Travel mode choice in the past decade in Mexico City[a]

Sara Ávila Forcada [b] Isaac Medina Martínez[c]

September, 2018

Abstract

This paper analyzes travel mode choice for urban commute in Mexico City in 2007 and compares it with 2017. After a decade, gender, car ownership and income still determine car use.

The use of bike more than doubled in the past decade. A decade ago, educated, older and wealthier people were not likely to commute in bike, but not anymore.

Two dangerous trends call for action in the policy arena: In 2007, longer trips were more likely to use public transportation while in 2017 longer trips are more likely to use a private car instead. Gender inequality is exacerbated because in 2017, as in 2007, women are more likely to commute by transit, while men are more likely to commute by car.

Keywords: travel mode choice, pollution, traffic congestion, non-motorized mobility.
JEL- classification: R41, C25, T11

[a] All comments are appreciated. Please send them to sara.avila@flacso.edu.mx

[b] Affiliated Researcher in Environmental Economics at FLACSO-MEXICO, Carretera al Ajusco 377, Tlalpan, Ciudad de Mexico, 14200. sara.avila@flacso.edu.mx

[c] Assistant Researcher at FLACSO-Energy and Environment Program and Associate Professor at CIDE-Environmental Economics. isaac.medina@cide.edu

1 Introduction

Traffic congestion generates pollution, causes longer commutes, increases the probability of accidents, generates health problems due to emissions and lack of physical activity, and contributes to climate change. It also contributes to increasing supply costs and it lowers the quality of life of those who experience it.

Although private cars promise a faster, more efficient commute, they also generate negative externalities such as congestion and pollution. Motorization causes congestion, air pollution and climate change (Adler and van Ommeren, 2016). Also, it decreases physical activity, which in turn increases obesity and related illnesses (Lachapelle et al., 2016) particularly for children and the elderly (Casey et al., 2014; Ewing et al., 2014). The World Health Organization (2018), reports that pollution causes 4.2 billion premature deaths every year and 91% of those are in low and middle-income countries. Costs of negative externalities of congestion for cities in Latin America are estimated around 18% of the average income (Hidalgo and Huizenga, 2013).

Mexico City is the largest metropolitan area in the Western Hemisphere and the fifth largest in the world. It is also one of the most congested and polluted cities in the world. Since 2016 the Tom-Tom Index gives Mexico City the first place as the most congested city among the 390 cities evaluated in their Index. Parry and Timilsina (2010) calculated an average speed of 22 km/hr (13.7 mph) in the year 2000. For the year 2007 our calculations using the origin destination survey was 20 km/hr (12.4 mph), and 13 km/hr (8 mph) for 2017.

Mexico City is not alone. Megacities all over the Developing World have commuters that spend hours in the traffic: Mumbai, Beijing, Bangkok, Rio de Janeiro, Jakarta (Tom-Tom Index 2018). Sperling and Claussen (2004) find that in developing countries traffic congestion is often worse than in developed cities. Overall, the world-wide tendency seems to be towards more congestion. According to Navigant Research (2015), there will be around 1.7 billion cars and trucks in 2030.

Despite this gloomy perspective, the past decade has been witness of major shifts in the approach to the congestion problem at least from the point of view of international organizations such as the World Bank, the Organization for Economic Cooperation and Development and the United Nations (see for example, OECD (2013); CEC (2007); UNECE (2011); OECD (2013); World-Bank (2017)). The new approach calls for urban sustainability, improving public transportation, fostering non-motorized transportation and overall trying to reduce the use of automobiles. Several cities are setting as a priority the promotion of transit-oriented development that leads to a shift in the planning of the cities all over the World (Khan, 2013; Suzuki et al., 2015).

Mexico City has not been oblivious to the shift in perspective. Several measures have been taken towards better public transportation and the introduction of bike lanes and a bike sharing system. However, in the opposite direction, Mexico City has also invested in more roads for private vehicles, particularly building a second floor to its main interurban highway. This paper aims to shed light on the congestion problem by comparing the behavior of commuters a decade ago, with commuters in 2017. By understanding the determinants of public transportation use, private car use and non-motorized means of transportation, we are able to design better policies to reduce the use of the private car and thus, reduce the congestion problem. This paper compares the behavior of commuters in 2007 with the behavior of commuters in 2017. After a decade of economic and population growth; after several attempts to foster the use of public transportation but also the construction of a second floor to the main road in the city, we explore changes and continuities in commuter behavior.

2 Literature Review

Congestion in Mexico City has been studied from different perspectives. We divide those studies into Urban Economics studies that contribute to find the costs from congestion and pollution, several studies that analyze the health impacts of congestion, and finally, studies that include geographical considerations.

The urban economics literature has devoted several studies to the case of Mexico City. Some of the most cited literature in the topic is devoted to the study of the policies that seek to solve the pollution problem derived from motorized vehicles. Davis (2008) analyzed the impact of driving restrictions. The program "A Day without Car" was intended to reduce pollution from private cars. He found that the "A Day Without Car" Program in the nineties resulted in more pollution since drivers opted to buy additional cars that were older and more polluting. More recently, Davis (2017) finds that increasing the days with no car to Saturdays had a negligible effect on emissions. Apparently, drivers do not switch to lower emitting options such as walk, bike or public transportation. Blackman et al. (2015) calculated the cost for drivers of not using cars due to the driving restrictions in Mexico City. They found that not using their car, costs around $103 USD per year per vehicle.

We identify other papers that contribute to the analysis of congestion and its costs in Mexico City. Parry and Timilsina (2010) calculate the size of the externalities from road use and thus suggest an auto toll of 20.3 cents per mile or a gasoline tax of $2.72 USD per gallon to account for the externalities of congestion and pollution. In a different exercise, Filippini and Martínez-Cruz (2016) measure the willingness to pay (WTP) for improved air quality and find that the average annual WTP for cleaner air is US $262 (2008 US dollars).

In an attempt to better understand the demand for subway, Crotte et al. (2011) studied the price elasticity of the subway fare. They found that it is zero, which means that the quality of the service and not the price, would determine the use of the subway in Mexico City.

The effects from emissions on human health have also been addressed. Calderón-Garcidueñas et al. (2013); Block and Calderón-Garcidueñas (2009) and Gómez-Perales et al. (2004) have studied the effect on pollution on respiratory and brain health on the population.

Analyses that include geographical considerations have derived results that highlight the aspect related with inequality in urban mobility in Mexico City. Suárez et al. (2016) find that the poor travel nearby to avoid transportation costs and they are likely to work in the informal job market. Guerra (2015) analyzes the link between income, distance and travel costs of commuting in Mexico City. He finds that commuters who live farther from the center, have longer, more costly commutes; these commutes, in turn, have consequences for their wellbeing, and they also increase congestion for the whole city.

To our knowledge, this is the first attempt to apply a choice model to commute alternatives in Mexico City. We use robust data from two reliable surveys one conducted in 2007 and the other in 2017. Thus, we are able to observe any shift in behavior. The econometric framework is a choice model as in McFadden (1973); McFadden and Train (2000), therefore, we use the Random Utility Framework. The purpose of discrete choice modelling is to analyze the individual's choice in relation to the characteristics of the alternative. In this case, we consider the costs and commute time of each alternative. We control for the most important variables according to the empirical literature: education, age, gender and income Cervero (2002). We are not surprised to find that after a decade the older, the richer and men rather than women are more likely to commute using car.

