted with cautious, in view of the difficulties of isolating causal effects among the variables analyzed. However, this paper is an advance in the understanding of the competitive aspects of both the cab-hailing app market and the ridesharing market. We must emphasize that this study did not go deep in relevant topics related to the results found such as the importance of a local urban mobility planning that addresses the complementarities between the types of transportation efficiently and sustainably, prioritizing a quality public transportation and that can adapt to the rapid changes we are witnessing.

Finally, it is worth observing that, in addition to generating benefits to consumers and encouraging the entry of new suppliers in the individual passenger transport sector, such innovations solved some market failures present in the sector, making the current taxi regulation outdated. In this regard, the recently enacted Federal Law 13,640/2018, which regulates the ridesharing services, was parsimonious in that it included safety standards but did impose neither major regulatory barriers nor restrictions to pricing freedom. Likewise, municipal authorities should avoid measures that hinder the operation of such services via apps. In a complementary way, it is necessary to improve the debate towards a gradual deregulation of taxi services, especially on issues related to barriers to entry and pricing freedom.

Such deregulation can be thought of, for example, only for the radio taxi segment via Internet apps. Thus, it would be possible to encourage more competitive business models for apps, bringing benefits for the consumer in terms of more innovative services, with improved quality and security, lower prices and more options.

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Annex A

Table A.1 - List of the main cab-hailing and ride-sharing apps operating in Brazil

App	Beginning of Operations	Pioneer City	Number of Cities in operation	Number of Google Play Installations
Uber	2014	Rio de Janeiro	103 cities	100 million to 500 millions
Cabify	2016	São Paulo	8 cities	5 million to 10 millions
*99Pop**	2016	São Paulo	26 cities	5 million to 10 millions
EasyTaxi	2011	Rio de Janeiro	89 cities	10 million to 50 millions
*EasyGo***	2016	São Paulo	-	-
T81	2016	Recife	8 cities	50 thousand to 100 thousand
*TeLevo***	2016	Brasília	-	-
WillGo	2016	São Paulo	6 cities	50 thousand to 100 thousand
4Move	2017	São Paulo	2 cities	50 thousand to 100 thousand
FemiTáxi	2016	São Paulo	6 cities	10 thousand to 50 thousand
Venuxx	2016	São Paulo	2 cities	5 thousand to 10 thousand
Vá de Táxi	2013	-	-	100 thousand to 500 thousand
Yet Go	2017	São Paulo	10 cities	100 thousand to 500 thousand
Safer Taxi	2012	-	4 cities	100 thousand to 500 thousand
Vou de Táxi	2013	São Paulo	3 cities	one thousand to 5 thousand

Note: Information collected in January 2018. This list includes applications that work in at least in two cities.* It should be noted that 99 started its operation in 2012, having only taxis on its platform (99Taxis) and, in 2016, the platform was also opened for ride-sharing cars (99Pop). ** EasyGo and TeLevo apps are no longer available for installation on Google Play.

Table A.2 - Entry of cab-hailing and ride-sharing apps between 2014 and 2016

Macroregion	Capital	*Uber Entry*	*Cabify Entry*	*Easygo Entry* (ride-sharing cars)	*99 Entry* (ride-sharing cars)	*EasyTaxi Entry* (cab-hailing)	*99Taxis Entry* (cab-hailing)
North	Belém	No entry	No entry	No entry	No entry	December 2013	September 2013
North	Boa Vista	No entry	No entry	No entry	No entry	June 2015	No entry
North	Macapá	No entry	No entry	No entry	No entry	December 2013	October 2013
North	Manaus	No entry	No entry	No entry	No entry	December 2013	September 2013
North	Palmas	No entry	No entry	No entry	No entry	June 2015	February 2014
North	Porto Velho	No entry	No entry	No entry	No entry	December 2013	January 2014
North	Rio Branco	No entry	No entry	No entry	No entry	June 2015	December 2013
Northeast	Aracaju	December 2016	No entry	No entry	No entry	December 2013	September 2013
Northeast	Fortaleza	April 2016	No entry	No entry	No entry	December 2013	August 2013
Northeast	Joao Pessoa	September 2016	No entry	No entry	No entry	December 2013	August 2013
Northeast	Maceió	October 2016	No entry	No entry	No entry	December 2013	September 2013
Northeast	Natal	August 2016	No entry	No entry	No entry	December 2013	September 2013
Northeast	Recife	March 2016	No entry	No entry	No entry	December 2013	July 2013
Northeast	Salvador	April 2016	No entry	No entry	No entry	December 2013	August 2013
Northeast	Sao Luís	No entry	No entry	No entry	No entry	December 2013	October 2013
Northeast	Teresina	November 2016	No entry	No entry	No entry	December 2013	September 2013
Southeast	Belo Horizonte	September 2014	October 2016	No entry	No entry	December 2013	June 2013
Southeast	Rio de Janeiro	May 2014	August 2016	No entry	No entry	December 2013	April 2013
Southeast	São Paulo	June 2014	June 2016	July 2016	September 2016	December 2013	August 2012
Southeast	Vitória	August 2016	No entry	No entry	No entry	December 2013	August 2013
South	Curitiba	March 2016	No entry	No entry	No entry	December 2013	October 2012
South	Florianópolis	September 2016	No entry	No entry	No entry	December 2013	August 2013
South	Porto Alegre	November 2015	September 2016	August 2016	No entry	December 2013	August 2013
Midwest	Brasília	November 2014	August 2016	August 2016	No entry	December 2013	August 2013
Midwest	Campo Grande	September 2016	No entry	No entry	No entry	December 2013	September 2013
Midwest	Cuiabá	November 2016	No entry	No entry	No entry	December 2013	September 2013
Midwest	Goiânia	January 2016	No entry	No entry	No entry	December 2013	July 2013

