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Research Article

The government as an inducer of the automotive industry: propositions for Brazilian automotive sector

Valter Silva Ferreira Filho[a*], Maurício César Delamaro[a**], Fernando Augusto Silva Marins[a***], Henrique Martins Rocha[b****]

[a]Universidade Estadual Paulista "Júlio de Mesquita Filho", Faculdade de Engenharia de Guaratinguetá, Departamento de Produção, Guaratinguetá, SP, Brasil

[b]Universidade do Estado do Rio de Janeiro, Faculdade de Tecnologia, Departamento de Engenharia de Produção, Resende, RJ, Brasil

*valter.ferreira@unesp.br, **mauricio.delamaro@unesp.br, ***fernando.marins@unesp.br, ****prof.henrique_rocha@yahoo.com.br

Abstract

Paper aims: This paper aims to create propositions that would be a guide the future construction of an industrial policy capable of rebuilding the Brazilian automotive industry (IAB) through the creation of demand by scrappage policy. **Originality:** This paper is based on more than 470 IAB representatives' answers, C-Level/Senior Executives, converting experience and empiric perspectives in scientific knowledge. **Research method:** Hypothetical-Deductive research were conducted applying survey as procedure and Delphi Method as technique, using electronic tools to collect data, combining quantitative and qualitative approaches in statistical data analysis. **Main findings:** Were identified a consensus among IAB representatives and literature evidences about scrappage policy as an engine regarding sustenance of automotive industry and the need for rules that guide national competitiveness key factors. **Implications for theory and practice:** The paper theoretical and practice implications are provide subsidies to future sectorial policies based on empirical experience of more than 470 IAB representatives.

Keywords

Automotive industry. New developmentalism. Industrial policy.

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1. Introduction

Since its creation, the Brazilian automotive sector has shown itself to be strategic for the national economy. Its implementation took place through government import substitution programs in the 1930s. Between the 1960s and 1970s, the automotive sector grew at annual rates above 20%, supported mainly by direct state intervention (Santos & Pinhão, 1999; Santos & Burity, 2002; Lima, 2011).

In the 1990s, as a way of reversing stagnant sales and technological levels were compatible with those of the 1970s, the Brazilian government created a plan to modernize the Brazilian automotive industry (IAB), the Brazilian automotive regime - RAB that was in force between 1995 and 1999 (Pinheiro & Motta, 2001; Banco Nacional de Desenvolvimento Econômico e Social, 2008; Pinto, 2011; Santos & Burity, 2002).

In 2008, eight years after the closing of the RAB, the world economy was shaken by a serious economic crisis, which forced the automotive sector to adopt conceptual changes of vehicles. To maintain domestic sales, the Brazilian government reduced the tax rate on industrialized products - IPI between 2008 and 2011, a waiver of R$ 4.5 billion (Instituto Brasileiro de Planejamento e Tributação, 2014). To replace the IPI waiver, the federal government introduced, in 2012, the Inovar-Auto Program, which ran from 2013 to 2017, whose objectives, among others, were to create conditions for the competitiveness and insertion of the IAB in the

global technological route (Leon & Goulart, 2012; Brasil, 2012; Associação Nacional dos Fabricantes de Veículos Automotores, 2013).

After the closure of Inovar-Auto, the Brazilian government launched a new sectoral program, Rota 2030 Mobilidade e Logística, in December 2018, as a long-term public policy, in three five-year cycles and with the promise of making the IAB effectively competitive. (Brasil, 2018, 2020).

Despite the new long-term public policy Rota 2030, old problems as the inability to create a R&D ecosystem, low international competitiveness, global markets misalignment, incapacity to maintain production volumes and high pollution vehicles with more than ten years in operation still remains.

The purpose of this paper is to present the results obtained in an extensive application of the Delphi method to executives of the Brazilian automotive industry that originated and validated a set of propositions for a long-term developmental policy backed by a program to replace the fleet of vehicles with more than 10 years of manufacture.

2. Literature review

This research explores the dimensions of a country's competitiveness factors and the government's role in creating these factors. Some authors (Dunning, 1992; Van Den Bosch & Man, 1994; Stopford et al., 1998; Carayannis & Grigoroudis, 2014; Bresser-Pereira, 2016; Chang & Andreoni, 2016) emphasize that the role of governments occupies the centrality in creating factors and consequently in the development of national economies, which according to Bresser-Pereira (2020a), dependent on supply-related factors such as skilled labor, technological and scientific development, investment in infrastructure, in addition to robust institutions, and has as a sensitive point , the demand.

Bresser-Pereira (2020a) highlights that development depends on a chain relationship, between a high investment rate, which is dependent on profitable investment opportunities for the private sector, which, in turn, depend on the existence of domestic demand and demand. external, which brings us to the second pillar of the theoretical foundation, the new developmentalism.

