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**Article**

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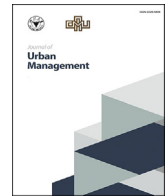
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## Research Article

# Off We Go! An interregional input-output analysis of e-hailing in Brazil



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## ABSTRACT

This study aims to assess the nature and the magnitude of the productive links of consumer operations made possible by the revenue generated by ride-hailing. We seek to map the interdependencies established between the consumption decisions of drivers that use the 99 app, a leading e-hailing provider, with other sectors and segments of the Brazilian economy. The dataset comprises operational information from 99 and an interregional input-output table for the Brazilian economy. In 2019, the intermediated trips only for 99 unfolded in more than 12 billion (BRL) added to the Brazilian GDP (equivalent to 0.18% of the total), each sector of the Brazilian economy being affected in different magnitudes. This study shows the degree of interdependence between these sectors and 99's business. In addition to the value added, indirect taxes were collected in the order of 1 billion (BRL), and 267.9 thousand jobs were generated.

## 1. Introduction

By the mid-2010s, ride-hailing apps emerged and quickly consolidated in major urban centers worldwide. This market expanded quickly, becoming one of the most vibrant and dynamic sharing economy sectors. This new transport alternative changed the range of possibilities faced by urban residents, who now have a more accessible and cheaper option for traveling by a private car without the necessity and costs of owning a vehicle.

Although its main activity – the intermediation between drivers and passengers, suppliers and customers of private urban trips – takes place in a digital, online environment, its consequences are tangible and spill over to the traditional, offline economic environment.

There are different dimensions of urban impacts that have been much explored academically or in the public debate, such as the ambiguous effect on mode substitution from public transit (Hall et al., 2018; Hoffmann et al., 2016; Malalgoda & Lim, 2019; Nelson & Sadowsky, 2019; Rayle et al., 2014; Shaheen et al., 2018; SUMC, 2016), fewer accidents caused by drinking and driving (Dills & Mulholland, 2018; Greenwood & Wattal, 2017; Peck, 2017), significant shifts in the labor market equilibrium due to the demand for

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drivers (Cramer & Krueger, 2016; Nie, 2017), and impacts of the IT-based on-demand ridesharing platforms on traffic congestion (Barreto et al., 2021; Fageda, 2021; Li et al., 2021).

Kitchel (2017) suggests that ride-hailing services, such as Uber, Lyft, or 99, and the sharing economy continually shift individual consumption habits and have important policy implications for city planning and urban transportation. Ridesharing services have transformed the traditional taxi industry (Cramer et al., 2016; Kim et al., 2018; Akimova et al., 2020) and affected the automobile industry (Guo et al., 2020; Sengupta et al., 2021). Jin et al. (2018) and Webb (2019) present a systematic review of the future of transport and the impact of ridesourcing on the efficiency, equity, and sustainability of urban development.

Although the urban effects of ridesharing services are well documented, few studies explore the impact of the e-hailing value chain. One of the reasons for the relative scarcity of studies on systemic economic effects is the lack of data that produces practical measurement difficulties and understates the contributions of the sharing economy. Watanabe et al. (2018) and Bellatin and Houle (2021) suggest that the mismeasurement of the goods and services powered by new technologies and the limitation of gross domestic product (GDP) statistics in measuring the advancement of the digital economy also could be driving incorrect measurement on productivity growth.<sup>1</sup> Ahmad and Schreyer (2016), Ribarsky and Ahmad (2018), and Barrera et al. (2018) show the measurement challenges of the digital economy that include new platforms that facilitate peer-to-peer transactions, such as Airbnb and ridesharing services, new activities such as crowdsourcing, and the prevalence of 'free' media services. Brynjolfsson et al. (2019) introduce a new metric to measure the welfare contributions of the digital economy to offset the measurement error of the new technologies in current national accounts. In a pioneering effort, the United States' Bureau of Economic Analysis (BEA) has developed preliminary digital economy statistics, including a digital economy satellite account and related research on quantifying the value of 'free' digital media the treatment and measurement of data (Barefoot et al., 2018; Strassner & Nicholson, 2020).

One available possibility to circumvent the lack of official, consolidated statistics for the sector is the use of detailed firm-level data drawn from managerial and financial accounts. Given the relative concentration of key players in prominent sharing economy sectors, specifically in the e-hailing markets, access to business information may become a good asset for better understanding the role such enterprises play in the real economy. As such, enterprise input-output models may be a valuable tool to complement the managerial, environment, and financial accounting and business plan, which can be applied in various areas, including the sharing economy.