Source: DEE/CADE elaboration with information obtained through official request to EasyTaxi, 99, Uber and Cabify.

Table A.3 - Municipal regulations for ride-sharing apps

City/State	Sharing of data with the Public Authorities	Driver Registration	Vehicle Age Restrictions	Municipal Licensing Restrictions	Registration of companies	Vehicle Inspection	Driver Training Course	Restriction on the number of drivers	Public Price	Legislation
Maceió/AL	Yes	No	5 years	Yes	Yes	Yes, once a year	No	No	Yes, a monthly value of R$ 120.00 per registered vehicle.	Law 6.683/17
Vitória/ES	Yes	No	5 years. However, such restriction does not apply to those who have insurance of more than 100 thousand in case of death or disability.	No	Yes	No	Yes	No	Yes, a monthly value correspondent to 1% of each ride performed.	Municipal Decree 16.770/17
Federal District	Yes	Yes	5 years for fossil fuel cars; 8 years for adapted, hybrid and electric cars	Yes	Yes	Yes	No	No	Yes, determined by the distance traveled.	Law 5.601/16
Goiânia/GO	Yes	Yes	-	Yes	Yes	Yes	Yes	No	Yes, a value of R$ 0.10 per kilometer driven.	Law without number
Campo Grande/MS	Yes	Yes	5 years	Yes	Yes	Yes	Yes	Yes	Yes, a monthly value correspondent to 7% of each ride performed.	Municipal Decree 13.157/17
Belo Horizonte/MG	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes, a monthly value correspondent to 1% of each ride performed.	Municipal Decree 16.832/18
Santarém/PA	Yes	No	5 years	No	Yes	No	Yes	No	Yes, but not yet specified	Law 20.309/17
Cascavel/PR	Yes	No	8 years	No	Yes	No	No	No	Yes, but not yet specified	Municipal Decree 13.726/17
Curitiba/PR	Yes	No	5 years	Yes	Yes	No	No	No	Yes, a progressive price ranging from R$ 0.08 to R$ 0.03 per kilometer driven.	Municipal Decree 1.302/17
Maringá/PR	Yes	No	10 years	Yes	Yes	No	Yes	No	Yes, but not yet specified.	Law 10.453/17
Caxias do Sul/RS	Yes	Yes	8 years	No	Yes	Yes	Yes	No	Yes, a monthly value correspondent to 1 VRM (municipal reference value) per registered vehicle.	Law 8.257/2018
Gravataí/RS	Yes	Yes	10 years for the first 12 months after the publication of the law and 6 years after this period	No	Yes	No	No	No	Yes, but not yet specified	Law 3.953/2018
Porto Alegre/RS	Yes	No	6 years	Yes	Yes	Yes	Yes	No	Yes, a monthly value correspondent to 20 UFMs (Municipal Financial Units) per registered vehicle.	Law 12.162/16

(Continuation)