New developmentalism is defined by some authors (Bresser-Pereira, 2015, 2016, 2019, 2020a, 2020b, 2021; Bresser-Pereira et al., 2020; Capriata & Souza, 2021; Castelo, 2012; Ferreira, 2012; Giuliano, 2021; Moraes & Ibrahim, 2020; Moraes, 2021; Neris Junior & Battahin, 2020; Nunes, 2018; Paiva-Silva, 2020; Schwartz, 2020; Tijerina, 2020) as a theory based on successful economic experiences of rapid growth and continuous, where the government uses sectoral policies as a means of inducing the promotion of the industry in the long term and in the creation of competitiveness factors (reduce demand uncertainty, create market, create innovation ecosystems, use of new technologies).

For Bresser-Pereira (2020b, 2021), Moraes & Ibrahim (2020), Medeiros (2020), Schwartz (2020) and Tijerina (2020), new developmentalism moves away from traditional interventionist policies and is directed towards collaboration between the state and private initiative as a foundation to achieve productive investment, social welfare, technological innovation, export-oriented growth through taking advantage of global economies of scale and technological upgrading processes.

For Carayannis & Grigoroudis (2014), Porter (2011) , Stanovnik & Kovačič (2000), the term national competitiveness is linked to the ability of a country to achieve long-term economic growth and achieve an economic structure that easily adapts to changes in demand. in world markets. Bresser-Pereira (2019, 2020a) states that from the definition of globalization, the topic of national competitiveness gains prominence in the relations between nation-states, bringing countries, their national economies and their policies to the forefront of the discussion on competitiveness.

According to Porter (1990, 2011), the national scenario plays a central role in the competitive success of companies, thus, understanding the role of the country in creating factors that lead to the competitiveness of its firms is essential for designing policies that create and sustain the competitive advantage. The author states that there are four major attributes of a country, which individually or as part of an ecosystem constitute what he calls the determinants of national advantage, namely:

- Factor conditions: the country's position in the factors of production;
- Demand conditions: the nature of domestic market demand;
- Related and supporting industries: the presence of a supply chain in the country;

- Firm strategy, structure, and rivalry: Conditions govern how firms are created, organized, and managed, as well as the nature of domestic rivalry.

According to some authors (Van Den Bosch & Man, 1994; Stopford et al.,1998; Carayannis & Grigoroudis, 2014; Delgado et al., 2012), governments have the ability to improve or worsen a country's advantage, either through its role in regulation, investments in human resources training, government purchases, or even through policies that influence the entire system, sectoral public policies. The authors suggest that the government is the fifth determinant of national competitiveness, with different levels of action depending on the maturity of each of the determinants.

Dunning (1992), Bresser-Pereira (2016), Chang & Andreoni (2016) and Tijerina (2020) cite the government as a cornerstone in fostering national competitiveness and highlight public-private collaboration as fundamental for productive investments, integration into global production chains and fostering the technological innovation ecosystem.

This role of the state in the creation of national competitiveness finds its place in the theoretical framework of developmentalism, which according to some authors (Bresser-Pereira, 2015, 2016, 2019, 2020a, 2020b; Castelo, 2012; Ferreira, 2012; Fonseca, 2015, 2016; Herrlein Junior, 2011; Medeiros, 2020; Moraes & Ibrahim, 2020), can be defined as the economic policy formulated to foster the creation of a competitive and innovative industrial environment, in addition to creating factors and stimulating demand.

The market is, according to Bresser-Pereira & Bechelaine (2019) and Bresser-Pereira (2021), an unsurpassed institution in the coordination of competitive economic sectors, but not for the protection of the environment, in the pricing and investment policy in non-industrial sectors. competitive prices, and in the policy concerning the five macroeconomic prices (interest, exchange, wages, investment and profit), for these cases, state intervention is necessary.

The government's role in structuring public policies that foster conditions that promote the competitiveness of a country are part of debates in the business and academic world, especially since the 2008 financial crisis and more recently, the COVID-19 pandemic.

The State, through the implementation of sectoral policies, can assume the role of inducing the economy, directly influencing the market structure, creating factors of production, promoting demand, as well as establishing the bases and incentives for technological development. Thus, it was analyzed how the governments of the largest vehicle producer/consumer markets stimulated their economies in the 2008 financial crisis through the creation of fleet replacement programs, also called cash for clunckers or scrappage policy.

In China over the last twenty years, annual vehicle production and sales have experienced rapid growth, from just over two million vehicles in the year 2000 to over twenty-five million in 2020 (International Organization of Automobile Manufactures, 2021). The increase in vehicle production and sales has been accompanied by the compulsory disposal of old vehicles, and to regulate the vehicle disposal process, China implemented mandatory disposal standards in 1986 and revised the standards in 1997, these being based on the service time and distances traveled for different vehicle classifications (Hao et al., 2011; Yue, 2012).