3 Urban mobility policy in the past decade in Mexico City

In this section we present the most important policies in urban transportation undertaken in Mexico City in the past decade.

Investment in urban mobility in Mexico is slanted in favor of car infrastructure. This is not surprising given that investment in motorized transportation leads to an increase in productivity and economic growth Agénor (2010); Berg et al. (2017). In 2013 the Institute for Transportation and Development Policy in Mexico, analyzed the expenditures in urban mobility conducted by the Federal Government in 2012. 650 million USD were invested in urban mobility in the country. 65% of which was used to maintain roads for automobiles. 95% of the rest was invested in Line 12 of the subway system in Mexico City. This means that only 1.7% of the budget was used for public transportation, sidewalks, bike lanes and other public spaces (Garduño, 2016). In this past decade, one of the mayor investments in urban mobility was the second floor to the Interurban Highway (Periférico) that includes a tolled bridge. The cost of the first 42 kilometers (26 miles) was more than 800 million USD (Tovar et al., 2007).

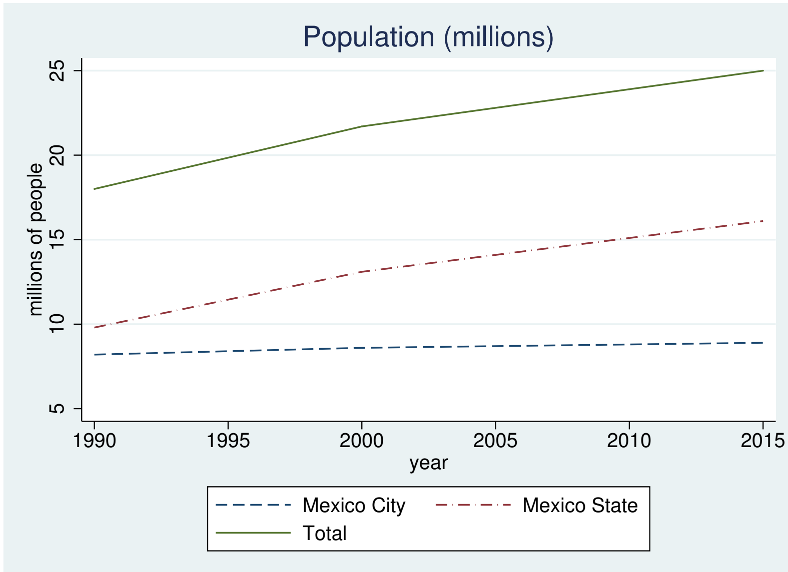
On the other hand, this decade was also witness of unprecedented impulse of sustainable mobility. Several environmental organizations: The Center for Sustainable Transportation-EMBARQ, that later became the World Resources Institute Mexico Branch, joined efforts with the Ministry of Environment and the Government of Mexico City and promoted a Bus Rapid Transit System locally known as Metrobus. The first line began operating in 2005. The Metrobus currently operates six lines, serves 125 kilometers and operates in 208 stations. Bel and Holst (2018) demonstrate that the construction and expansion of the BRT system has indeed resulted in lower emission levels.

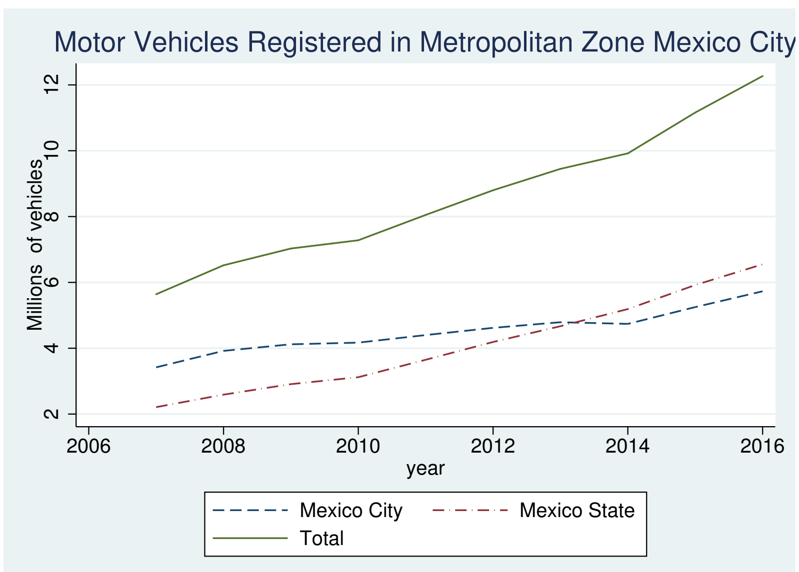
Another important investment in public transit was Line 12 of the Subway System. The construction began in July 2008; a first section was completed in April 2011; a second one in 2012. In March 2014, the line was suspended due to design malfunction. Service was also suspended after the earthquakes in September 2017. Still, the Line served more than 29 million trips in 2017 Ciudad de Mexico (2018b). One of the most influential projects of the decade was the bike sharing system: Ecobici. Ecobici started in February 2010 with 1,200 bikes and 85 stations and in 2018 the system has 6,500 bikes and 452 stations Ciudad de Mexico (2018a). According to Pérez López (2013), Ecobici became an alternative for the middle classes of the center of the city while lower classes in the periphery were already bike users.

In terms of policies to influence the behavior of commuters, in this decade Mexico City adapted some strategies to reduce car use, parking meters were installed in certain busy neighborhoods around the city. A new traffic regulation was issued in August 2015. Speed limits were set at more stringent levels. The sanctions under the new regulation followed a system of points that corresponds to fees or even the loss of driving privileges (Gaceta Oficial del Distrito Federal, 2015). In July 2017 a new regulation allowed for buildings to have no parking or a reduced number of parking spaces (Gaceta Oficial de la Ciudad de México, 2017). Several sidewalks and streets were rehabilitated in the downtown area of Mexico City and some other neighborhoods in the core (Pérez López, 2013).

Finally, the Program A Day Without Car functions together with the Emissions Inspection System and has been in place since 1989. In 2008 a new phase of the Program was implemented: Saturdays without car. Analyzing this particular policy, Davis (2017) concludes that drivers did not shift to other forms of transportation, therefore, there was no reduction on emission levels. A mayor shift occurred in July 2015 when the Supreme Court determined that the model of the car could not determine circulation rights, thus, 1.7 million cars were able to transit every day as long as they passed inspection(Valdez (2016)). Other events that counter acted against the Program A Day without Car were the elimination of the sales tax for cars in 2012 and the increase of auto-credits in the market (Valdez, 2016; Lira, 2017).

In the meantime, the number of people in Mexico City Metropolitan Area grew from 14 million in 2007 to 19 million in 2017(INEGI, 2017). The number of registered vehicles in Mexico City and State of Mexico grew from 5.6 million in 2007 to 12.27 in 2016 (INEGI, 2016). Population has grown, but the number of vehicles has grown at higher rates. The impact of such growth has been translated into more congested streets. What we explore next is the behavior of commuters.


