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## BRAZILIAN AUTOMOTIVE FLEET REVIEW: PUBLIC POLICY INFLUENCES

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**Abstract.** *Considering Brazil's dependence on the road network and the consequent expression of the share of vehicle sales in its economy, presenting a retrospective of Brazil's automobile sector, relating it to recently implemented public policies, from a recent past and still in force. To consider the impacts and the prospects for interference, a data collection related to all reports available in the public domain of FENABRAVE is exposed. Thus, one can observe the peculiarities of a large automotive fleet contained in a country of equally large dimensions, which is Brazil. It can be understood the effect of proposed policies, and the need for their existence for the market to remain active in the wake of the financial crises that the country went through in the 2010s. A forecast assessment of the automotive fleet growth and its category share using the ARIMA method was proposed, in order to discriminate the discretization of the wide fleet and the consequent impacts of the policies already in force. Among the vehicle discrimination, the current hegemony stands out of Flex vehicles and the large participation of the SUV category, which may be highlighted in the consideration of new energy efficiency policies.*

**Keywords:** *Brazilian Automotive Fleet, Automotive Policies, Brazilian Automotive Manufacturers, FENABRAVE Yearbooks.*

### 1. INTRODUCTION

Pereira; Lessa (2011) in their retrospective work of transport in Brazil, it was identified the dependence of the road network. In passenger transport, growth was continuous between 1970 and 2000, a period in which 90% of passenger transport was through the road network. The historical influence goes back to the 1930s when national policies encouraged the arrival of large automakers to Brazil. Until the 1970s, expansion projects were continued, referring to the large road network then, and how dependent the country was of them.

At the end of the 2000s, Bastin et al. (2010) identified a change in the consumption profile of Brazilian automobiles, and the automotive market was in a growing trend, passenger transportation was gaining strength. Having a fleet already considerably large, the question of the efficiency of cars was urgent, relating the power and weight of the vehicles. In 2008, Brazil's government established a national efficiency-labeling program, to encourage consumers to purchase more efficient engines.

Ministério da Economia (2020) highlights the growth of the Brazilian automotive market in the 2000s as a reflection of the recovery of the economy after the international financial crisis of the 1990s. The reduction in unemployment and the consequent increase in worker income associated with economic maneuvers such as the extension of the financing terms for acquiring new vehicles and the reduction of taxes, in general, were striking in this resumption in sales. However, this resumption was associated with an increase in sales of imported vehicles. In 2011, the Brazilian Federal Government and representatives of the sector were concerned with global effects to come and established the need to create a plan that valued the national industry to suppress the effects of international exchange.

Welch et al. (2019) evaluated the Big Data study methodologies in the transport sector, highlighting the importance of the creation of strategic plans and detailed assessment of the sector, the combination being most frequently pointed out by regression-estimation. With this consideration, the present work aimed to create a detailed database of the Brazilian automotive fleet and to use regression, self-correlation, and forecasting assessment methods to assess the influence of Brazilian automotive sector policies.

### 2. BRAZILIAN AUTOMOTIVE POLICIES

Bastin et al. (2010) denote that since the first concepts of policies for the insertion of new technologies, the process can be divided into three major phases: the invention of the technology itself, the complete development, and finally the

diffusion for general use. In the specific case of energy technologies, there is an intrinsic relationship with market needs and vehicles, being energy consumers, and having their demand correlated with the pricing of the fuels used, that must coexist with the relevant technological capabilities.

## 2.1 National Alcohol Program

Bastin et al. (2010) presented an overview of the National Alcohol Program, having as its main predecessor motivation for its effective application the reduction of dependence on the import of fuel fuels. In a first step, it was proposed to mix anhydrous ethanol with gasoline, and the pure use of hydrated ethanol was decided upon in a subsequent step, which was divided into three phases:

- I) 1979-1981: first ethanol vehicles were launched, presenting technical problems regarding the development of the main manufacturers;
- II) 1982-1983: a combination of technological solutions to a better situation in the national market;
- III) 1983-1985: characterized by mass dissemination of the ethanol-powered vehicle, mixing the conversion of the existing fleet and encouraging manufacturers to use such technology.

## 2.2 Brazilian labeling program (PBE, Programa Brasileiro de Etiquetagem)

In 2008, the National Vehicle Labeling Program was instituted, whose tabulation of approved models is available from 2009 to this day, at the Instituto Nacional de Metrologia, Qualidade e Tecnologia (Inmetro) website, the autarchy responsible for classification. According to INMETRO (2020), the purpose of this voluntary membership program is to allow the consumer easy access to vehicle energy efficiency data, thus facilitating conscious consumer's decision making, and consequently favoring the market to automatically tend towards a more efficient vehicle within the same category. In real operating conditions, several factors interfere with the efficiency of the vehicle, both mechanical and in use (driver's way of driving, traffic patterns, climate, among many others). The laboratory data obtained by a series of tests disclosed that in 90% of the cases are within a gap of 20% of the actual declared consumption.