According to Linhua & Guilin (2015), data from the traffic management office of the Chinese Ministry of Public Security indicate that China had more than 264 million vehicles in its circulating fleet at the end of 2014, of which 154 million were automobiles, occupying second place after the USA in the world. The authors state that with the rapid and continuous growth of the Chinese automotive industry, the speed of compulsory scrapping and car replacement has also increased dramatically. In 2000, 580,000 cars were scrapped, in 2011 there were 4 million cars scrapped in China, estimating that as of 2020, more than 14 million cars would be scrapped annually, thus creating a cycle of steady growth.

As seen with the compulsory scrapping policy, which creates cycles of steady growth in the Chinese automotive industry, in addition to normal market behavior factors that can affect the structure of the auto industry, such as investment level, operating structure, or stage of economic development. , this structure is also influenced by direct government interventions (Ma et al., 2019). According to the authors, the Chinese government pays special attention to companies in the automobile manufacturing industries, as they contribute more to intermediate goods and capital.

In the US, several efforts were initiated by the US government from 2008 onwards in response to the financial crisis. The main initiative was the "Troubled Asset Relief Programstry" - TARP, a broad economic support program instituted by the US government to rescue companies during the crisis. Thus, as part of TARP, the Automotive Industry Financing Program (AIFP) was instituted in December 2008, whose macro objective was to prevent the runaway liquidation of Chrysler and GM and the collapse of the US auto industry. The AIFP also had a sub-program, the automotive supplier support program, to support the main GM and Chrysler suppliers

(US Government Accountability Office, 2010; US Department of the Treasury, 2015; Canis & Yacobucci, 2010; Canis et al., 2010; Canis, 2020).

In addition to TARP and AIFP, the US government launched in 2009 the consumer assistance to recycle and save act - CARS. According to US treasury data (US Department of the Treasury, 2012, 2015), the government provided approximately $51 billion to GM and $12.5 billion to Chrysler through TARP, in addition to an automotive supply chain support program with $5 billion in funding (US Department of the Treasury, 2009b). In addition to direct support to automakers and the supply chain, the US government launched Consumer Assistance to Recycle and Save – CARS. This is because, in 2009, with the recession caused by the 2008 financial crisis, monthly vehicle sales fell to the lowest levels not seen in more than 25 years (Blinder & Zandi, 2010; Cooper et al., 2010).

CARS stimulated the replacement of the fleet of old vehicles with new and less polluting vehicles through the issuance of discount bonds for the purchase of more efficient cars and also helped to revitalize the US automotive industry, which was already weakened before the crisis. 2008. With an injection of $3 billion in new vehicle bonuses, overall vehicle sales rose more than 40%, generating a positive impact of $6.8 billion on GDP and contributing to the creation or maintenance of approximately 120,000 jobs in the second half of 2009, a total of 370,000 new jobs in the automotive sector between 2009 and 2015 (Canis & Yacobucci, 2010; Cooper et al., 2010; Tyrrell & Dernbach, 2010; Blinder & Zandi, 2010; Lenski et al., 2010; US Department of the Treasury, 2015).

Japan instituted its vehicle replacement program in June 2009, known as "Eco-Car", retroactive to April 10, 2009. Originally, the program applied to all new vehicles that met the program's requirements sold by 31 March 2010; later, it was extended to run until September 2010. The "Eco-Car" was divided into two initiatives: a replacement program, in which a consumer replaced an old car with a new one that met Japanese energy efficiency standards in effect in 2010; and a no-change purchase program, where the new car had to be at least 15% more efficient than the current energy efficiency standard, in addition to a "four-star" emissions rating, which meant emissions levels 75% below Japanese standards of 2005 (Japan Automobile Manufacturers Association, 2009). Under the replacement program, a consumer would be entitled to a subsidy of $515 to $2,577 depending on vehicle type, which excluded certain low-volume US and European-made vehicles that were not certified to safety, mileage, and emissions standards. from Japan (Japan Automobile Manufacturers Association, 2009; Canis et al., 2010).

Germany was hit by the effects of the global financial crisis in the third quarter of 2008, which led to a 2.2% contraction in GDP in the following quarter, forming a consensus between sectors of the economy and government, which culminated in the adoption of a of fiscal policy in two stages, in late 2008 and early 2009, the Umweltprämie, as it was called, had a budget of €5 billion (Bundesamt für Wirtschaft und Ausfuhrkontrolle, 2018; Heimeshoff & Müller, 2011; Böckers et al., 2012).