Population (millions)
millions of people
5
10
15
20
25
1990
1995
2000
2005
2010
2015
year
Mexico City
Mexico State
Total


Motor Vehicles Registered in Metropolitan Zone Mexico City
Millions of vehicles
2
4
6
8
10
12
2006
2008
2010
2012
2014
2016
year
Mexico City
Mexico State
Total

4 Data

This paper uses the two most recent origin and destination surveys in Mexico City. One was conducted in 2007 and the other in 2017. The Origin-Destination Survey from 2007 samples 231,000 thousand trips. This survey was conducted by the National Institute of Geography and Informatics (INEGI). It has been used extensively in the literature to analyze the mobility of Mexico City (Guerra, 2015; Izquierdo, 2012; Caudillo Cos, 2016; Negrete and Paquette Vassalli, 2011; Pérez López, 2013; Lara Pulido et al., 2017; Suárez-Lastra and Delgado-Campos, 2010). The 2007 survey interviewed 43,868 households in May and June 2007. The most recent Origin-Destination Survey (2017), also conducted by INEGI, considers 591,534 thousand trips. The 2017 survey interviewed 66,625 households in January and March 2017. Both surveys are representative of Mexico City and the surrounding area. Mexico City and its surroundin area is known as the Metropolitan Zone of Mexico City.[*]

Table 1 presents the commuting trips and mode split in 2007 and in 2017. An important consideration is the fact that walking was an alternative included in 2017, but not in 2007. In order to compare behavior over the decade we exclude the walking option.

The number of trips and the proportion of trips conducted by private car have increased over a decade. This is shown in the data from the origin-destination surveys and also by the number of registered cars in official databases and the increase in commuting times in the Tom-tom index (2016, 2017). A decade ago, 29% of trips were conducted in private cars; in 2017 the proportion was 44%. The use of taxi and the use of motorcycle also increased. As a beam of hope, the proportion of trips conducted by bike also increased from 2% to almost 5%. The proportion of trips conducted by BRT also increased. The increase in everything else was compensated by a reduction in the use of subway and bus.

[*]The boroughs from the State of Mexico considered are: Atizapán de Zaragoza, Cuautitlán, Cuautitlán Izcalli, Coacalco de Berriozabal, Chalco, Chicoloapan, Chimalhuacán, Ecatepec de Morelos, Huixquilucan, Ixtapaluca, La Paz, Naucalpan de Juárez, Nezahualcóyotl, Nicolás Romero, Tecámac, Tlalnepantla de Baz, Tultitlán and Valle de Chalco Solidaridad.

Table 1: Commuting trips and mode split in 2007 and 2017 in Mexico City

	2007		2017	
	trips	% of all trip portions	trips	% of all trip portions
CAR	65,964	28.7	109,431	43.6
BIKE	4,576	1.99	11,714	4.7
TAXI	16,059	6.99	25,799	10.3
SUBWAY	21,817	9.50	12,220	4.9
BUS	119,066	51.8	82,739	32.9
METROBUS	1,386	0.6	3,554	1.4
MOTO	890	0.4	5,679	2.3
	229,758	100	251,136	100

As we aim to understand the commuting behavior in Mexico City, we consider several variables that allow us to explain the decision of commuting choice. Table 2 presents the variables that we use for both years: 2007 and 2017. The distance that we use is that from the centroid of the neighborhood (colonia) of their origin to the centroid of the neighborhood of their destination. When the origin and destination was the same, then 0.5 kilometers is the value of the distance.

By the descriptive statistics in both databases, we observe that the values of the variables in both years are within a similar range. Almost half of the respondents are female; the education level dropped less than 1%; average age is similar (35 years in 2007, 36 years in 2017); 53% of households owned a car in 2007 while 43% of respondents own a car in 2017; the proportion of households in the high-income quartile drops from 29% to 11%. As expected, distance and minutes are a bit greater in 2017 than in 2007.

5 Model

This study represents transport mode decisions in a random utility framework following McFadden (1978). This choice model has been applied extensively to transportation mode analysis (see for example Ben-Akiva and

Table 2: Explanation of variables

Female	1 when the respondent is female and 0 otherwise.
Education	01 Kindergarden 02 Elementary 03 Middle School 04 Technical Career no HS 05 Teachers School 06 High School 07 High School and Technical Career 08 College 09 Graduate Studies
Age	Age of the respondent Respondent needed to be older than 6.
Car	1 when someone in the household owns a private car, 0 otherwise.
High-class	The survey considers 4 income levels. High class is 1 if the income level is from the highest income.
Distance	Manual quantification from the centroid of the district of origin to the centroid of the neighborhood of destiny measured in Kilometers.
Bike	1 if there are, at least, one bicycle available in the household 0 otherwise

Lerman (1985), and more recently,Garrow (2016)). The model used in this case is a conditional logit where some variables are case-specific: gender, age, education, income; while distance and cost are alternative specific of each transportation mode. The model considers alternative-specific independent variables and person-specific independent variables because we assume that commuters choose their daily mean of transportation based on the monetary cost and the minutes that they are likely to spend on their commute. We also assume that their budget, education, age and other variables are determinants of their election.

The model assumes that commuters have available all the transportation means for every trip that they do. Thus, each commuter may choose between car, bike, taxi, subway, metrobus (RTD), bus, or motorcycle. The likelihood of picking one mode over the others is determined by which alter-

Table 3: Descriptive Statistics

2007 Variable	Obs	Mean	Std. Dev.	Min	Max
Female	232,317	0.48	0.499	0	1
Education	232,317	14.8	3.152	3	23
Age	232,317	35	16.02	6	99
Car	232,317	0.53	0.49	0	1
Bike	232,317	0.17	0.15	0	6
Month income	118,598	4,198	11,907	0	900,000
High class	232,317	0.29	0.17	0	1
Distance	232,317	16.7	13.9	0.3	380
Minutes	232,317	52.06	40.07	1	1140

2017 Variable	Obs.	Mean	Std. Dev.	Min	Max
Female	531,594	0.52	0.50	0	1
Education	531,594	13.5	3.83	3	23
Age	531,594	36.5	18.05	6	97
Car	531,594	0.43	0.49	0	1
Bike	531,594	0.19	0.12	0	5
High class	531,594	0.11	0.32	0	1
Distance	531,594	17.2	15.3	.5	450
Minutes	531,594	57.8	43.1	1	240

native gives the commuter a higher utility, given a budget constraint. Each commuter faces seven alternatives with specific costs and commuting time. These two independent variables were created considering the average speed and cost for every transportation mode in the corresponding year. We obtained the average speed and cost per kilometer of each mode. For the values of 2007, we used the consumer price index of 2017 to bring all prices to 2017 pesos.

Table 4 presents the average speed and costs. Over the decade, the average speed of cars decreased almost by half, taxis by 25 percent, buses by 55 percent, metrobus and motorcycles maintained their average speed. Biking also shows the same average speed. The fourth and fifth columns in table

4 present the costs. Cars and motorcycles had the greatest cost increase. Among other things, this is due to the rise in gasoline price over the decade. The second biggest cost increase was observed in the subway and bus. Taxi commute experienced a slightly cost reduction and biking cost per kilometer was also less in 2017 than in 2007.