Bastin et al. (2010) noticed, at the beginning of the PBE, an important step on the path of Brazilian energy efficiency due to the simplicity of the label design and consequently a wide range of population reach, but pointed out a disadvantage in comparative labeling. A vehicle of a higher category can present a better efficiency, even if its consumption is greater than that of a given vehicle of a lower category, which deceptively discourages downsizing from larger to smaller vehicles. Table 1 exposes the evolution of labeling in the middle 2010s.

Table 1. Effectiveness of the National Vehicle Labeling Program.

Available from: <http://www.mdic.gov.br/index.php/competitividade-industrial/setor-automotivo/inovar-auto>

Year	Labeled Vehicles
2013	36%
2014	49%
2015	64%
2016	81%
2017	100%

According to the Ministério da Economia (2020), the full participation in the National scope in the PBE only started to have a full adhesion of the manufactures when fiscal incentives were significant, and its label became a standard of measuring the parameter of efficiency. 2017 culminated in total adherence to the consolidation of General Motors.

## 2.3 INOVAR AUTO

According to Ministério da Economia (2020), the “*Programa de Incentivo à Inovação Tecnológica e Adensamento da Cadeia Produtiva de Veículos Automotores*” (Inovar-Auto) was a program implemented by the government between 2013 and 2017 aiming to increase the productivity in the automotive industry, looking for systematic efficiency gains at the production chain, from manufacturing to servicing and marketing network. The program was divided into two major actions: the first one, incentives during the current period, with benefits of Taxes on Industrialized Products (IPI) up to 30%. In the second one, in 2017, when vehicles manufactured in Brazilian achieving a reduction of 15.46% in fuel expenditure, it was entitled to a reduction of 1% in the IPI tax, and those that reached the target of 18.84% were entitled to 2%.

At the end of the current period, Inovar-Auto (2019), through the Program Monitoring Group, prepared an evaluation report, in the public domain, aiming to detail the efficiency and results, impacted indicators in the national

industry to expose the aggregation value obtained and encourage manufacturers to take part to subsequent public policies. The program was based on a retrospective study carried out by the Agência Brasileira de Desenvolvimento Industrial (ABDI), a Brazilian agency for encouraging industrial development, thus the analysis of the measures taken reflected in the reflections of what currently establishes the current program.

## **2.4 ROTA 2030**

FI Group (2020) is a private initiative that incorporated Federal Law No. 13,755 / 2018, known as Rota-2030, its range of tax advice to reduce taxes. The program currently in force differs from its predecessor, Inovar-Auto, in that it does not have as an incentive, but it did require participation in issues of energy labeling corresponding to efficiency and assistive driving technologies (such as the ABS brake). At this stage in the country's development, largely because of the economic crisis scenario in which the targets were established, tax incentives are not associated with large investments in research and development (R&D), as in the decade of 2010 there was already a mass migration from factories to Brazil. The focus in the 2020s is to add knowledge, from researching materials (including applicable fuel sources, such as biofuels) to automate the manufacturing process, logistically improving the efficiency of the production chain.

Considering the automotive sector as fluctuating in the unstable global economy, within the scope of the Rota-2030 program, the publication of an annual report reported by Ministério da Economia (2020), prepared by its respective Monitoring Group, is already foreseen. The factors of production, employment, investments, innovation, and value-added were listed as annual comparative measures to even assert the goals established in 2018 to assert the dynamics of the economy.

## **2.5 RenovaBio**

Agência Nacional do Petróleo, Gás Natural e Bicomcombustíveis (ANP) (2020), the Brazilian regulatory agency for fossil and renewable fuels, describes the National Biofuels Policy in force, established by Law 13.576 / 2017, RenovaBio. It aims to contribute to the fulfillment of the Paris Agreement commitments by expanding the participation of biofuels in the energy matrix. It has a great focus on the dynamics of the national hydrated ethanol markets, based on macro-econometric studies in conjunction with automotive technologies to determine CBio, a cost associated with the reversal of the necessary subsidy to find the convergence between pricing and gasoline pumps. This aimed to guarantee to the consumer the viability of using ethanol and to the automotive manufacturer the resilience of the market for the flex vehicle.

## **3. FLEET REVIEW**

ANP (2020) in its predefined scenarios and simulation of the impact from the RenovaBio program, consumption of the Otto Cycle is an intrinsic variable. Three main branches are active: fuel pricing, real income per capita, and the automotive fleet itself, the latter being related to the sale of new cars and their scrap curve. This item describes the behavior of the light car fleet, taking into account the finding of the effects of predecessor automotive policies and the need for a neglected database aiming at relevant economical assessments and inspection of the most comprehensive niches and consequently of greater national impact.