City/State	Sharing of data with the Public Authorities	Driver Registration	Vehicle Age Restrictions	Municipal Licensing Restrictions	Registration of companies	Vehicle Inspection	Driver Training Course	Restriction on the number of drivers	Public Price	Legislation
Balneário Camboriú/SC	Yes	No	8 years	Yes	Yes	No	No	No	Yes, but not yet specified.	Law 4.040/17
Joinville/SC	Yes	No	No	No	Yes	Yes	No	No	Yes, a progressive price ranging from R$ 0.15 to R$ 0.25 per kilometer driven.	Law 8.467/17
Americana/SP	Yes	Yes	10 years	Yes	Yes	Yes	No	No	No	Law 6.044/17
Campinas/SP	No	Yes	8 years	Yes	Yes	Yes	No	No	Yes, a monthly value correspondent to 1% of each ride performed.	Law 15.539/17
Jacareí/SP	Yes	No	8 years	No	Yes	No	Yes	No	Yes, a monthly value correspondent to 1% of each ride performed.	Municipal Decree 292/2017
Jundiai/SP	Yes	No	5 years	Yes	Yes	Yes	Yes	No	Yes, but not yet specified.	Municipal Decree 27.282/17
Limeira/SP	Yes	Yes	6 years	Yes	Yes	No	Yes	Yes, 100 vehicles	Yes, 0.4% of one UFESP per kilometer driven.	Complementary Law 794/17
Osasco/SP	Yes	No	No	No	Yes	No	No	No	Yes, a monthly value correspondent to 1% of each ride performed.	Law 4.850/2017
Piracicaba/SP	Yes	No	8 years	No	Yes	No	Yes	Yes, OTTC vehicles cannot exceed the number of taxis in the city	Yes, a monthly value correspondent to 1% of each ride performed or 2% of the total value of the rides, if OTTC does not have a customer service center in the city.	Municipal Decree 17.188/17
Rio Claro/SP	Yes	Yes	10 years	Yes	No	No	No	Yes, 123 drivers	No	Law 5.104/17
São Paulo/SP	Yes	Yes	5 years 8 years for cars that have Anti-lock braking system until November 2017.	Yes	Yes	Yes	Yes	No	Yes, a progressive price that varies with distance traveled.	Municipal Decree 56.981/16
São José dos Campos/SP	Yes	No	8 years	No	Yes	No	Yes	No	Yes, a monthly value correspondent to 1% of each ride performed or 2% of the total value of the rides, if OTTC does not have a customer service center in the city.	Municipal Decree 17.462/17
Palmas/TO	Yes	No	7 years	Yes	Yes	Yes	Yes	Yes	Yes, a value of R$ 0.10 per kilometer driven.	Law 2.330/17

Source: DEE/CADE with information from document No. 0460623 available at the SEI/CADE in the public process nº 08700.000924/2017-87.

Annex B

Table B.1 – Effects (Elasticities) of Uber's entry on the rides of cab-hailing apps, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Log (Uber Rides)	-0.0411***	-0.0932***
	(0.008)	(0.009)
Log (Population)	9.6402***	-0.3936
	(0.418)	(0.480)
Log (Car Density)	28.6457***	1.7695**
	(0.503)	(0.796)
Log (Average Wage)	-0.9653**	2.7943***
	(0.482)	(0.429)
Constant	-63.3907***	-14.0820**
	(7.272)	(6.878)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	6,825	6,825
R^2	0.372	0.555
Number of Municipalities	590	590

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

Table B.2 - Effects (Elasticities) of Uber's entry on the rides of cab-hailing apps 2014-2016: all Brazilian capitals, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Log (Uber Rides)	-0.0638***	-0.0585***
	(0.007)	(0.010)
Log (Population)	7.9507***	2.1587***
	(0.497)	(0.687)
Log (Car Density)	34.8083***	12.1398***
	(1.234)	(2.666)
Log (Average Wage)	-4,4250***	-0.4279
	(0.795)	(0.887)
Constant	-19.8393*	0.5229
	(11.628)	(10.915)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	921	921
R^2	0.504	0.608
Number of Municipalities	27	27

Note: Standard deviation in parentheses. *Statistically significant at the 10% level;
** statistically significant at the 5% level; and *** statistically significant at the 1% level.

Table B.3 - Effects (Elasticities) of Uber's entry on the rides of cab-hailing apps 2014-2016: North and Northeast capitals, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Log (Uber Rides)	-0.0933***	-0.0634**
	(0.012)	(0.026)
Log (Population)	13.1224***	7.3844***
	(1.261)	(1.915)
Log (Car Density)	39.7362***	25.4631***
	(1.627)	(5.376)
Log (Average Wage)	-0.8885	1.6839
	(1.563)	(1.870)
Constant	-99.5642***	-64.1182**
	(27.570)	(30.246)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	525	525
R^2	0.580	0.613
Number of Municipalities	16	16

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.

Table B.4 - Effects (Elasticities) of Uber's entry on the rides of cab-hailing apps 2014-2016: South, Southeast and Midwest, 2014-2016

	Dependent Variable: Log (number of cab-hailing rides)	
	(1)	(2)
Log (Uber Rides)	-0.0279***	-0.0383***
	(0.008)	(0.007)
Log (Population)	5.2647***	-0.7080
	(0.497)	(0.481)
Log (Car Density)	23.1522***	-2.6229
	(1.778)	(2.021)
Log (Average Wage)	-3.6787***	0.9804
	(0.818)	(0.688)
Constant	-13.4465	12.0333
	(11.160)	(7.325)
Fixed-Effect	Yes	Yes
Time Effect (month and year)	No	Yes
Time Trend	No	Yes
Number of Observations	396	396
R^2	0.389	0.790
Number of Municipalities	11	11

Note: Standard deviation in parentheses. *Statistically significant at the 10% level; ** statistically significant at the 5% level; and *** statistically significant at the 1% level.