Table 4: Average speed and cost by transportation means

Transportation mean	Average speed km/h		Average cost per km (Mexican real pesos-base 2017)	
	2007	2017	2007	2017
Car	20	13	1.09	8.20
Bicycle	16	16	0.62	0.40
Taxi	17	10.9	6.68	6.02
Subway	30	9.9	0.39	0.90
Bus	17	8.6	1.23	2.30
Metrobus	18	17.4	0.93	1.10
Motorcycle	20	20	0.46	11.50

Some transportation modes may be not available for all the commuters. However, this absence will be captured by the model because the commuters only choose a transportation mode if it is available.

Utility is composed of two deterministic observable components and a random component. We observe the characteristics of the individual: age, gender, income, education and whether or not they have a car or a bike. We also observe characteristics of the each alternative for each individual: the time and the cost of each different alternative for each different individual. This model becomes an econometric model when a specific distribution for the random component is assumed. This model assumes the type 1 extreme value distribution. Thus, it is estimated with a conditional logit. The modeling approach considers a Random Utility for each individual i, associated with choice j, over all other choices k. Here is the utility function for one person:

$$U_{1j} = v_{1j} + \varepsilon_{1j} = \alpha_1 + \varphi_1' \delta_1 + \omega_1' \gamma_{1j} + \varepsilon_{1j} \tag{1}$$

where:

δ denotes individual characteristics and γ denotes choice characteristics for each individual.

$$\text{then} \quad Y_1 = j$$

$$\text{if} \quad (U_{1j} - U_{1k}) > 0 \quad \forall j \neq k$$

This utility form is assumed for each individual i. Then we assume $f(\varepsilon_i)$ has an extreme value distribution and thus, we obtain the conditional logit form.

The model specification for each year is a conditional logit model determined by minutes and cost of each variable, given the age, gender, income, education, distance, if car or bike ownership of each individual, and clustered by individual.

The results of the model are in table 5.

Table 5: Results

	2007	2017
m_trans		
hminutes	-0.2176***	-61.9770***
	(0.0168)	(1.6372)
hcost	0.0360*	-30.0066***
	(0.0158)	(0.6240)
Bike		
age	0.0051***	0.0101***
	(0.0009)	(0.0006)
female	-0.6566***	-0.3702***
	(0.0375)	(0.0285)
dcar	-2.7383***	-2.2877***
	(0.0375)	(0.0297)
dbike	2.9132***	0.7398***
	(0.0393)	(0.0484)
high_income	-1.1463***	-1.4403***
	(0.1652)	(0.0595)
education	-0.0665***	-0.0041
	(0.0041)	(0.0028)
km_viaja	-0.0350*	-287.8357***
	(0.0161)	(5.0248)
moto		
age	-0.0197***	-0.0361***
	(0.0019)	(0.0012)
female	-1.3023***	-0.9536***
	(0.0879)	(0.0436)
dcar	-1.8461***	-2.5057***
	(0.0653)	(0.0410)
dbike	0.3136***	4.2456***
	(0.0697)	(0.0433)
high_income	-1.3053***	-0.7810***
	(0.3197)	(0.0707)
education	-0.1005***	-0.1041***
	(0.0068)	(0.0043)
km_viaja	-0.0638***	-1.1227
	(0.0111)	(3.4040)
PTR		
age	0.0026***	0.0107***
	(0.0003)	(0.0003)
female	0.9470***	0.8683***
	(0.0108)	(0.0108)
dcar	-2.4997***	-2.2426***
	(0.0134)	(0.0126)
dbike	0.4207***	0.0827***
	(0.0129)	(0.0235)
high_income	-1.1188***	-1.1331***
	(0.0297)	(0.0148)
education	0.0690***	0.1044***
	(0.0012)	(0.0012)
km_viaja	-0.0005	-182.8130***
	(0.0193)	(3.5148)
N	928684	908292
chi2	90160.1239	1.184e+05

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6: Predicted probabilities

2007 Pr(choice = Car| 1 selected) =.230
2017 Pr(choice = Car| 1 selected) =.241
2007 Pr(choice = Bike| 1 selected)=.000
2017 Pr(choice = Bike| 1 selected)=.019
2007 Pr(choice = Moto| 1 selected) = .001
2017 Pr(choice = Moto| 1 selected) = .003
2007 Pr(choice = PTR| 1 selected)= .767
2017 Pr(choice = PTR| 1 selected)= .735

Table 7: Margins age

Pr(choice = Car| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	.000	-8.35	0.000	-.001	-.000
2017	-.002	.000	-38.67	0.000	-.002	-.002

Pr(choice = Bike| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	2.9e-06	8.2e-07	3.50	0.000	1.3e-06	4.5e-0
2017	.000	.000	3.97	0.000	.000	.000

Pr(choice = Moto| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	3.5e-06	-9.32	0.000	-.000	-.000
2017	-.000	5.7e-06	-26.21	0.000	-.000	-.000

Pr(choice = PTR| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	.000	.000	8.86	0.000	.000	.000
2017	.002	.000	40.13	0.000	.002	.002

Table 8: Margins female

Pr(choice = Car| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.166	.001	-88.91	0.000	-.170	-.163
2017	-.152	.001	-79.17	0.000	-.155	-.148

Pr(choice = Bike| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.001	.000	-16.27	0.000	-.001	-.001
2017	-.019	.000	-35.34	0.000	-.020	-.018

Pr(choice = Moto| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.003	.000	-16.96	0.000	-.003	-.002
2017	-.005	.000	-26.93	0.000	-.006	-.005

Pr(choice = PTR| 1 selected)

year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	.171	.002	90.83	0.000	.167	.1747
2017	.176	.002	89.72	0.000	.173	.180

Table 9: Margins high income

Pr(choice = Car| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	.198	.005	37.58	0.000	.188	.208
2017	.209	.003	78.03	0.000	.204	.214

Pr(choice = Bike| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	.000	-1.72	0.085	-.000	.0000
2017	-.011	.001	-10.23	0.000	-.013	-.009

Pr(choice = Moto| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	.000	-1.39	0.163	-.002	.000
2017	.000	.001	1.17	0.242	-.000	.000

Pr(choice = PTR| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.197	.005	-37.07	0.000	-.208-.187	
2017	-.198	.003	-69.30	0.000	-.204	-.193

Table 10: Margins education

Pr(choice = Car| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.012	.000	-57.79	0.000	-.012	-.011
2017	-.018	.000	-91.36	0.000	-.019	-.018

Pr(choice = Bike| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	7.7e-06	-14.20	0.000	-.000	-.000
2017	-.002*	.000	-26.68	0.000	-.002	-.001

Pr(choice = Moto| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	.000	-11.68	0.000	-.000	-.000
2017	-.001	.000	-25.70	0.000	-.001	-.001

Pr(choice = PTR| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	.012	.000	59.14	0.000	.012	.013
2017	.021	.000	99.66	0.000	.020	.021

*This coefficient was not significant in the model. However, marginal effects are calculated at the average. So a unit increment in education corresponds to a large increase in predicted outcome probability when we are in the steep area of the distribution function (logistic distribution). Therefore, the marginal effect is significant.