Rodrigues; Bacchi (2017) correlated the inelasticity of fuel prices to income in the short run, limiting more significantly to the fleet in operation. Table 2 gathers the data from the Brazilian automotive fleet and its average age from the years 2004 to 2018, discriminating against the distribution of the five major Brazilian geographic regions.

Table 2. Brazilian Automotive Fleet: Evolution and regionalization.  
 Available from: Author – Compilation of FENABRAVE’s Yearbooks

Year	Brazil		Midwest		Northeast		North		Southeast		South	
	Fleet	Age [years]	Fleet	Age [years]	Fleet	Age [years]	Fleet	Age [years]	Fleet	Age [years]	Fleet	Age [years]
2004	24.730.954	13	1.857.600	12	2.578.283	11	561.177	10	14.225.657	14	5.508.237	14
2005	25.955.283	13,4	1.925.313	12,6	2.641.476	11,4	596.256	10,4	15.105.271	13,7	5.686.967	14,3
2006	27.465.470	12,7	2.059.030	11,8	2.843.020	10,5	667.299	9,3	15.918.450	13	5.977.660	13,6
2007	28.550.918	13,3	2.156.311	12,3	2.988.341	11,1	709.799	9,8	16.489.380	13,6	6.207.080	14,3
2008	31.778.209	12,7	2.459.861	11,6	3.389.404	10,4	823.758	9,1	18.238.235	13,1	6.866.951	13,7
2009	34.032.121	12,8	2.676.410	11,5	3.694.189	10,4	912.056	9,1	19.411.926	13,2	7.337.540	13,8
2010	36.601.642	12,8	2.924.083	11,4	4.078.995	10,3	1.019.458	9	20.716.699	13,3	7.862.407	13,8
2011	39.150.895	12,9	3.165.689	11,5	4.460.239	10,4	1.119.014	9	22.002.566	13,4	8.403.387	13,9
2012	41.893.241	12,9	3.434.168	11,5	4.897.355	10,4	1.227.777	9,1	23.342.588	13,5	8.991.338	13,9
2013	44.529.992	13,1	3.698.116	11,6	5.317.700	10,5	1.334.314	9,3	24.613.855	13,7	9.566.007	14
2014	49.403.239	12,9	4.142.106	11,5	6.070.674	10,4	1.520.760	9,3	27.070.388	13,6	10.599.311	13,8
2015	51.195.642	13,4	4.314.123	12	6.390.390	10,9	1.602.492	9,8	27.932.073	14,1	10.956.564	14,2
2016	52.750.925	13,9	4.460.997	12,5	6.655.153	11,4	1.664.677	10,4	28.714.338	14,6	11.255.760	14,8
2017	54.466.840	14,4	4.618.688	13	6.941.926	11,9	1.732.029	10,9	29.583.358	15,1	11.590.839	15,3
2018	56.455.672	14,8	4.809.823	13,5	7.248.759	12,4	1.817.571	11,3	30.585.315	15,5	11.994.104	15,7

### 3.1 FENABRAVE

The Federação Nacional da Distribuição de Veículos Automotores (FENABRAVE), the Brazilian private association of automobile distribution, brings together 51 Automobile Vehicle Brand Associations from different segments, seeking to defend sector interests, including exchanging information with other countries. In addition to promoting congresses that guide the future of the Brazilian market, it carries out a series of studies and research on the sector, from international spheres in partnership with the International Car Distribution Program (ICDP) to the Indices and Numbers of the Brazilian automotive fleet (FENABRAVE – 2020). Its annual reports since 2004 are in the public domain, systematizing data from the Brazilian automotive sector.

In addition to statistics per se, in the annuals, a summary of the sector's assessment by FENABRAVE is reported. From 2004 to October 2008, an impulse in the sector was reported, related to an implemented policy of reducing interest rates and innovations in the credit sector. To ease the effects of the crisis, the Government then employed a policy to reduce the IPI, which is essential for the sustainability of the sector in 2009. In 2010, the end of the IPI reduction did not cause major impacts, thanks to the confidence resulting from the increase in jobs and real wage growth. 2011 was marked by the beginning of a phase of defaults, and a consequent gradual reduction in credits. There were successive years of declining sales in the sector, until 2016, which was the worst recession in history. In 2017, the economy began to recover, and 2018 was highlighted by the large participation of Rental Companies, as loans from individuals remained restricted (FENABRAVE – 2020).

### 3.2 Automotive Manufacturers Market Share

In the Yearbooks, there are sales data from most significant automakers. From 2004 to 2009, the 8 most significant ones are shown, 12 are shown in 2012, and 10 in the other years leading to 2018. The data provided by FENABRAVE (2020) can be seen in Tables 3 and 4.