There is vast literature assessing the systemic characteristics of enterprises using the input-output framework. The analyses usually deal with a different range of sectors, primarily traditional ones, such as public sector enterprises (Lenzen et al., 2010) and manufacturing corporations (Albino et al., 2003; Arvanitis & Hollenstein, 2006; Kuhtz et al., 2010; Lenzen & Lundie, 2012; Marangoni & Fezzi, 2002), and a diverse number of countries like Australia (Lenzen et al., 2010); China and Italy (Kuhtz et al., 2010; Italy (Albino & Kühtz, 2004; Marangoni & Fezzi, 2002); New Zealand (Lenzen & Lundie, 2012); and Switzerland (Arvanitis & Hollenstein, 2006).

The enterprise input-output analysis has also been applied in single-region contexts for a dominant enterprise (Farg, 1967; Lin & Polenske, 1998; Correa & Craft, 1999; Albino & Kühtz, 2004; and ; Lave, 2006), treating the enterprise as a regional sector per se (Billings & Katz, 1982; Lenzen et al., 2010; Tiebout, 1967), and in multi-regional contexts (Polenske, 1997). This approach is also popular in treating specific enterprises' impacts on environmental indicators (Fraccascia et al., 2017; Kuhtz et al., 2010), assessing the use and consumption of fuels, the production of pollutants, and waste within a firm's productive chain.

Our study contributes in different ways to the literature on the measurement of the systemic contribution of the digital economy, specifically ridesharing services. We present a new approach to measuring the digital economy based on the supply-use tables of the national accounts system. We capture the linkages in the supply chains and the inter-sectoral and interregional interdependence identified through an input-output model as the basis for our methodological approach. As an application for our method, we use data from the 99 app, a leading e-hailing provider for the Brazilian economy. Our framework for measuring the value-chain effects allows us to estimate different dimensions of the systemic economic impacts: gross output, value added, indirect tax, employment, and other economic variables.

This study also looks at wider socioeconomic impacts that are increasingly important. The socioeconomic impacts happen as transactions intermediated by platforms prompt other economic activities: for example, a driver who fuels his/her car with ethanol in Rio de Janeiro. When this happens, an entire supply chain is activated, extending from the early moment when sugarcane is planted in the countryside of the São Paulo state to the point ethanol is made available at the pump through industrial production, transportation logistics, the maintenance of the gas station and so forth. Each one of these steps creates jobs, adds value to the GDP, and levies taxes. Indirectly, they were all stimulated by e-hailing's economic activity. The same goes for the portion of drivers' private consumption of personal goods and services made possible by the revenue generated by the ride-hailing activity.

The value-chain effects also show that the revenue for drivers offering trips through the 99 platform turns into consumption and triggers a range of productive activities that play an important role in economic and social impacts. Our methodological framework allows assessing the nature and the magnitude of the productive links of consumer operations made possible by the revenue generated by e-hailing. Thus, we map the interdependencies established between the consumption decisions of drivers that use the 99 app with other sectors and segments of the Brazilian economy.

Once the production chains triggered by the revenue of drivers and taxi drivers using ride-hailing services in Brazil are outlined, their economic and social importance can be measured. The initial, direct, indirect, and induced impacts of this economic activity on all other

<sup>1</sup> In an attempt to circumvent this difficulty, Haddad et al. (2019) combined data from the 99 company, individual level data from a representative travel diary survey, and a structural traffic network simulation, to evaluate the impact of e-hailing on commuters' travel time and accessibility. They then estimated the effect of these changes on workers' productivity. Finally, using a Spatial Computable General Equilibrium (SCGE) model, they estimated the effect of these productivity shocks on broader economic outcomes.

sectors of the economy, including taxes and jobs that are stimulated by drivers who consume and earn their revenue with the 99 platform, are measured based on the company's aggregate and anonymized data with an additional set of assumptions and information, discussed in the following section.

The interregional input-output structure turns possible to capture systemic spatial effects. Therefore, when analyzing the results, we must consider the degree of sectoral and spatial interdependence. This structure makes it possible to capture possible spatial leakages and the relative importance of the sector's productive chain in a regional context. Moreover, the use of the input-output model to analyze the transport sector is widely found in the literature. Thus, the methodology fits the problem analyzed in this study, looking at an unconventional subsector.

Besides this introduction, this paper presents at Section 2 the database and methodology, at Section 3 the results, and at Section 4 the final considerations.

## 2. Data and methodology

### 2.1. Database

We use an input-output model to map and measure the value chain and the socioeconomic importance of drivers' revenue. Such a model represents an "economic photograph". The result is a unique and systemic view of how the economy works, how each sector becomes more or less dependent on others.