Table 11: Margins distance

Pr(choice = Car| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	.000	.003	0.03	0.974	-.006	.006
2017	33.86	.648	52.23	0.000	32.592	35.134

Pr(choice = Bike| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	.000	-1.24	0.215	-.000	.000
2017	-2.834	.066	-42.41	0.000	-2.965	-2.703

Pr(choice = Moto| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	-.000	.000	-2.55	0.011	-.000	-.000
2017	.471**	.024	18.88	0.000	.422	.521

Pr(choice = PTR| 1 selected)						
year	dp/dx	Std. Err.	z	$P > \|z\|$	[95% C.I.]	
2007	.000**	.003	0.00	0.996	-.006	.007
2017	-31.500	.626	-50.35	0.000	-32.727	-30.274

**These coefficients were not significant in the model.

6 Results

Private car is the reference alternative in this conditional logit. Therefore, all other alternatives are compared against car. These coefficients tell us which characteristics are significant and the effect on the probabilities: positive or negative.

Most variables kept their magnitude and significance over the decade. Thus, behavior in 2017 is not very different from behavior in 2007. A few differences stand out: education is not significant towards cars use and against bike use as it was in 2007; longer distance increases the likelihood of car use in 2017, which was not true in 2007, and longer distances do not impede the use of motorcycle, as it was the case in 2007.

According to our data, as people age, they are more likely to commute using public transportation. However when comparing bike or motorcycle against private car, they prefer car.

As in 2007, in 2017 women are less likely to commute in private car, bike or motorcycle; instead they are more likely to commute using public transportation. The sign of those coefficients was the same in 2007 as in 2017, which shows that the trend that women are more likely to use public transportation is constant, even when a private car is present in the household.

As expected, when there is a car in the household, the probability of using all other modes of transportation diminishes. When there is a bike in the household, the probability of biking is positive both in 2007 and in 2017. However, in 2017 the magnitude of the coefficient is smaller. This might suggest that having a bike at home is not as important in 2017 as it was in 2007. In 2017 more people bike using bike sharing systems, even if they don't own a bike. Interestingly, if there is a bike in the household, people are less likely to commute using private car.

Higher income implies less use of all means except private car. So richer people are more likely to commute in private car. If a person belongs to the highest quartile of the surveyed sample, then the probability of using a private car increases and the probability of commuting in any other means of transportation decreases.

The influence of education had a mayor shift. In 2007 it was the case that the more educated a person, the less likely that person would be to commute by bike. In 2017, not anymore. Ever since 2007, the more educated people are more likely to use public transportation. Considering we are controlling for income, this is not a result of more educated people having worse jobs and thus less income. However, the result might be linked with the fact that the neighborhoods connected with BRT and subway might be more accessible to more educated people.

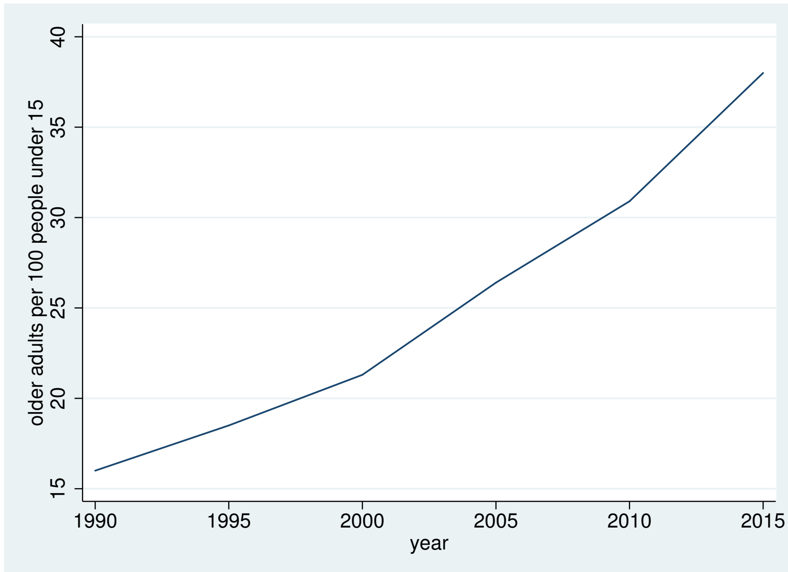
As travelled distance increases, the probability to use bike, understandably, decreases. Motorcycle used to be less preferred with greater distances in 2007. In 2017, there is no clear relationship between distance and motorcycle use. The likelihood of using public transportation was not influenced by the travelled distance in 2007. This might be a result of the effect that (Guerra, 2015) identifies as peripheral commuters that travel long distances and usually use public transportation cancelled out with the fact that longer distances might call for the use of private car. In 2017, as distance increases, the likelihood of using car increases against all other alternatives.

In summary, the characteristics that increase the likelihood to use car to commute in Mexico City in 2007 that persist to 2017 are: being a man, owning a car, having a higher monthly income, and having to commute a longer distance. The traits that have shifted over the decade are the influence of more educated people who are likely to commute using bike and the fact that longer distances increase the likelihood of car use.

7 Discussion

7.1 Age

The population in Mexico City is aging, thus it is important to notice if there were any shifts over the span of a decade. The Aging Index shows how many older adults per 100 people under fifteen, and the growth has been steep in the past decade, see figure 7.1. As the aging trend continuous, the city must be prepared to have a more numerous elder population. From our model we



know that the trend is very similar in 2017 as it was in 2007. Older people are more likely to use public transportation and less likely to use private car and motorcycle. If Mexico City will have older citizens who tend to use public transportation, then it makes sense to prepare the public infrastructure to serve this population.

7.2 Gender

The trait that clearly affects all choices is gender. According to Table 8 being a man in 2007 increased in 16% the likelihood to commute using private car. In 2017 the likelihood increases by 15%. On the other hand, being a woman increases the likelihood to use public transportation by 17% (2007) and 18% (2017). Apparently, the trait is clear: men are more likely to commute in private car and women are more likely to use public transportation. Since we control for car ownership, we are safe to claim that the trend subsists regardless of the household owning a car. So if there is a car in the household, it is likely to be used by men instead of women.

The literature has extensively shown that women have fewer and shorter commutes than men in other latitudes (Lersch and Kleiner, 2018; Gimenez-

Nadal and Molina, 2016; Oakil, 2016). For Mexico City, (Connolly, 2009) mentions that women are more likely to use public transportation in 1994 and in 2007. The literature has also been keen to evidence the presence of sexual harassment in public transportation in Mexico City (Dunkel-Graglia, 2015; Aguilar, A., Gutiérrez, E., Soto, 2015). This means that women not only experience less mobility, but it is likely that the quality of the experience of commuting might be less pleasant than for men. According to Pardo and Echavarren (2010) this is partly due to a gender biased city planning.

As men are more likely to be private car users, it also means that men generate more emissions and more congestion than women. From one perspective, this might be contradictory to the fact that in Mexico City women are more likely to play the role of caregivers. Caregivers might need to take children to school, work, do grocery and other shopping, and take care of the disabled or the elderly, and other domestic tasks. These activities imply a higher need of mobility. In consequence, Rosenthal and Strange (2012) find that women having fewer transport choices locate their business closer to their residences, thus missing out on the benefits of business districts. Berg et al. (2017) claim this is exacerbated in developing countries.