Table 3. Brazilian Manufacturers Market Share.  
Available from: Author – Compilation of FENABRAVE's Yearbooks

Year	VW	Fiat	GM	Ford	Renault	Honda	Toyota	Nissan	Hyuindai
2004	294.908	304.811	325.230	114.006	50.247	50.403	42.371	No data	No data
2005	323.407	344.939	329.558	133.954	43.878	56.517	44.000	No data	No data
2006	371.848	405.763	374.012	141.453	47.906	66.693	44.432	No data	No data
2007	489.712	523.512	444.849	175.105	69.907	83.878	43.683	6.879	No data
2008	526.051	557.994	468.378	191.578	110.796	109.634	49.378	10.210	No data
2009	626.127	619.639	502.242	235.028	113.622	114.610	68.184	No data	20.984
2010	601.490	612.101	561.686	265.061	154.482	107.676	55.732	No data	44.017
2011	586.104	597.223	529.139	244.029	174.366	76.597	No data	53.536	62.328
2012	651.231	679.976	535.621	255.420	180.698	120.036	63.576	87.188	62.965
2013	539.059	605.003	540.545	238.226	170.861	130.990	116.691	62.215	174.776
2014	471.424	505.433	492.186	282.784	219.879	137.884	152.062	60.767	228.433
2015	290.434	316.319	330.976	236.672	166.351	153.367	142.862	55.457	198.464
2016	185.314	190.398	304.541	164.402	127.536	122.541	146.337	57.300	193.540
2017	217.696	172.454	348.786	188.893	148.480	131.085	155.188	74.760	197.914
2018	302.155	183.343	389.485	205.844	193.040	131.592	160.800	91.180	202.355

In Table 4 it is exposed the relation between the hole sales per year and the participation of the top 10 manufacturers in the way to conduce to a reduced but valid sample to study the parameters of the Brazilian automotive fleet.

Table 4. Brazilian Percentual Participation  
Available from: Author – Compilation of FENABRAVE's Yearbooks

Year	BRAZIL	Percentage of Top 10	Growth
2004	1.252.821	0,943451618	-
2005	1.369.093	0,932188683	0,04951
2006	1.557.244	0,932485211	0,05818
2007	1.977.135	0,929387725	0,03952
2008	2.195.425	0,921925823	0,11304
2009	2.479.245	0,92787764	0,07093
2010	2.651.799	0,905892566	0,0755
2011	2.645.597	0,878184395	0,06965
2012	2.841.882	0,927804532	0,07005
2013	2.755.063	0,935864625	0,06294
2014	2.795.147	0,912600303	0,10944
2015	2.122.657	0,890818441	0,03628
2016	1.688.149	0,883754337	0,03038
2017	1.855.870	0,881126372	0,03253
2018	2.101.837	0,884842164	0,03651

The year 2014 stands out in Table 4. Although it was a year of low sales, FENABRAVE started to classify Sport Utility Vehicle (SUV) vehicles as light vehicles instead of light commercial vehicles. Such adherence was justified by the Federation in consonance with the effective use of such vehicles. The 10 manufacturers listed as most expressive in the country have at least 87% of market share, attesting that for market analysis, the monitoring of these allows adequate general visibility. Honda is highlighted in Table 3 for the year 2011, with its substandard sales below average, due to climatic problems that occurred in Japan.

### 3.3 Flex Vehicles

Rodrigues; Bacchi (2017) proposed in their work, a model for analyzing the elasticities of demand for each type of fuel in Brazil, taking into account the peculiarity of ethanol, diverging from global analyzes that take gasoline pricing as input variables. Flex vehicles (defined as being able to burn ethanol, gasoline or a mixture of both), were introduced in the Brazilian market in 2003, is, therefore, a comprehensive correlation specification factor, since its consumption permeates the fluctuation of the fuel market. Du; Carriquiry (2013) focused on the dynamics of ethanol and gasoline prices to implicate the development of ethanol markets abroad and concluded that Flex Fuel vehicles share allow consumers to arbitrage in the substitution, so establishing higher ethanol blends its essential encompassing Flex technology.

De Souza Nascimento et al. (2012) signalize Volkswagen and General Motors as the predecessor of the Flex Fuel technology, even not expecting great success, as it happened in Brazil. In both cases, they shared the strategy of monitoring the market, to decide the perfect timing to launch a car. The introduction of the electronic injection system started a period of innovations for all manufacturers; Table 5 allows an analysis of said introduction.