Although the Brazilian economy's official input-output table considers the passenger transport sector in a decentralized manner, it is impossible to immediately distinguish the ride-hailing segment's role in, for example, the generation of revenue and jobs generated in other sectors. For this reason, a particular methodology has been developed in this paper to segregate part of this segment related to a specific e-hailing company from its sector set.

Schematically, Fig. 1 shows the relationships of the ride-hailing sector in the context of an economy's revenue streams. From these flows, it is possible to model explicitly the contribution of the 99-app company to the ride-hailing sector embedded in the input-output structure.

Subsequently, the characterization of the regional revenue structure is based on drivers' revenue data using 99 app net of the app's share in trips' payments (as well as their expenditure structure, which is modeled based on official national surveys), and the input-output model to meet the objective of this paper, based on the flow-structure presented above.

Service providers (99 drivers) allocate their revenues to three sets of accounts: a) operational expenses; b) consumption expenses; and c) savings. In the first set of expenses, we have those fixed, related to the car (e.g., lease and financing) and variable, which are directly related to the maintenance of the vehicle and fuel costs and vary with the mileage traveled.

Therefore, to mimic the flow structure of Fig. 1, we present in more detail the database needed to include the ride-hailing transport sector in the Brazilian input-output system. The Brazilian input-output system, in its supply-use tables, presents only the "passenger transport product" and the "ground transportation sector". Therefore, the first step is to disaggregate this product and this sector in passenger transport by 99 app and ground transportation by applications, respectively. Thus, it is possible to map the sector's cost structure at an intermediate level and in terms of the payments sector (e.g., value added, taxes and margins, and the sector's sales structure both in intermediate terms and for final demand).

To make this disaggregation, it is necessary to use information from other official databases for the Brazilian economy and the 99 app company data. The initial database structure for this paper consists of:

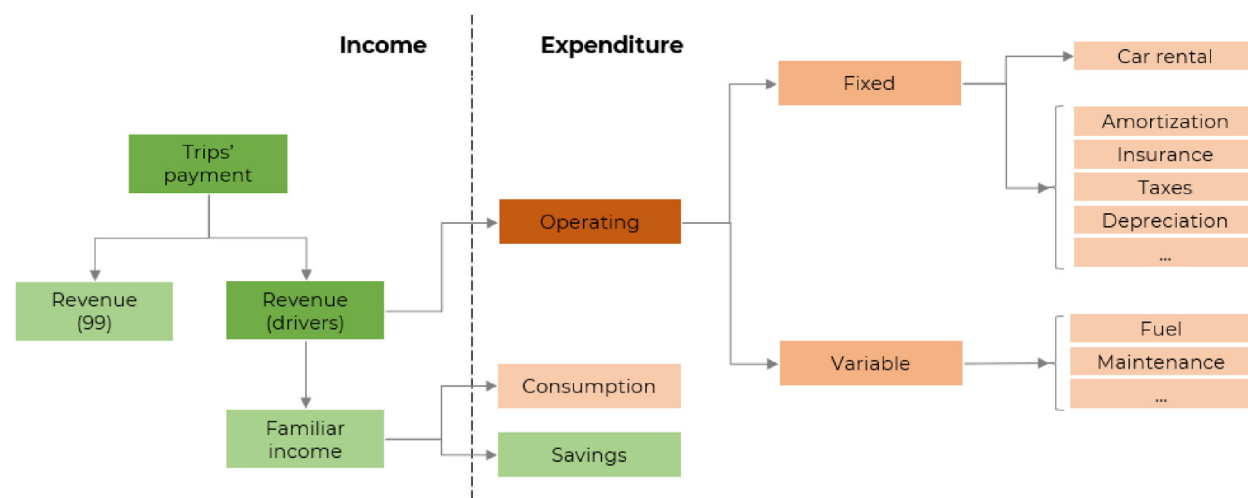


Fig. 1. Ride-hailing sector revenue flows.

- a) Input-output table for the Brazilian economy: we use the input-output table for the Brazilian economy provided by IBGE for 2015.<sup>2</sup> This table presents 127 products and 67 sectors, updated for 2019. We use the interregional version of the input-output table for Brazil, which includes the 27 Brazilian states.
- b) Structure of expenditures and income: to build the structure of expenditures, represented schematically in Fig. 1, as well as in the modified input-output table to capture the e-hailing sector, we use data referring to the IPVA rate, leasing, fuel costs, maintenance costs, insurance and depreciation expenses.
- c) 99 app information: the number of drivers, kilometers traveled, total income, and percentage of rented cars.
- d) PNAD Household Survey data: we use the PNAD<sup>3</sup> for 2019 to capture information on wages and average wages for the group of car drivers.