Studies in European countries, Miralles-Guasch et al. (2016); Keinänen and Beck (2017) find that public transportation policies are insufficient to solve women's' discrimination in urban mobility due to the social complexity of the problem. In developing countries, particularly in Mexico, the problem of gender discrimination related with urban mobility is reflected in high levels of sexual harassment. 91% of surveyed women report having had some sort of violence Garibi et al. (2010). Medrano et al. (2017) consider that violence against women in Mexico is chronic and endemic. From this perspective, most of the violence is generated at home and affects urban mobility, economic and social mobility and has consequences in overall wellbeing.

7.3 Income

From our results, we find that people that belong to the richest quartile are 20% more likely to commute using private cars while they are also 20% less likely to use public transportation than people outside of this income range. This result is a notable manifestation of inequality in the city. According to Guerra (2015), in 2007, poorer households that lived in the outskirts of the city spent a higher proportion of their income in their commute and also traveled longer distance at lower speeds. By Table 4 we know that the average speed of car in 2017 is 34% faster than bus (13 km/h vs 8.6 km/h).

In a strict sense, richer individuals who use car to commute generate several externalities that impose costs on the poorer individuals who experience congestion, pollution and health impacts. Thus, the proposal by Parry and Timilsina (2010) to charge for those externalities through a differentiated toll: lower for buses and higher for cars.

According to (Sampson, 2017; McDonnell and MacGregor-Fors, 2016; Piketty, 2015) some of the problems derived for inequality exacerbated by inequal urban mobility are disruption of the social fabric (violence), lack of trust, lack of collective civic engagement and lack of organizational capacity. Thus, urban inequalities affect the behavioral dynamics of citizens within and across neighborhoods.

7.4 Education

One more year of education increases the probability to use public transportation in 0.02, while it decreases the probability to use a car in -0.02. The effect of education shifted slightly in the past decade with regards to the use of bike: In 2007, one more year of education used to reduce the probability to bike. The variable "education" is not significant in 2017. This means that educated people might be willing to commute in bike. The literature shows that in Barcelona, the educated are more likely to bike (Cole-Hunter et al., 2015). Cloutier et al. (2017) find that public education programs have an influence and result in more sustainable commutes.

Given the current average speed of the private car, alternative transportation modes such as subway, BRT and bike are faster than car, thus, speed might be one of the reasons educated people are more willing to avoid the use of car. Other factors that influence the decision might be a greater concern for the environment or better information, such as the health consequences of driving.

7.5 Distance

In this study, we use distance as an independent variable that influences the choice the individual may pick. Back in 2007, greater distance increased the probability of having transit commute. This was the effect of peripheral commuters who were likely to use public transportation and travel long distances. However,in 2017, an extra travelled kilometer increases the likelihood in 33 points to use car. and decreases the likelihood to use public transportation in 31 points. In 2017 as the distance increases, the likelihood to use car increases as well.

Some believe this result is due to the fact that the credit market for automobile acquisition in Mexico City has grown in the past decade (CEFP, 2017). This result is consistent with the behavior in developed countries where there has been an insistence to try to shorten distances, thus create more compact cities (Vale, 2013; Schiller, Preston and Kenworthy, 2018). Several studies have researched the relationship between urban density and private car travel, showing that greater city sprawl, means larger distances to travel and thus generates more car use (Glaeser and Kahn, 2004; Newman and Kenworthy, 2011). In the developing world this might have been hindered by a budget constraint that precludes some families from buying a car, but as credit markets grow and the economy grows, then more families are able to purchase cars.

7.6 Car

There is no surprise in finding that being male, being older, owning a car, longer distances to travel and higher monthly income are determinants of car use (Oakil, 2016; Chatterjee, 2015). The surprise is to find that being educated is not a determinant for car use under every circumstance. Instead, we find that education increases the likelihood to use public transportation.

This might be a result of problem awareness that influences the personal willingness to reduce car use (Nordlund and Garvill, 2003). Following van Acker et al. (2010), commute behavior is the result of reasoned and unreasoned influences. More educated people might be able to incorporate information such as the health and cost consequences of car use to their behavior.

A hypothesis that would require data on the geographical location of educated people, is that which claims that educated people usually live in the core of the city, where BRT, subways and bike sharing systems are within walking distances. People with lower education levels might live further away and thus, need a private car to get to their daily destination.

7.7 Bike

The percentage of people who bike in 2017 increased substantially from those in 2007 (from 2% to 5%). The implementation of a bike sharing system, as well as the construction of bike lanes was fundamental in generating this shift.

Pérez López (2013) found two types of cyclists. In the East of the city, where there are no bike lanes, and bikes usually share the road with cars, she found that only 5% have a college degree, and 79% are manual workers. Using the data from a bike sharing system that serves the core area of the city, she found that 60% of bike sharing users have a college degree, and more than half live in the center. These new users shift the determinants of bike use. Bike sharing system users commute in bike for convenience: it is faster than car in certain areas and hours. In this study we find that the effect of more educated bikers makes education non-significant as determinants of this mode choice.

Men still bike more than women, which is a trend in low cycling countries (Adler and van Ommeren, 2016). Men duplicate the number of cyclists in the US and in several cities in the developed world (Baker, 2009; Iwińska et al., 2018). According to Iwińska et al. (2018) and Pucher et al. (2010), the most important factor to convince women to use bike to commute is better cycling infrastructure

7.8 Motorcycle

The use of motorcycle has increased from 0.4% of travels in 2007 to 2.3% of travels in 2017. This represents a 475% growth. Motorcycles are being used in Latin America because they represent time and cost reductions (Hagen et al., 2016). Motorcycles in Mexico City are being used for private use, but also for delivery purposes and even as taxis.

According to Márquez et al. (2018) motorcycle users value the speed and lower costs over comfort and safety. Several studies also claim that the perception of these variables differ by gender and age; therefore, women and older people are less willing to commute by motorcycle (Márquez et al., 2018; Cole-Hunter et al., 2015; Borstlap and Saayman, 2018).

In Mexico City, motorcycles are more likely to be used to commute by men, younger people, from lower incomes and lower education levels. Owning a car deters the use of motorcycle, but owning a bicycle increases the likelihood to commute in motorcycle. The main result is the fact that greater distance used to reduce the likelihood of motorcycle use in 2007. In 2017, as distance increases, there is no effect in motorcycle use. This means that distance may not stop commuters from using motorcycle anymore.

8 Conclusions

In the last decade, some forces lead by experts, national and international organizations, academia, and government officials are working towards a reduction in motorization trends. These attempts encourage a higher use of transit, bike and pedestrian modes. Mexico City has invested in infrastructure to improve its public transportation system. The city built seven lines of BRT, it also hosts several bike share systems and has created some green pockets in rehabilitated streets and parks. A new transit regulation was approved that prioritized walkers and bikers. Yet, we find that several trends persist from 2007. Age, gender and income have the same influence in 2017 as they did in 2007.

The elderly are still likely to commute using public transportation. All variables being set at the average, women are 18% more likely to use pubic transportation. Likewise, men are 15% more likely to use private car to commute. Those who belong to the richest 25% have a 0.20 higher probability to commute using a car and -0.20 to use transit.

Some determinants shifted in this decade. greater distances preclude the use of public transportation and instead encourage the use of private motorized transportation: private car and motorcycle. On a more hopeful light, a positive new trend is the impact of education in the use of bicycle. A decade ago, higher education implied less likelihood for bikes commute and that is not the case anymore.