Table 5. Flex Vehicles Evolution.  
 Available from: Author – Compilation of FENABRAVE’s Yearbooks

Year	VW	Fiat	GM	Ford	Renault	Honda	Toyota	Nissan	Hyuindai
2004	0,34	0,23	0,22	0,07	0,02	0,00	0,00	No data	No data
2005	0,82	0,69	0,49	0,25	0,37	0,00	0,00	No data	No data
2006	0,97	0,99	0,97	0,41	0,81	0,03	0,00	No data	No data
2007	0,98	0,98	1,00	0,72	0,81	0,47	0,55	0,00	No data
2008	0,97	0,98	1,00	0,92	0,94	0,81	0,93	0,00	No data
2009	0,98	0,99	1,00	0,80	0,97	0,98	0,77	No data	0,00
2010	0,99	0,99	1,00	0,95	0,88	0,99	0,98	No data	0,00
2011	0,99	0,99	0,99	0,96	1,00	1,00	No data	1,00	0,00
2012	0,98	0,99	1,00	0,98	1,00	1,00	1,00	1,00	0,35
2013	0,97	0,99	1,00	0,97	1,00	1,00	1,00	1,00	0,93
2014	0,95	0,98	0,99	0,96	1,00	1,00	0,87	0,99	0,81
2015	0,94	0,98	0,99	0,97	0,91	0,93	0,92	0,99	0,97
2016	0,93	0,99	0,99	0,98	1,00	0,98	0,91	1,00	0,98
2017	0,95	1,00	0,99	0,98	1,00	0,96	0,91	1,00	0,97
2018	0,97	1,00	0,98	0,97	1,00	0,95	0,89	1,00	0,97

### 3.4 Vehicles Categories

Table 6 shows the participation of each segment of Brazil’s Market Share in the automotive sector. The data is a compilation of FENABRAVE’s yearbooks (2020). For each yearbook, the value of the year and its four predecessors are shown and according to the institution, the data disagreement is due to the deadlines for closing the manufacturers’ reports, so the most recent data has always been adopted. In the 2014 yearbook, SUV vehicles were classified as light cars, so there has been a reclassification from 2010, which is considered in the present work.

Table 6(a). Vehicles Categories Share.  
 Available from: Author – Compilation of FENABRAVE’s Yearbooks

Year	Entrance	Hatch Small	Hatch Medium	Sedan Small	Sedan Compact	Sedan Medium	Sedan Big
2004	0,4804	0	0,0516	0,1323	0,0314	0,0555	0,0047
2005	0,4484	0,1552	0,0475	0,1426	0,0226	0,0544	0,0054
2006	0,4285	0,1525	0,0441	0,1463	0,0207	0,0759	0,0061
2007	0,4089	0,1478	0,0543	0,1676	0,0227	0,082	0,0042
2008	0,4	0,1437	0,0687	0,1666	0,0185	0,0925	0,0061
2009	0,3829	0,1424	0,066	0,1948	0,0263	0,078	0,007
2010	0,3664	0,1759	0,0744	0,1862	0,0357	0,0665	0,0072
2011	0,3272	0,1719	0,0665	0,1508	0,0308	0,072	0,0106
2012	0,3131	0,1997	0,0529	0,1391	0,0471	0,0819	0,0057
2013	0,2589	0,2504	0,0457	0,1659	0,0391	0,0761	0,0065
2014	0,2507	0,2463	0,0356	0,1741	0,0346	0,0854	0,006
2015	0,2347	0,236	0,029	0,1721	0,0286	0,0895	0,0079
2016	0,2068	0,2644	0,0195	0,1683	0,0242	0,0869	0,0058
2017	0,2043	0,2695	0,011	0,1486	0,0217	0,0825	0,0049
2018	0,1736	0,2859	0,0063	0,1399	0,0446	0,0675	0,0049

Table 6(a). Vehicles Categories Share.  
Available from: Author – Compilation of FENABRAVE’s Yearbooks

Year	SW Medium	SW Big	Monocab	Grandcab	Sport	SUV
2004	0,0307	0,0048	0,0503	0,028	0,0004	0
2005	0,0365	0,0064	0,052	0,0234	0,0005	0
2006	0,0426	0,0062	0,0607	0,0157	0,0007	0
2007	0,0405	0,0082	0,0497	0,0132	0,0007	0
2008	0,0379	0,0045	0,0479	0,0125	0,0008	0
2009	0,0371	0,0018	0,0524	0,0105	0,0009	0
2010	0,0238	0,0017	0,0521	0,0087	0,0012	0,0763
2011	0,0197	0,0041	0,0423	0,0073	0,0017	0,0949
2012	0,0179	0,0036	0,0388	0,01	0,0009	0,0892
2013	0,0136	0,0002	0,0325	0,015	0,0012	0,0949
2014	0,0102	0,0001	0,0344	0,014	0,001	0,1077
2015	0,0084	0,0006	0,0304	0,0132	0,001	0,1487
2016	0,0058	0,0007	0,0229	0,0139	0,0011	0,1798
2017	0,003	0,0005	0,0169	0,0137	0,0007	0,2227
2018	0,0042	0,0004	0,0157	0,0123	0,0011	0,2438

### 3.5 Automotive growth forecast

Karpušenkaite et al. (2018) from an automotive waste analysis, they demonstrated the relevance of mathematical models not based on a simple time series, attesting to the greater accuracy of a hybrid modeling. Chauhan; Singh (2017) applied an autoregressive integrated moving average (ARIMA) model, explaining the need for testing autocorrelation indexes and lags in order to obtain a reliable forecast. From the repercussions proposed by Contreras et al. (2017) regarding risks, the ARIMA methodologies (1.1.1), (1.1.8), (8.1.8) and (8.1.8) were applied, being selected for home prediction the most assertive option was selected according to with Correlogram D (segment) and the Least Squares method. The criteria for choosing the best method are, in order, the lowest volatility, the highest r-square, the lowest Akaike Info Criterion and the lowest Schwartz Criterion. For the growth of the automotive fleet as a whole, the retroactive data from Table 2 was used, and the forecast is shown in Fig. 1.