This was, according to Kaul et al. (2012), the largest subsidy program for the global automotive sector, following the scrappage model, implemented as a measure to mitigate the effects of the 2008 financial crisis. The German program, according to Böckers et al. (2012), in contrast to other fleet replacement subsidies, such as the American CARS scheme, and despite its official name, called Umweltprämie (environmental award), the purchase of a new car was not linked to any environmental requirement. To receive the €2,500 subsidy, buyers had to prove the scrapping of the old car and registration of a new one. Another important aspect was that the policy requirements for the new car purchased required a minimum age of nine years for the scrapped car, which led to a pool of 17 million cars eligible for the Program, or 41% of all registered cars (circulating fleet) in Germany in 2009 (Heimeshoff & Müller, 2011; Böckers et al., 2012; Kaul et al., 2012).

According to Böckers et al. (2012), with the implementation of C4C, the German automotive industry has become one of the most prominent examples of the positive effects of a scrapping program that was introduced to stabilize the industry and replace older cars with newer, more environmentally friendly ones.

Like the US, Japanese and German governments, the South Korean government implemented a temporary tax incentive program implemented between May and December 2009, promoted a reduction in the tax burden for new cars, with payment of a bonus of approximately US$2,000 per vehicle, considering the purchase of a new car and the disposal of an older car (Canis et al., 2010; Mah, 2007, 2017).

The program, according to Canis et al. (2010) had a supplement of tax breaks in July 2009 to stimulate the market for new hybrid cars, in which case it was not necessary for qualified buyers to replace the old cars. South Korea's scrap car program helped boost domestic sales for the whole of 2009 by 23% over 2008, an average of 111,000 a month, in a year when sales fell in most major countries. .

For example, car sales in the entire year of 2009 in the United States fell by more than 21%, although in the two months that CARS was in force (Canis et al., 2010; Mah, 2007, 2017). According to Canis et al. (2010) most South Korean automakers benefited from the scrapping program, especially Hyundai-Kia.

In Brazil, since 1995 with all its efforts the RAB failed to include country in the R&D infrastructure map of multinationals in the automotive sector (Arbix, 2001), and by creating differentiated rules by Brazilian regions, it gave rise to regional disputes, jeopardizing the finances of these levels of government and its ability to carry out social spending (Fligenspan & Calandro, 2002). In addition to domestic issues, the RAB was the subject of questioning within the WTO, however, the Brazilian Government managed to avoid opening a panel in the WTO Dispute Settlement Body (Veiga, 2002).

Like the RAB, Inovar-Auto also proved incapable of making the Brazilian automotive complex competitive, of raising the technological level of local products, or even of sustaining the economic relevance of the IAB (Associação Nacional dos Fabricantes de Veículos Automotores, 2021). This finding is possible when we analyze the indicators for monitoring the impacts of the program like the gross value of production at PIA-Company (Instituto Brasileiro de Geografia e Estatística, 2020) and Vehicle Production Statistics (Associação Nacional dos Fabricantes de Veículos Automotores, 2021) clearly illustrated by Figure 1.

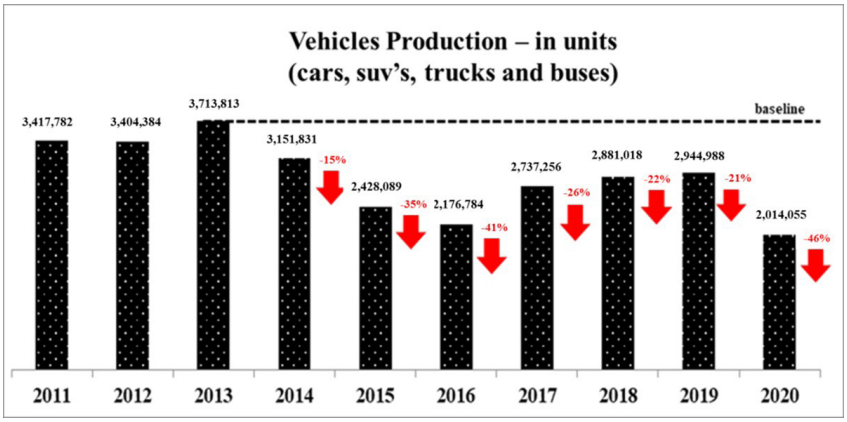

Figure 1. Vehicle production 2011-2020. Source: Adapted Associação Nacional dos Fabricantes de Veículos Automotores (2021).

Another indicator for the impacts of the program was the level of Employment, which used the average number of employed persons from the PIA-Company survey (Instituto Brasileiro de Geografia e Estatística, 2020). Figure 2 illustrates the reduction of people directly employed in the vehicle manufactures.