The description of products and sectors represented in the national input-output table is found in Annex 1. The base matrix contains, in addition to the original structure, the following products, sectors, and agents that are modified:

- a) Product 49002 – Passenger Ground Transportation: this product is broken down into two products, namely: 49002A – Ground Passenger Transportation and 49002B – Ground Passenger Transportation by the 99 App.
- b) Sector 4900 – Ground Transportation: this sector is broken down into two sectors, namely: 4900A – Ground Transportation and 4900B – Ground Transport by the 99 App.
- c) Final Demand: Household Consumption is broken down into Consumption from the rest of families and Household Consumption “99”.

Expenditure data are grouped under the following headings:

- a) IPVA (vehicle property tax) – we use the tax rate of 4% on the vehicle's market value.
- b) Rental contracts (Leasing) – we assume a standard vehicle rental for a 6-month rental and use as a passenger transport vehicle.
- c) Fuel costs<sup>4</sup> – we use the average mileage (provided by the 99 databases) and the average fuel price in the city of São Paulo. For this calculation, we assume flex-fuel vehicles but with a gasoline supply.
- d) Maintenance costs – we use the standard value of 3% in relation to the market value with the vehicle.
- e) Insurance costs – we carry out simulations on insurance companies' websites, characterizing the vehicle for passenger transport.
- f) Depreciation – we use the standard depreciation percentage (10%).

Table 1 shows the summary of expenses for 99 drivers for the Brazilian economy. It is important to note that for the calculation, we take into account the distribution between the average share of cars rented in the 99 fleet (9.65%) and those owned (90.35%).<sup>5</sup> The information set for rented cars does not incur insurance and depreciation expenses, leaving only the expenses with the lease. In addition, the average salary information for drivers from the PNAD was used to construct a ratio between the average salaries of the total category (car drivers) and 99 drivers to weigh the expenses and have the real dimension of the structure 99 drivers' expenses.

The characterization of the regional income structure is based on the data provided by 99 company and the interregional input-output table to meet the scope of this study, based on the premises of the dataset presented above.

Based on the information provided by 99, it is possible to estimate the total income of 99 drivers for the Brazilian states. The data for 2019, considered our baseline, are shown in Fig. 2. The results in Table 2 show that around 56% of the total income of drivers is concentrated in the three main states in the Southeast region (São Paulo, Rio de Janeiro, and Minas Gerais).

## 2.2. Methodology<sup>6</sup>

The input-output model is a general equilibrium model representing the relations in an economy, where the sectoral output varies to satisfy the final demand. We use an inter-regional input-output framework, which, for illustrative purposes, can be represented in a two-region case as follows:

$$A = \begin{bmatrix} A^{LL} & \vdots & A^{LM} \\ \dots & \dots & \dots \\ A^{ML} & \vdots & A^{MM} \end{bmatrix}; X = \begin{bmatrix} X^L \\ \dots \\ X^M \end{bmatrix}; Y = \begin{bmatrix} Y^L \\ \dots \\ Y^M \end{bmatrix} \quad (1)$$

where A is the technical coefficient matrix, X is the total output, Y is the final demand. L and M are the two hypothetical regions.

<sup>2</sup> For more details about the input-output table see: <https://www.ibge.gov.br/estatisticas/economicas/contas-nacionais/9085-matriz-de-insumo-produto.html>.

<sup>3</sup> Definition of driver in PNAD: i) Occupation: “drivers of cars, taxis and trucks”; ii) Sector of activity: “road passenger transport” and iii) Type of work: “own account” For more information about PNAD see: <https://www.ibge.gov.br/estatisticas/multidominio/condicoes-de-vida-desigualdade-e-pobreza/17270-pnad-continua.html?=&t=o-que-e>.

<sup>4</sup> We use data from: [www.pre&ccedil;odoscombustiveis.com.br](http://www.pre&ccedil;odoscombustiveis.com.br).