Overall, the shifts that we observe after a decade are towards motorization. Thus, there is still much to do. According to our data, a better educated population might be less prone to use private cars. Less distance will also reduce the need for cars and motorcycle, thus, the more compact the city,the better for traffic reduction. Finally, as we address congestion, we must consider inequality between genders, between income groups and between age groups.

References

Adler, M. W. and van Ommeren, J. N. (2016). Does public transit reduce car travel externalities? Quasi-natural experiments' evidence from transit strikes. *Journal of Urban Economics*, 92:106–119.

Agénor, P.-R. (2010). A theory of infrastructure-led development. *Journal of Economic Dynamics and Control*, 34(5):932–950.

Aguilar, A., Gutiérrez, E., Soto, P. (2015). Women only Subway Cars, Sexual Harassment, and Physical Violence, Evidence from Mexico City.

Baker, L. (2009). How to get more bicyclists on the road. *Scientific American*, 301:28–29.

Bel, G. and Holst, M. (2018). Evaluation of the impact of Bus Rapid Transit on air pollution in Mexico City. *Transport Policy*, 63:209–220.

Ben-Akiva, M. and Lerman, S. R. (1985). *Discrete Choice Analysis. Theory and Application to Travel Demand*.

Berg, C. N., Deichmann, U., Liu, Y., and Selod, H. (2017). Transport policies and development. *The Journal of Development Studies*, 53(4):465–480.

Blackman, A., Alpizar, F., Carlsson, F., and Rivera-Planter, M. (2015). A Contingent Valuation Approach to Estimating Regulatory Costs: Mexico's Day Without Driving Program.

Block, M. L. and Calderón-Garcidueñas, L. (2009). Air pollution: mechanisms of neuroinflammation and cns disease. *Trends in neurosciences*, 32(9):506–516.

Borstlap, H. and Saayman, M. (2018). Is there difference between men and women motorcyclists? *Acta Commercii*, 18(1):1–10.

Calderón-Garcidueñas, L., Serrano-Sierra, A., Torres-Jardón, R., Zhu, H., Yuan, Y., Smith, D., Delgado-Chávez, R., Cross, J. V., Medina-Cortina, H., Kavanaugh, M., and Guilarte, T. R. (2013). The impact of environmental metals in young urbanites' brains. *Experimental and Toxicologic Pathology*, 65(5):503–511.

Casey, R., Oppert, J. M., Weber, C., Charreire, H., Salze, P., Badariotti, D., Banos, A., Fischler, C., Hernandez, C. G., Chaix, B., and Simon, C. (2014). Determinants of childhood obesity: What can we learn from built environment studies? *Food Quality and Preference*, 31(1):164–172.

Caudillo Cos, C. (2016). De la casa, al trabajo, evolución de la movilidad laboral. In *Tendencias territoriales determinantes del futuro de la Ciudad de México*, pages 117–151.

CEC (2007). Towards a New Culture for Urban Mobility. Technical report, Commission of the European Communities, Brussels.

CEFP (2017). Boletín: evolución del crédito. pages 1–11.

Cervero, R. (2002). Built environments and mode choice: Toward a normative framework. *Transportation Research Part D: Transport and Environment*, 7(4):265–284.

Chatterjee, K. (2015). Understanding changing travel behaviour over the life course : Contributions from biographical research. *The 14th International Conference on Travel Behavior Research, Windsor, London, United Kingdom, 19-23 July, 2015*, (July):19–23.

Ciudad de Mexico ("2010 (accessed August 31, 2018)"a). Ecobici.

Ciudad de Mexico (2018b). Linea 12-Metro Ciudad de Mexico.

Cloutier, S., Karner, A., Breetz, H. L., Toufani, P., Onat, N., Patel, S., Paralkar, S., Berejnoi, E., Morrison, B. A., Papenfuss, J., et al. (2017). Measures of a sustainable commute as a predictor of happiness. *Sustainability*, 9(7):1214.

Cole-Hunter, T., Donaire-Gonzalez, D., Curto, A., Ambros, A., Valentin, A., Garcia-Aymerich, J., Martínez, D., Braun, L., Mendez, M., Jerrett, M., et al. (2015). Objective correlates and determinants of bicycle commuting propensity in an urban environment. *Transportation Research Part D: Transport and Environment*, 40:132–143.

Connolly, P. (2009). La pérdida de movilidad. *Ciudades*, 81:9–19.

Crotte, A., Graham, D. J., and Noland, R. B. (2011). The role of metro fares, income, metro quality of service and fuel prices for sustainable transportation in Mexico City. *International Journal of Sustainable Transportation*, 5(1):1–24.

Davis, L. W. (2008). The effect of driving restrictions on air quality in mexico city. *Journal of Political Economy*, 116(1):38–81.

Davis, L. W. (2017). Saturday driving restrictions fail to improve air quality in Mexico City. *Scientific Reports*, 7.

Dunkel-Graglia, A. (2015). Rosa, el nuevo color del feminismo: un análisis del transporte exclusivo para mujeres. *Revista de Estudios de Género. La Ventana*, 4(37):148–176.

Ewing, R., Meakins, G., Hamidi, S., and Nelson, A. C. (2014). Relationship between urban sprawl and physical activity, obesity, and morbidity - Update and refinement. *Health and Place*, 26:118–126.

Filippini, M. and Martínez-Cruz, A. L. (2016). Impact of environmental and social attitudes, and family concerns on willingness to pay for improved air quality: a contingent valuation application in mexico city. *Latin American Economic Review*, 25(1):7.

Gaceta Oficial de la Ciudad de México (2017). Vigésima Época, Acuerdo por el que se modifica el Numeral 1.2 Estacionamientos de la Norma Técnica.

Gaceta Oficial del Distrito Federal (2015). Decima Octava Época, Reglamento de Tránsito del Distrito Federal.

Garduño, J. (2016). Invertir para movernos, diagnóstico de inversiones en movilidad en las zonas metropolitanas de México 2014. *LARCI-ITDP-BRITISH EMBASSY*.

Garibi, M., Núñez, M. F. Z., and Ríos, E. P. (2010). La discriminacion y violencia contra las mujeres en el transporte publico de la ciudad de mexico.

Garrow, L. A. (2016). *Discrete choice modelling and air travel demand : theory and applications*.

Gimenez-Nadal, J. I. and Molina, J. A. (2016). Commuting time and household responsibilities: Evidence using propensity score matching. *Journal of Regional Science*, 56:332–359.

Glaeser, E. L. and Kahn, M. E. (2004). Sprawl and urban growth. In *Handbook of regional and urban economics*, volume 4, pages 2481–2527. Elsevier.

Gómez-Perales, J. E., Colvile, R. N., Nieuwenhuijsen, M. J., Fernández-Bremauntz, A., Gutiérrez-Avedoy, V. J., Páramo-Figueroa, V. H., Blanco-Jiménez, S., Bueno-López, E., Mandujano, F., Bernabé-Cabanillas, R., and Ortiz-Segovia, E. (2004). Commuters' exposure to PM2.5, CO, and benzene in public transport in the metropolitan area of Mexico City.

Guerra, E. (2015). The geography of car ownership in Mexico City: A joint model of households' residential location and car ownership decisions. *Journal of Transport Geography*, 43:171–180.