It is possible to notice in Figure 2 that Inovar-Auto did not affect the maintenance of jobs in the industry, which has fallen since its implementation of the program, when the number of directly employed personnel decreased from 1.5 million to 1.3 million people.

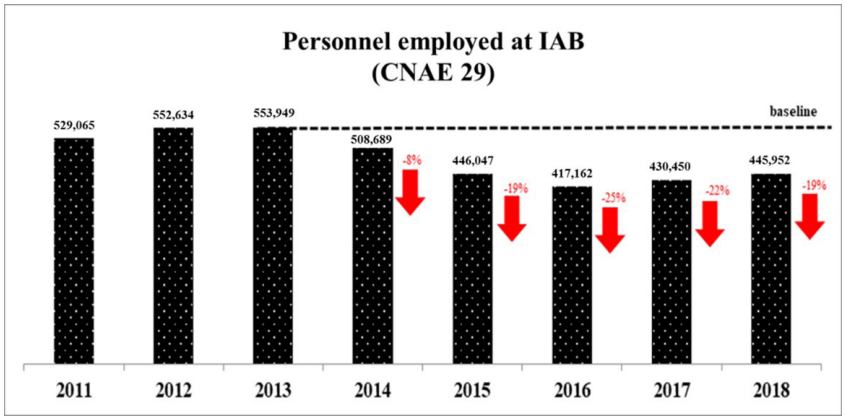

Figure 2. Personnel employed at IAB 2011-2018. Source: Adapted Instituto Brasileiro de Geografia e Estatística (2020).

Another important indicator is R&D expenses, which considers a percentage of Gross Operating Revenue, using PINTEC data for vehicle manufactures as a metric (Brasil, 2019). The Table 1 shows the comparison between R&D spontaneous expenses from PINTEC survey and the minimum compulsory application established by Inovar-Auto.

Table 1. R&D expenses PINTEC versus Inovar-Auto.

Calendar Year	PINTEC Spontaneous rate	Inovar-Auto Compulsory rate
	% of Gross Operating Revenue	
2011	2.8%	-
2012/2013	2.1%	0.15%
2014	2.1%	0.30%
2015/2016	2.1%	0.50%
2017	2.3%	0.50%

Source: Adapted Instituto Brasileiro de Geografia e Estatística (2017) and Brasil (2019).

When compares historical data from PINTEC R&D expenses and Inovar-Auto minimum compulsory application expenses, it is evident that the expense required by Inovar-Auto is only a fraction of the PINTEC historical data amounts.

According to the Global Innovation Index (World Intellectual Property Organization, 2021), patents are the main indicator of innovation in a country. In this way, the filed patents between 01/01/2000 and 12/31/2019 by automakers installed in Brazil were evaluated at the INPI repository focusing Inovar-Auto period. The total amount of 6,443 patents were deposited by automakers, thereof 3,257 of during Inovar-Auto. The patents were analyzed by three qualitative verified: ownership, unionist priority and date of the original patent.

It was verified that only 1.0% of the patent files were originated in Brazil, all the others were filed in other countries before (Figure 3), which corroborates the data from PINTEC, about Inovar-Auto haven't been able to encourage increased investments in R&D locally.

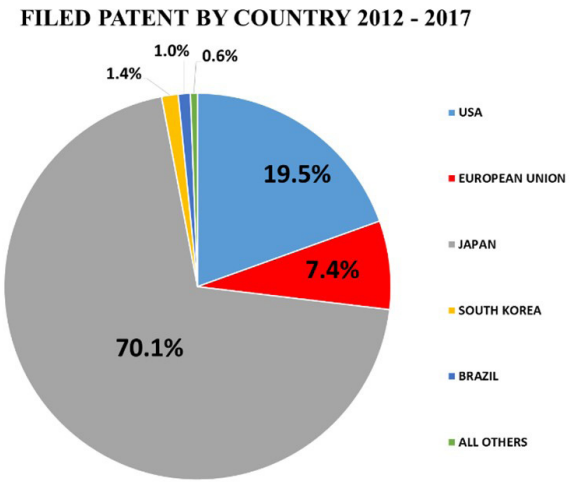

Figure 3. Patents filed with the INPI by country. Source: Instituto Nacional da Propriedade Industrial (2020).

This corroborates the Inovar-Auto inability to include Brazil in the automakers R&D map.