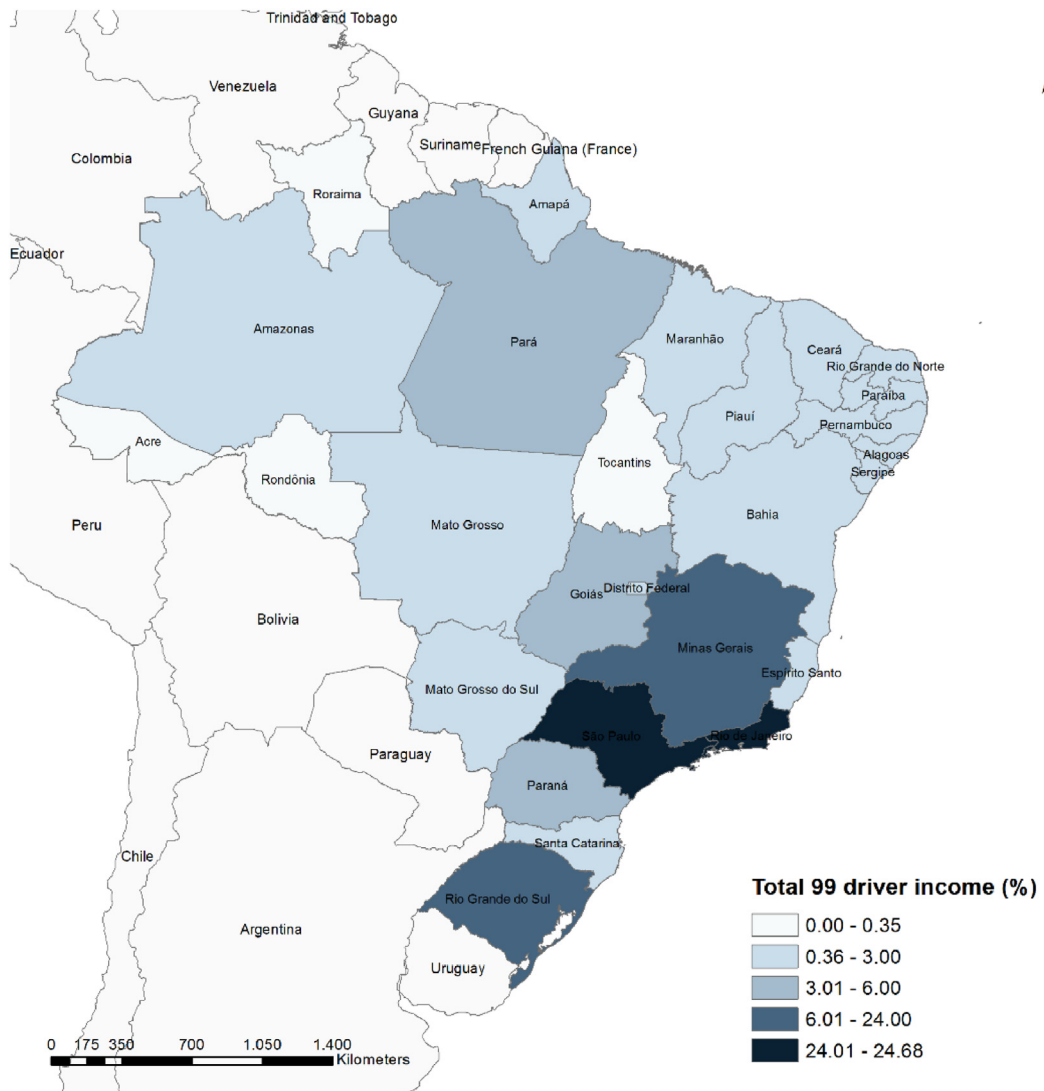
<sup>5</sup> Those data are collected directly with 99 company.

<sup>6</sup> For a detailed presentation of input-output framework see: Miller and Blair (2009).

**Table 1**  
Expenditure structure: 99 drivers.

Type of expenditure	Expenditure structure (%)
IPVA – Vehicle taxes	9,22
Leasing	7,91
Fuel	20,29
Maintenance (3%) 99	18,15
Insurance	10,20
Depreciation	23,01
FGTS	4,28
Total	100,00

Source: Based on authors' calculations.



**Fig. 2.** Estimated total 99 driver income, 2019 (regional share in %)  
Source: Based on 99's information.

**Table 2**  
Socioeconomic impacts: Brazilian States (2019).

	Gross Output*	Value Added*	Jobs**	Indirect taxes*
Rorônia	24.34	11.36	408	0.71
Acre	21.25	13.13	414	0.85
Amazonas	575.00	277.41	7012	28.79
Roraima	42.49	30.73	767	1.55
Pará	506.15	275.73	9025	24.15
Amapá	63.74	42.70	1122	2.56
Tocantins	23.77	10.92	366	0.78
Maranhão	187.41	89.40	3704	9.59
Piauí	137.51	74.74	2927	6.57
Ceará	366.29	193.74	6274	17.29
Rio Grande do Norte	128.28	62.51	1683	6.24
Paraíba	106.79	58.96	2021	4.64
Pernambuco	483.29	250.78	7419	21.24
Alagoas	125.50	76.76	2220	4.85
Sergipe	143.84	72.27	2185	7.15
Bahia	730.74	318.86	9261	38.57
Minas Gerais	1581.36	797.38	20,909	71.88
Espírito Santo	367.90	181.67	3757	16.05
Rio de Janeiro	5,154.81	2,877.55	56,550	244.09
São Paulo	7,323.50	3,909.66	67,076	316.35
Paraná	1,209.15	542.46	12,769	57.77
Santa Catarina	693.11	349.58	8152	30.78
Rio Grande do Sul	1704.11	812.10	20,378	84.29
Mato Grosso do Sul	200.98	91.32	2201	8.40
Mato Grosso	263.71	105.02	2609	12.45
Goiás	877.71	451.98	12,152	39.40
Distrito Federal	457.68	283.58	4560	18.36
<b>BRAZIL</b>	<b>23,500.40</b>	<b>12,262.29</b>	<b>267,922</b>	<b>1,075.34</b>