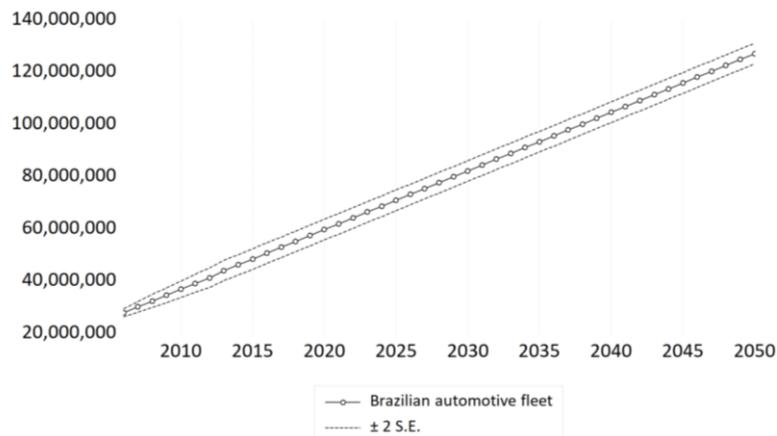


Figure 1. Brazilian automotive fleet forecast.  
Available from: Author

Based on the data for each vehicle category shown in Table 6, the ARIMA method was applied. Table 7 presents the compilation of growth results for all categories, presenting the expected forecast value (FORE), the value presented in its upper and lower confidence limits (respectively FORE + and FORE-).