Finally, a Brazilian issue: more than 43% of vehicle fleet over ten years old. A significant percentage of greenhouse gas emissions originate from the burning of fossil fuels by motor vehicles over ten years old, with CO2 being considered the most important greenhouse gas (Intergovernmental Panel on Climate Change, 2007). Thus, energy efficiency/consumption reduction was another indicator used by Inovar-Auto, calculated from metrics established by Ibama and by on Denatran based on vehicles powered by gasoline and ethanol (Brasil, 2017). However, according to Wallerius (2016), diesel-powered vehicles represent approximately 53% of the total CO2 emissions of the national fleet, even representing only 10% of the circulating fleet (Departamento Nacional de Trânsito, 2021), while Inovar-Auto has considered in its basic conditions only the energy efficiency and consumption reduction of Otto cycle vehicles (gasoline/ethanol), which obtained an improvement of 15.46% (Brasil, 2019), the diesel vehicles weren't even considered on the program.

Penna et al. (2013) highlight that vehicles over ten years old represent 80% of vehicles air pollutants emission, and vehicles over twenty years old represents 49% of these emissions. If there was a total renewal of the Brazilian fleet over ten years old, there would be a 69% reduction in the emission of polluting gases into the atmosphere

(Penna et al., 2013; Wallerius, 2016). In this direction, it is important to highlight that vehicles over ten years old represent approximately 43% of the circulating fleet, that is, about 32.9 million vehicles with more than ten years of manufacture (Sindicato Nacional da Indústria de Componentes para Veículos Automotores, 2019; Departamento Nacional de Trânsito, 2021).

Thus, the Brazilian issue: more than 43% of vehicle fleet over ten years old could turn the Brazilian opportunity to support a long-term policy based on old car replacement.

3. Research method

This research adopted an adaptation of the hypothetical-deductive method, which emerges from the identification of a problem, the subsequent formulation of hypotheses, and finally the deductive inference process, where the prediction of the occurrence of phenomena covered by the aforementioned hypothesis is tested (Gerhardt & Silveira, 2009; Diniz & Silva, 2008; Gil, 2008; Popper, 1962). The adaptation adopted here consisted of replacing the hypotheses with propositions as a convergence to the use of the Delphi method which, as in the original method, was tested and validated using statistical methods.

Regarding nature, the research must be classified as applied, as it aims to generate knowledge aimed at practical applications aimed at solving specific problems, in this case, the creation of means for the IAB to grow in a sustainable way. and competitive. As for its objective, the research will be exploratory in nature, as it aims to provide greater familiarity with the problem, thus making it explicit and/or building hypotheses. Thus, understanding the characteristics of the interrelationships of public policies applied to the IAB and thus establishing the relationships between variables of a policy proposal and its effects on the Brazilian economic fabric (Prodanov & Freitas, 2013; Gerhardt & Silveira, 2009; Moresi, 2003; Gil, 2002).

About proceedings, Documentary research and surveys were used, as it provides direct knowledge of reality, economy and speed, and from the grouping of collected data, the possibility of statistical analysis is created. Regarding techniques, the execution uses as a technique the Delphi method by electronic means, combining quantitative and qualitative approaches, in a mixed way (Safadi, 2001; Hsu & Sandford, 2007; Creswell, 2009; Salgado, 2011; Flostrand, 2017; Santos et al., 2017).

3.1. Delphi application

According to Dalkey (1969), the Delphi technique is a method of extracting and refining group judgment literally based on the popular saying “two heads are better than one”, especially when there is no knowledge formed to solve a problem. The author defines three characteristics for the method’s procedures: (1) anonymous responses - expert opinion must be collected through formal and individual questionnaires (2) Interaction and controlled feedback - the process must be carried out in a systematic and repetitive way with controlled feedbacks between rounds (3) Statistical response – group opinions are considered appropriate when they converge with individual opinions at the end of rounds.

This process, according to Dalkey (1969), was designed to minimize the effects of polarization caused by individuals with an individual dominance profile, irrelevant communication and pressures on the group towards conformity of responses. According to the theoretical framework consulted (Dalkey & Helmer, 1962; Brown et al., 1969; Dalkey, 1969; Dalkey et al., 1970; Grisham, 2009; Kayo & Securato, 1997; Linstone & Turoff, 2002; Serra et al., 2009; Silva & Tanaka, 1999; Yousuf, 2007), implementation of the Delphi method takes place in several stages, as seen in Figure 4.

Regarding the temporal delimitation, the research was carried out between August 2016 and January 2022. In its documental survey phase, the temporal cut referring to three distinct periods was analyzed: from the RAB (1995-1999), Inovar-Auto (2013-2017) and Route 2030 (2019-2021).

The questionnaires were applied between the Q1/2019 and Q1/2022. Regarding the geographic delimitation, the research presented an initial exploratory phase in the Automotivo Sul-Fluminense hub and in a second moment it had a national character.

As for the institutions, assemblers/manufacturers of vehicles and machines, auto parts, banks, insurance companies, research institutions and universities, systemists, rental companies, consultancies, service providers, commodity suppliers and government participated. As for the respondents, 64,8% with more than 15 years of professional experience from the areas of operations, purchasing, finance, engineering, sales, quality, strategy, among others participated. The present work was developed in five phases as presented by Table 2.