OBS: \* BRL millions, \*\* Yearly-job-equivalent.

Those matrices can be represented together as:

$$\left\{ \begin{bmatrix} I & \vdots & 0 \\ \dots & \dots & \dots \\ 0 & \vdots & I \end{bmatrix} - \begin{bmatrix} A^{LL} & \vdots & A^{LM} \\ \dots & \dots & \dots \\ A^{ML} & \vdots & A^{MM} \end{bmatrix} \right\} \begin{bmatrix} X^L \\ \dots \\ X^M \end{bmatrix} = \begin{bmatrix} Y^L \\ \dots \\ Y^M \end{bmatrix} \tag{2}$$

The final equation used for impact analysis follows:

$$\begin{bmatrix} X^L \\ \dots \\ X^M \end{bmatrix} = \left\{ \begin{bmatrix} I & \vdots & 0 \\ \dots & \dots & \dots \\ 0 & \vdots & I \end{bmatrix} - \begin{bmatrix} A^{LL} & \vdots & A^{LM} \\ \dots & \dots & \dots \\ A^{ML} & \vdots & A^{MM} \end{bmatrix} \right\}^{-1} \times \begin{bmatrix} Y^L \\ \dots \\ Y^M \end{bmatrix} \tag{3}$$

For a given level of final demands in either or both regions, the necessary gross outputs in both regions can be found using Equation (3) expressed more compactly as:

$$X = (I - A)^{-1}Y \tag{4}$$

where **I** is a identify matrix, and  $(I - A)^{-1}$  is known as the Leontief inverse.

Household consumption is an essential component in this study. Thus, we use the closed model with households endogenous. In addition to presenting the direct and indirect effects of an exogenous variation in final demand, this approach allows capturing the induced (income) effects caused by the change in the amounts spent by households.

This closed model removes the household consumption from the final-demand column and labor-input row and places it inside the technically interrelated table, making it one of the endogenous sectors (Miller & Blair, 2009). This procedure requires a row and a column of transactions for the new household sector in the table of inter-industry flows. Thus, Equation (4) would now be modified to  $X = (I - A^*)^{-1}Y^*$ , where **A\*** includes the  $(n + 1)$ st row and the  $(n + 1)$ st column, representing household purchases of labor services, and **Y\*** is understood to represent the remaining final demand – exclusive of that from households.

Thus, the following effects are then calculated:

- *Initial effects*: the focus on the ride-hailing industry and its magnitude is related to the value of travel payments by passengers using drivers' services, modeled as a final demand shock;
- *Direct effects*: Include those economic sectors directly affected by drivers' direct operating expenses (e.g., rent, financing, fuel, maintenance, communication) – including trips' payments to the app provider (part of the computer and information services sector) –, and consumption demand (e.g., housing, food, transportation, personal expenses, health, clothing, education);



- *Indirect effects*: Impacts resulting from the chain effects of inter-sectoral purchases and sales required to meet increased demand;
- *Induced effects*: Expressed through purchases made by consumers, directly and indirectly employed, through economic activities benefiting from the variation in final demand (consumption of passenger transport services by the 99 app).

### 2.2.1. Input-output database

The Regional and Urban Economics Lab (NEREUS)<sup>7</sup> at the University of São Paulo estimated the Interregional Input-Output Model (IOM) used in this study. The construction of IOM is based on the Interregional Input-Output Adjustment System (IIOAS) method, illustrated in Haddad et al. (2017) and adapted to the Brazilian case. IIOAS is a hybrid method that combines data made available by official agencies such as the Brazilian Institute of Geography and Statistics (IBGE) with non-census techniques for estimating unavailable information. The main advantages of IIOAS are its consistency with the information from the national input-output table and the flexibility of its regionalization process, which is applicable to any country that: (i) publishes its national supply-use tables; and (ii) make available a regionalized sectoral information system.