Table 7. Vehicles Categories Share.  
 Available from: Author

Categorie Method	Entrance			Hatch Small			Hatch Medium			Sedan Small			Sedan Compact			Sedan Medium			Sedan Big		
	ARIMA (8.1.1)			ARIMA (1.1.8)			ARIMA (8.1.8)			ARIMA (8.1.8)			ARIMA (8.1.1)			ARIMA (1.1.8)			ARIMA (8.1.8)		
	FORE	FORE-	FORE+																		
2019	-3,34	-6,70	0,00	1,20	-3,70	6,10	-0,02	-1,60	1,60	1,40	-1,90	4,80	-0,30	-2,00	1,40	0,10	-2,20	2,40	-0,30	-0,40	-0,21
2020	-1,70	-4,70	1,30	1,20	-3,70	6,10	0,25	-1,40	1,90	0,60	-2,70	4,00	1,10	-0,50	2,80	0,10	-2,20	2,40	0,50	0,41	0,60
2021	-3,41	-9,00	2,20	1,20	-3,70	6,10	-0,28	-2,20	1,60	0,10	-4,00	4,10	-0,50	-2,50	1,50	0,10	-2,20	2,40	0,07	-0,14	0,27
2022	-2,14	-5,50	1,30	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,20	0,00	-2,10	2,00	0,10	-2,20	2,40	0,07	-0,14	0,27
2023	-2,12	-5,50	1,30	1,20	-3,70	6,10	-0,21	-2,10	1,70	0,00	-4,10	4,00	0,20	-1,90	2,20	0,10	-2,20	2,40	-0,17	-0,38	0,03
2024	-1,66	-5,50	2,20	1,20	-3,70	6,10	-0,19	-2,10	1,70	0,20	-3,80	4,30	-0,10	-2,20	1,90	0,10	-2,20	2,40	0,18	-0,03	0,38
2025	-2,02	-5,50	1,40	1,20	-3,70	6,10	-0,27	-2,20	1,60	-0,10	-4,20	3,90	0,40	-1,60	2,50	0,10	-2,20	2,40	0,08	-0,12	0,29
2026	-1,99	-5,50	1,50	1,20	-3,70	6,10	-0,22	-2,10	1,70	0,30	-3,50	4,30	0,50	-1,50	2,50	0,10	-2,20	2,40	0,02	-0,19	0,23
2027	-2,97	-7,20	1,20	1,20	-3,70	6,10	-0,29	-2,20	1,60	0,60	-3,70	4,60	-0,20	-2,20	1,90	0,10	-2,20	2,40	0,31	0,11	0,52
2028	-1,89	-5,40	1,70	1,20	-3,70	6,10	-0,32	-2,20	1,60	0,30	-4,00	4,40	0,80	-1,20	2,80	0,10	-2,20	2,40	-0,45	-0,65	-0,24
2029	-3,01	-8,60	2,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,10	-3,90	4,30	-0,30	-2,50	1,80	0,10	-2,20	2,40	-0,03	-0,30	0,23
2030	-2,18	-5,80	1,40	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-4,00	4,30	0,00	-2,20	2,20	0,10	-2,20	2,40	-0,03	-0,30	0,23
2031	-2,17	-5,80	1,40	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,10	-3,90	4,20	0,10	-2,00	2,30	0,10	-2,20	2,40	0,19	-0,08	0,46
2032	-1,87	-5,90	2,10	1,20	-3,70	6,10	-0,28	-2,20	1,60	0,20	-4,00	4,30	-0,10	-2,20	2,10	0,10	-2,20	2,40	-0,14	-0,41	0,13
2033	-2,10	-5,80	1,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,10	-3,90	4,20	0,30	-1,90	2,50	0,10	-2,20	2,40	-0,05	-0,32	0,22
2034	-2,08	-5,80	1,60	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,40	-1,80	2,60	0,10	-2,20	2,40	0,01	-0,26	0,28
2035	-2,71	-7,10	1,60	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,30	-3,80	4,40	-0,10	-2,30	2,10	0,10	-2,20	2,40	-0,27	-0,54	0,00
2036	-2,01	-5,80	1,70	1,20	-3,70	6,10	-0,26	-2,20	1,60	0,20	-3,90	4,30	0,60	-1,60	2,80	0,10	-2,20	2,40	0,45	0,18	0,72
2037	-2,75	-8,00	2,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	-0,20	-2,40	2,10	0,10	-2,20	2,40	0,06	-0,26	0,37
2038	-2,20	-5,90	1,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,00	-2,20	2,30	0,10	-2,20	2,40	0,06	-0,26	0,37
2039	-2,20	-5,90	1,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,10	-2,10	2,40	0,10	-2,20	2,40	-0,15	-0,47	0,16
2040	-2,00	-6,00	2,00	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,00	-2,20	2,20	0,10	-2,20	2,40	0,16	-0,16	0,47
2041	-2,15	-5,90	1,60	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,30	-2,00	2,50	0,10	-2,20	2,40	0,08	-0,24	0,39
2042	-2,14	-5,90	1,60	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,30	-2,00	2,50	0,10	-2,20	2,40	0,02	-0,30	0,33
2043	-2,56	-6,80	1,70	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,00	-2,30	2,20	0,10	-2,20	2,40	0,28	-0,04	0,59
2044	-2,10	-5,90	1,70	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,10	-1,80	2,70	0,10	-2,20	2,40	-0,40	-0,71	-0,08
2045	-2,58	-7,40	2,20	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	-0,10	-2,40	2,20	0,10	-2,20	2,40	-0,03	-0,38	0,32
2046	-2,22	-5,90	1,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,10	-2,20	2,30	0,10	-2,20	2,40	-0,03	-0,38	0,32
2047	-2,22	-5,90	1,50	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,10	-2,20	2,40	0,10	-2,20	2,40	0,17	-0,18	0,52
2048	-2,09	-5,90	1,80	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,00	-2,20	2,30	0,10	-2,20	2,40	-0,12	-0,05	0,23
2049	-2,19	-6,00	1,60	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,20	-2,10	2,50	0,10	-2,20	2,40	-0,04	-0,40	0,31
2050	-2,18	-5,90	1,60	1,20	-3,70	6,10	-0,27	-2,20	1,60	0,20	-3,90	4,30	0,20	-2,00	2,50	0,10	-2,20	2,40	0,01	-0,34	0,36