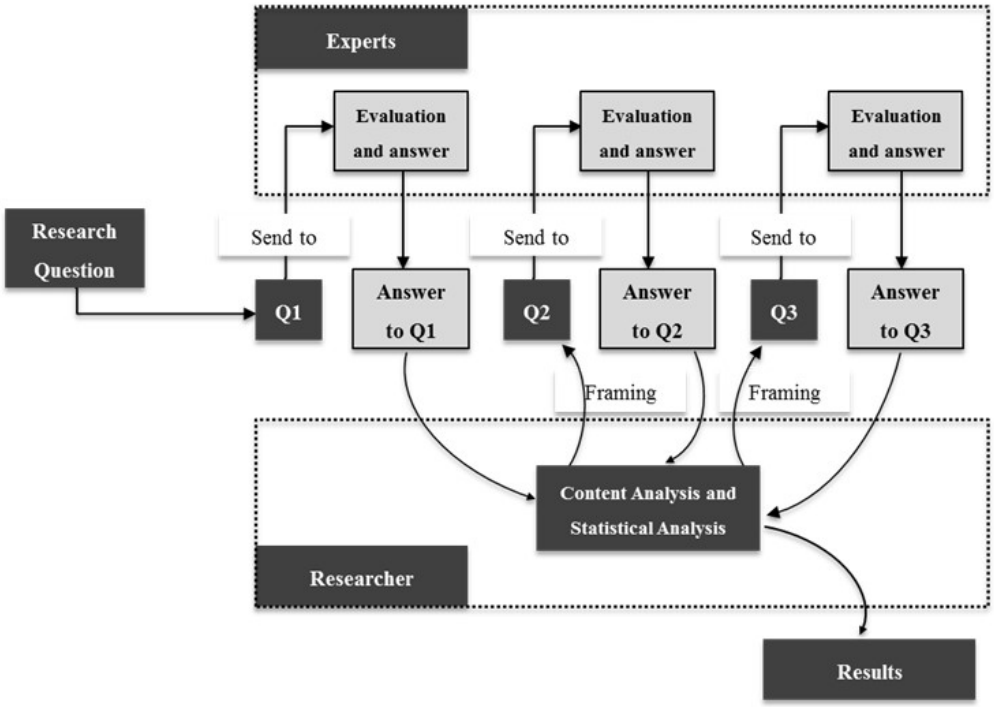

Figure 4. Delphi application schema. Source: Prepared by authors (2020).

Table 2. Research phases.

RESEARCH PHASES	
Phase	Description
1.	Documentary survey: Automotive policies related in Brazil and worldwide
2.	Based on Phase 1, a questionnaire was prepared containing 1 closed and 3 open questions, applied to 30 high-level executives from 5 automotive companies from the Sul-Fluminense Automotive Hub, supported by Federation of Industries of the State of Rio de Janeiro (Q4/2018).
3.	Based on Phase 2, a new questionnaire was created, with 14 closed questions and applied to the same audience plus National Association of Automotive Vehicle Manufacturers (Q1/2019).
4.	Based on Phase 3, a set of 7 propositions was elaborated that would guide actions aimed at building a sectoral policy. From these propositions, a new questionnaire composed of 32 closed questions was derived and applied to 550 professionals linked to the automotive ecosystem (C-Level/Senior executives from automakers, autoparts, consultants, researchers, service providers etc), from 96 companies in Brazilian territory (Sep-Oct/2021).
5.	Based on Phase 4, the 7 propositions was revised to 6 and its expected results. This new set of propositions gave rise to a fourth questionnaire composed by 6 closed questions and submitted to the same population of 550 professionals (Dec/2021-Jan/2022).

Source: Prepared by the authors.

To mitigate the induction of erroneous answers to the questionnaires, clarity and precision in the concepts addressed in the statements of each statement were fundamental. Thus, to fulfill the purposes of this research, each proposition was conceptualized and contextualized so that its veracity or falsity can be accepted by the respondents in terms of total disagreement, partial or null disagreement, partial or total agreement.

It is emphasized that the questionnaire validation test was carried out by four researchers with extensive experience in scientific research methodologies. Thus, after each proposition, the assessment of the degrees of consensus or dissent by industry experts was performed using a traditional 5-item Likert scale (Dalmoro & Vieira, 2014).

The questionnaires were made available to the experts by e-mail and Google Forms, the answers were inserted in the same document, and later tabulated and structured in an electronic spreadsheet. The evaluation of the answers was carried out by applying the statistical calculations of the Average (1), the Median (2), the Variace (3), the Sample standard deviation (4), the Concordance Validation Index (5), the Coefficient of Variation (6) and the Interquartile Range (7), whose formulas are presented in Table 3, that also presents the expected values for the CVI-h, CV and IR indicators, when applied to consensus and dissent of measurements, according to

Table 3. Statistical calculations parameters applied to data processing.