## 3. Results

This section presents the main set of 99's value chain, using projected corporate information for 2019,<sup>8</sup> with national impacts on selected economic aggregates (gross output, value added, jobs, and indirect taxes generated on other sectors) in their full magnitude, for Brazil (Fig. 3), for each Brazilian State (Table 2). The following figures refer to the total impact of 99 alone, not including other companies in the sector.

The services intermediated by 99 were responsible for the addition of R\$12.262 billion in the value added of the economy in 2019 (0.18% of the national GDP). Results also show that about 108.3 thousand additional jobs were created in other sectors of the economy (267.9 thousand in total), of which 7,642 are direct, 10,419 indirect, and 90,290 induced jobs by the consumption of households associated with the company's value chain. Also, about R\$1.1 billion were generated in indirect taxes (IPI, ICMS, ISS, and others). Of this total, the most significant portion (R\$331.91 million) was generated through the consumption of households associated with the company's value chain, *i.e.*, the induced effect.

The regional distribution of the total impacts on the gross output shows that the states of São Paulo and Rio de Janeiro absorb almost 60% of these impacts. There is very large heterogeneity concerning the absorption of total impacts, and in addition to São Paulo and Rio de Janeiro, only Minas Gerais, Paraná, and Rio Grande do Sul present results above 5% (Table 2).

Table 2 shows the correspondent figures for each Brazilian State. These regional distributions of the outcome variables are not equivalent to 99's revenue share in each location since production links vary from place to place, and one BRL spent in one given region might add value to somewhere else's economy through the links specified before.

### 3.1. Sectoral impacts

The input-output model also allows a systemic evaluation in which it is possible to assess the productive interdependence among economic sectors and 99's services relative importance. This section presents both measures.

Table 3 shows the 30 sectors with the largest variation in gross output and their respective changes in the other dimensions (value added, jobs, and taxes). These are the sectors with the highest degree of interdependence to e-hailing activity. Looking at the table, we see that, for the four macroeconomic aggregates analyzed, the most significant impacts occur in a diversified manner, both in the manufacturing sectors and the services and commerce sectors.

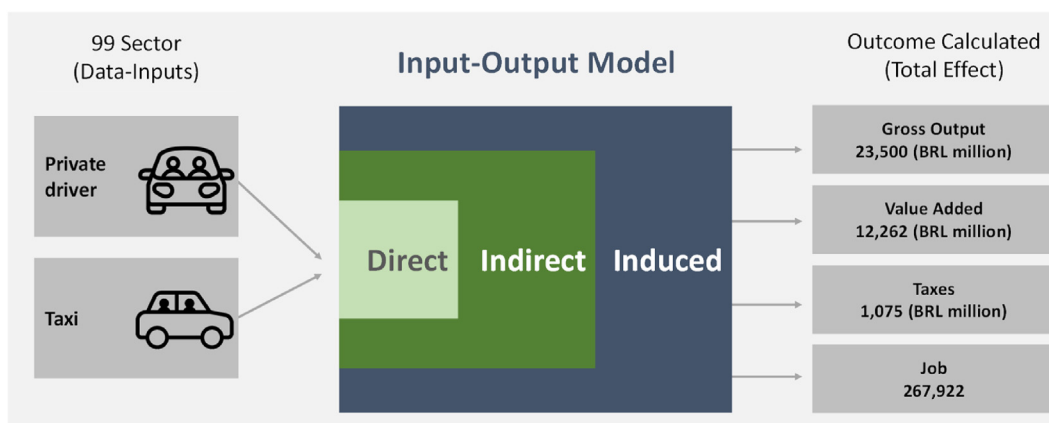
The three sectors that are most impacted in terms of gross output due to 99's activity are: "Coke and refined petroleum products", "Wholesale and retail trade", and "Computer and information services". In the case of value added, it is possible to highlight the impacts on the activities of "Wholesale and retail trade", "Real estate activities" and "Computer and information services". The three sectors with the greatest impact on job creation are "Wholesale and retail trade", "Activities of households as employers", and "Food and beverage service activities". Finally, the first three sectors in indirect taxes are "Coke and refined petroleum products", "Computer and information services", and "Wholesale and retail trade".

Table 4 presents the results in terms of value added relative to the size of each sector. The systemic evaluation also allows us to capture the relative importance of the services offered by 99 for other sectors of the economy. The provision of 99 services has greater importance, in terms of value added, for the "Systems development and other information services" sector, the sector associated with the company's headquarter operations. For this sector, 0.90% of what it moves comes from the presence of 99 services in the economy. It is also possible to highlight the relative importance of 99 services for the sectors of: "Coke and refined petroleum products" (0.42%), "Oil and gas extraction, including support activities" (0.25%), "Manufacturing of parts and accessories for motor vehicle" (0.21%) and "Biofuel manufacturing" (0.19%). It is possible to affirm that the absence of 99's services would result in a percentage decrease in the

<sup>7</sup> <http://www.usp.br/nereus/>.