Hagen, J. X., Pardo, C., and Valente, J. B. (2016). Motivations for motorcycle use for urban travel in latin america: A qualitative study. *Transport Policy*, 49:93–104.

Hidalgo, D. and Huizenga, C. (2013). Implementation of sustainable urban transport in Latin America. *Research in Transportation Economics*, 40(1):66–77.

INEGI (2016). Vehículos de motor registrados en circulación 2016.

INEGI (2017). Población total por entidad federativa, 2017.

Iwińska, K., Blicharska, M., Pierotti, L., Tainio, M., and de Nazelle, A. (2018). Cycling in warsaw, poland–perceived enablers and barriers according to cyclists and non-cyclists. *Transportation Research Part A: Policy and Practice*, 113:291–301.

Izquierdo, J. M. C. (2012). La estructura policéntrica de los mercados laborales locales de la zona metropolitana del valle de México. *Investigaciones Geograficas*, 79:97–118.

Keinänen, M. and Beck, E. E. (2017). Wandering intellectuals: establishing a research agenda on gender, walking, and thinking. *Gender, Place & Culture*, 24(4):515–533.

Khan, J. (2013). What role for network governance in urban low carbon transitions? *Journal of Cleaner Production*, 50:133–139.

Lachapelle, U., Frank, L. D., Sallis, J. F., Saelens, B. E., and Conway, T. L. (2016). Active Transportation by Transit-Dependent and Choice Riders and Potential Displacement of Leisure Physical Activity. *Journal of Planning Education and Research*, 36(2):225–238.

Lara Pulido, J. A., Estrada Díaz, G., Zentella Gómez, J. C., and Guevara Sanginés, A. (2017). Los costos de la expansión urbana: aproximación a partir de un modelo de precios hedónicos en la Zona Metropolitana del Valle de México. *The costs of urban expansion: An approach based on a hedonic price model in the Metropolitan Area of the Valley of Mexico. (English)*, 32(1):37.

Lersch, P. M. and Kleiner, S. (2018). Coresidential Union Entry and Changes in Commuting Times of Women and Men. *Journal of Family Issues*, 39(2):383–405.

Lira, I. (2017). El olvido al transporte público colapsa las calles de la Ciudad de México y aviva la contaminación.

Márquez, L., Pico, R., and Cantillo, V. (2018). Understanding captive user behavior in the competition between brt and motorcycle taxis. *Transport policy*, 61:1–9.

McDonnell, M. J. and MacGregor-Fors, I. (2016). The ecological future of cities. *Science*, 352(6288):936–938.

McFadden, D. (1973). Conditional logit analysis of qualitative choice behavior.

McFadden, D. and Train, K. (2000). Mixed mnl models for discrete response. *Journal of applied Econometrics*, 15(5):447–470.

Medrano, B., Miranda, M., and Figueras, F. (2017). Violencia de pareja contra las mujeres en México: una mirada a la atención del sector salud desde una perspectiva interseccional. *Multidisciplinary Journal of Gender Studies*, 6(1):1231–1262.

Miralles-Guasch, C., Melo, M. M., and Marquet, O. (2016). A gender analysis of everyday mobility in urban and rural territories: from challenges to sustainability. *Gender, Place and Culture*, 23(3):398–417.

Navigant Research (2015). Transportation Forecast: Light Duty Vehicles. *Research Report*.

Negrete, M. E. and Paquette Vassalli, C. (2011). La interacción entre transporte público y urbanizació en la Zona Metropolitana de la Ciudad de México: un modelo expansivo que llega a sus límites. *Territorios*, 1(25):15–33.

Newman, P. and Kenworthy, J. (2011). 'peak car use': understanding the demise of automobile dependence. *World Transport Policy & Practice*, 17(2):31–42.

Nordlund, A. M. and Garvill, J. (2003). Effects of values, problem awareness, and personal norm on willingness to reduce personal car use. *Journal of Environmental Psychology*, 23(4):339–347.

Oakil, A. T. M. (2016). Securing or sacrificing access to a car: Gender difference in the effects of life events. *Travel Behaviour and Society*, 3:1–7.

OECD (2013). Green Growth in Cities. Technical report, OECD Green Growth Studies, Paris.

Pardo, M. and Echavarren, J. (2010). Transportation, mobility and women in cities of developed countries. *Social and Economic Development*, 3:168.

Parry, I. W. and Timilsina, G. R. (2010). How should passenger travel in Mexico City be priced? *Journal of Urban Economics*, 68(2):167–182.

Pérez López, R. (2013). El sistema de bicicletas públicas' Ecobici': del cambio modal al cambio social. *Espacialidades*, 03(02):106–124.

Piketty, T. (2015). About capital in the twenty-first century. *American Economic Review*, 105(5):48–53.

Pucher, J., Dill, J., and Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: An international review.

Rosenthal, S. S. and Strange, W. C. (2012). Female entrepreneurship, agglomeration, and a new spatial mismatch. *Review of Economics and Statistics*, 94(3):764–788.

Sampson, R. J. (2017). Urban sustainability in an age of enduring inequalities: Advancing theory and ecometrics for the 21st-century city. *Proceedings of the National Academy of Sciences*, 114(34):8957–8962.

Schiller, Preston and Kenworthy, J. (2018). *An Introduction to Sustainable Tranportation, Policy, Planning and Implementation*. Routledge Taylor and Francis, London, second edition.

Sperling, D. and Claussen, E. (2004). Motorizing the developing world.

Suárez, M., Murata, M., and Delgado Campos, J. (2016). Why do the poor travel less? Urban structure, commuting and economic informality in Mexico City. *Urban Studies*, 53(12):2548–2566.

Suárez-Lastra, M. and Delgado-Campos, J. (2010). Patrones de movilidad residencial en la ciudad de México como evidencia de co-localización de población y empleos. *Eure*, 36(107):67–71.

Suzuki, H., Murakami, J., Hong, Y. H., and Tamayose, B. (2015). Financing transit-oriented development with land values: Adapting land value capture in developing countries. *World Bank Publications*.

Tovar, L. A. R., Espejel, J. A. C., Hernández, B. M., Chávez, A., Tapia, S. C., Sarabia, É. V. C., and García, D. M. (2007). Incentivos y desincentivos en los sistemas de transporte público en Londres, Madrid y Ciudad de México. *INNOVAR. Revista de Ciencias Administrativas y Sociales*, 17(30):113–131.

UNECE (2011). Climate Neutral Cities. How to make cities less energy and carbon intensive and more resilient to climatic challenges UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE. Technical report, UNECE Information Service, Geneva.

Valdez, I. (2016). Más autos más contaminación, entrevista con Gutiérrez Lacayo.

Vale, D. S. (2013). Does commuting time tolerance impede sustainable urban mobility? analysing the impacts on commuting behaviour as a result of workplace relocation to a mixed-use centre in lisbon. *Journal of Transport Geography*, 32:38–48.

van Acker, V., van Wee, B., and Witlox, F. (2010). When transport geography meets social psychology: Toward a conceptual model of travel behaviour. *Transport Reviews*, 30(2):219–240.

World-Bank (2017). GLOBAL MOBILITY REPORT 2017 Tracking Sector Performance. Technical report, World Bank, Sustainability for All, Geneva.

World Health Organization (2018). Fact sheet. Technical report.