Categorie Method	SW Medium			SW Big			Monocab			Grandcab			Sport			SUV		
	ARIMA (1.1.8)			ARIMA (8.1.1)			ARIMA (1.1.8)			ARIMA (8.1.1)			ARIMA (1.1.8)			ARIMA (1.1.8)		
	FORE	FORE-	FORE+															
2019	-0,17	-1,22	0,89	-0,19	-0,62	0,24	-0,28	-1,67	1,12	-0,12	-0,77	0,54	0,00	-0,08	0,09	2,00	-1,10	5,10
2020	-0,17	-1,22	0,89	-0,05	-0,48	0,38	-0,28	-1,67	1,12	-0,09	-0,75	0,57	0,00	-0,08	0,09	2,00	-2,20	6,30
2021	-0,17	-1,22	0,89	0,01	-0,44	0,46	-0,28	-1,67	1,12	-0,10	-0,76	0,56	0,00	-0,08	0,09	2,10	-2,30	6,40
2022	-0,17	-1,22	0,89	-0,04	-0,52	0,43	-0,28	-1,67	1,12	-0,12	-0,78	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2023	-0,17	-1,22	0,89	0,01	-0,47	0,48	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2024	-0,17	-1,22	0,89	-0,12	-0,59	0,35	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2025	-0,17	-1,22	0,89	-0,10	-0,57	0,38	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2026	-0,17	-1,22	0,89	-0,04	-0,52	0,43	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2027	-0,17	-1,22	0,89	0,01	-0,46	0,49	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2028	-0,17	-1,22	0,89	-0,05	-0,52	0,42	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2029	-0,17	-1,22	0,89	-0,08	-0,56	0,40	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2030	-0,17	-1,22	0,89	-0,05	-0,54	0,43	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2031	-0,17	-1,22	0,89	-0,08	-0,56	0,41	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2032	-0,17	-1,22	0,89	-0,02	-0,50	0,47	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2033	-0,17	-1,22	0,89	-0,03	-0,51	0,46	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2034	-0,17	-1,22	0,89	-0,05	-0,54	0,43	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2035	-0,17	-1,22	0,89	-0,08	-0,56	0,40	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2036	-0,17	-1,22	0,89	-0,05	-0,53	0,43	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2037	-0,17	-1,22	0,89	-0,04	-0,52	0,45	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2038	-0,17	-1,22	0,89	-0,05	-0,53	0,44	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2039	-0,17	-1,22	0,89	-0,04	-0,52	0,45	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2040	-0,17	-1,22	0,89	-0,07	-0,55	0,42	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2041	-0,17	-1,22	0,89	-0,06	-0,55	0,43	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2042	-0,17	-1,22	0,89	-0,05	-0,52	0,44	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2043	-0,17	-1,22	0,89	-0,04	-0,54	0,45	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2044	-0,17	-1,22	0,89	-0,05	-0,54	0,44	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2045	-0,17	-1,22	0,89	-0,06	-0,54	0,43	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2046	-0,17	-1,22	0,89	-0,05	-0,54	0,44	-0,28	-1,67	1,12	-0,11	-0,77	0,54	0,00	-0,08	0,09	2,10	-2,30	6,40
2047	-0,17	-1,2																

The Inovar-Auto program established itself as a milestone in the country's automotive policy, incorporating the PBE energy efficiency concept but in an active way so that the improvement in efficiency started to trigger fiscal benefits for manufacturers. It also made mandatory the technological development of national industry, in an interdepartmental way, explaining the intrinsic network, which the Brazilian automotive industry is composed, a fact that culminated in the elaboration of the present work: understanding the relationships in the automotive environment for the elaboration of any project within the energy planning of the automotive sector.

The year 2010 was troubled in its macroeconomic issue, creating difficulties for the assemblers to solidly establish their goals in Brazil: in Table 4 when comparing the year in which the project was conceived until 2017, sales growth was at 50%, including SUVs only in the final period. This category even deserves to be highlighted, as it is characterized by large vehicles and large fuel consumption, in dissonance to reduce CO<sub>2</sub> emissions. A detailed analysis of the effects of the gradual increase in the participation of this segment is also necessary.

Analyzing Tables 3 and 4 as one, for a market share of about 90%, it is observed that the hegemony of Volkswagen, Fiat, General Motors, and Ford has been broken in the country, giving great prominence to Japanese automakers. These have been investing in efficient and reliable vehicles, gaining the preference of the Brazilian consumer. In this analysis, the Inovar-Auto program is highlighted in its obligation to bring manufacturing plants to Brazil.

When considering Rota-2030 associated with RenovaBio, the interdependence of the automotive economy and the ethanol market can be observed, and to achieve the decarbonization goals, which both programs set for the year 2030, the government must guarantee the pricing of ethanol. The factor of great geographical dimension in Brazil generates regional peculiarities as exposed in Table 1, thus highlighting the adherence of specific equations. In this way, the price associated with the policy is not only a subsidy for the maintenance of sugar cane producers but a way to guarantee the decarbonization and industrial and energy independence of Brazil. As it can be observed in Table 5, the flexibility of use of fuels of the Brazilian fleet, in the year 2018, reached a threshold very close to the maximum of Flex Vehicles, highlighting that the percentage that is not comprised SUV vehicles to diesel.

Adding all the considerations, a reliable database of the Brazilian automotive sector is established and more accurate to determine an energy planning analysis than considering the fleet in a generic model. The continuation of this work consists in firstly segment Brazil in the regional factors as RenovaBio did, and consider the insertion parameters in two aspects: the base of vehicle segments and their respective insertion factors, and the base of the 10 most significant manufacturers, aiming to compare the results obtained.

From the analysis of the prediction of the evolution of the segments using the ARIMA method, in addition to the accuracy issues, the decrease in the participation of vehicles in the entrance segment is highlighted, agreeing on safety issues established by the ROTA-2030. With the consideration of the share combination combined with the absolute trend of the fleet, environmental aspects of emission specified by the PBE in the given categories allow the creation of a project to minimize emissions focused on the operational discrepancies of the Brazilian automotive fleet.

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