<sup>8</sup> Our results refer to the last pre-COVID-19 year. There is increasing interest in understanding the performance of the e-hailing sector during the ongoing pandemic, since the public transportation was considered a super-spreading transmitter. In this context, the usage of car sharing is still unclear and remains to be further investigated (Alonso-Almeida, 2022). Data on 99 app suggest an increasing use of e-hailing in Brazil since company's revenues increased 19% in 2020.





**Fig. 3.** Aggregate Impacts: Brazil, 2019

Source: Based on the IO model results.

**Table 3**  
Sectoral impacts (in %).

Sector	Gross Output	Value Added	Employment	Indirect Taxes
Coke and refined petroleum products	7.6	1.4	0.0	16.1
Wholesale and retail trade	6.8	8.1	9.0	4.3
Computer and information services	5.5	7.0	2.6	4.3
Financial service activities	5.1	6.2	0.8	3.3
Real estate activities	4.1	7.3	0.2	1.2
Extraction of petroleum	2.1	1.7	0.1	1.7
Land transport	2.0	1.7	1.8	1.8
Electricity	1.6	1.0	0.1	1.0
Food and beverage service activities	1.6	1.5	2.7	1.8
Manufacture of other food products	1.5	0.6	0.6	0.7
Processing of meat and fish	1.5	0.4	0.3	0.8
Telecommunications	1.4	1.1	0.2	1.1
Private Health	1.4	1.6	1.4	1.4
Agriculture and related service activities	1.3	1.4	2.0	1.1
Legal and accounting activities	1.2	1.6	0.9	0.9
Support service activities	1.0	1.4	1.6	0.9
Manufacture of motor vehicles	0.9	0.3	0.1	1.0
Private Education	0.8	1.1	1.4	0.5
Other personal service activities	0.8	0.7	1.7	0.9
Parts and accessories for motor vehicles	0.7	0.4	0.2	0.6
Animal production	0.7	0.7	2.5	0.7
Support activities for transportation	0.7	0.7	0.4	0.4
Scientific and technical activities	0.6	0.4	0.3	0.5
Manufacture of chemicals	0.6	0.2	0.0	0.5
Manufacture of beverages	0.6	0.3	0.1	0.4
Activities of households as employers	0.5	0.9	3.8	0.0
Manufacture of rubber and plastics	0.5	0.2	0.2	0.4
Manufacture of wearing apparel	0.5	0.4	1.0	0.5
Other manufacturing	0.4	0.3	0.3	0.3
Manufacturing of biofuel	0.4	0.2	0.1	0.2
Sub-total	54.5	50.8	36.2	49.5

value added for these sectors, in the proportion shown in this table. The results reveal the interdependence between the “online” sector (or digital economy) to other “offline” sectors.

#### 4. Final remarks

This paper evaluated the nature and magnitude of the productive ties of consumption operations made possible by the income generated by the ride-hailing service, that is, the interdependencies between the consumption decisions of 99 drivers with the other sectors and segments of the Brazilian economy. Using firm-level data for a major e-hailing provider in Brazil, it was possible to assess its systemic socioeconomic impacts on different sectors and regions in the country.

**Table 4**  
Relative importance of 99 service in value added in selected sectors.

Ranking	Sector	Baseline (%)
1	Systems development and other information services	0.90
2	Coke and refined petroleum products	0.42
3	Oil and gas extraction, including support activities	0.25
4	Manufacture of parts and accessories for motor vehicles	0.21
5	Manufacturing of biofuel	0.19
6	Telecommunications	0.18
7	Financial intermediation, insurance and supplementary pension	0.18
8	Activities of households as employers	0.16
9	Real estate activities	0.16
10	Private education	0.15
11	Manufacture of clothing artifacts and accessories	0.15
12	Recording printing and playing	0.15

Given the increasing interest in understanding the real (“offline”) socioeconomic effects of digital (“online”) platforms, we offer a novel way of disentangling the impacts of an e-hailing platform on the real economy, derived from enterprise input-output analysis, providing a disaggregated value-chain perspective. Current discussions on regulating such services in urban areas require sound information to elicit public debate and build solid narratives to engage stakeholders in decision-making. Assessing the systemic economic impacts adds another dimension to the discussion, deemed important to put e-hailing activities in a perspective of its contribution to value added and job creation in local and national economies.

#### Declaration of competing interest

Authors declare no conflict of interests.

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