Parameter	What measures or determines	Formula
1. Average	The ratio of the sum of all elements in a data set.	$\overline{x} = \frac{1}{n}\sum_{i-1}^{n} x_i$
2. Median	The value that occupies the central position of the series of observations of a variable, in a roll, dividing the set in two equal parts.	$Med = \frac{x_{n+1}}{2}$
3. Variance	Shows the variation around the measure	$S^2 = \frac{\sum\left(x - \overline{x}\right)}{n-1}$
4. Sample standard deviation	Shows the distance of each value in the data set in relation to the central mean value. The smaller, the closer the value is to the average.	$S = \sqrt{\sum_{i=1}^{N} \frac{\left(x_1 + \overline{x}\right)^2}{n-1}}$
5. Concordance Validation Index	The degree of consensus measured about a proposition using n-point adapted Likert scale. Notes: (g = grades assigned) (r = maximum possible score). Expected value range according to the consulted literature ≥ 0,7	$CVI(h) = \frac{\sum g}{\sum r}$
6. Coefficient of Variation	The variation between data set measures on scales. Measures the variation relative to the average. Expected value range according to the consulted literature ≤ 30%	$CV = \frac{S}{\overline{x}} \times 100$
7. Interquartile Range	The degree of a spread of data around the centrality measure. A measure of data dispersion around the population average. Expected value range according to the consulted literature ≤ 40%	$R = \frac{\left(Q_3 - Q_1\right)}{Q_1}$

Source: Prepared by the authors.

some authors (Wynd et al., 2003; Okoli & Pawlowski, 2004; Alexandre & Coluci, 2011; Miguel, 2012; Dalmoro & Vieira, 2014; Beatty, 2018).

Regarding data treatment, it is important to highlight that statistical calculations are a tool for analysis and decision-making support, not constituting the decision itself (Beatty, 2018). Quantitative research data were processed using the free version of the IBM SPSS software. It should be noted that the Delphi method uses techniques that allow the analysis of qualitative and quantitative data, allowing to know the opinions of experts on complex issues. However, opinions may prove to be congruent or divergent, as they reflect the individual opinions and experience of the experts.

3.2. Procedures for obtaining and data analysis

To carry out the research, a group was created with 30 executives from the automotive industry working at the Polo Automotivo Sul Fluminense (Rio de Janeiro) with the initial objective of collecting data on the perception of automakers in the region about the effectiveness of Inovar-Auto, its benefits, counterparts, investments, technological evolution and its consequences. Subsequently, the National Association of Motor Vehicle Manufacturers - ANFAVEA was included, finally, data collection was expanded to 96 companies in the Brazilian automotive ecosystem (assemblers, auto parts, systemists, consultancies, banks, universities, commodity suppliers and service providers specialized). Thus, a set of data collection and analysis tools was used to meet the specific objectives of the research as presented in Table 4.

To carry out the study at the local level, a first round of Delphi was applied to a group of 30 executives from the areas of Finance, Engineering, Manufacturing, Quality and Purchasing from 6 of the companies that make up the Sul Fluminense Automotive Cluster, namely 2 automakers of commercial vehicles, 3 car manufacturers and a machine manufacturer, in addition to ANFAVEA, through a questionnaire with 14 closed questions using a 5-position Likert scale.

The result and subsequent feedback from this first round were transformed into a new questionnaire, this one containing 32 closed-ended questions applied to 550 executives from across the IAB ecosystem. The answers and feedbacks of this second questionnaire were transformed into a set of 6 propositions for the creation of a sectorial policy and its respective expected results.

This new set of propositions gave rise to a fourth questionnaire composed of 6 closed questions and submitted to a third round of Delphi, this one with the objective of validating the propositions. The option of applying the calculations of the Concordance Validation Index, Coefficient of Variation and Interquartile Range, already described in Table 3, was adopted to identify the levels of consensus or disagreement among experts, providing greater rigor and reliability in the use of the method and the Likert Scale as instrument.

Table 4. Procedures and tools for data collection and analysis.

RESEARCH PROCEDURES AND TOOLS			
Specific Goals	Acquisition Tools	Analysis Tools	Analysis Technique
Identify sectoral policies for the automotive industry.	Bibliographic/documentary research	Document analysis	Systematic Literature Review
Sul Fluminense IAB Executives Inovar-Auto perceptions.	Survey		Content analysis Method
Confirm Sul Fluminense IAB Executives Inovar-Auto perceptions	Delphi Survey Round	Parametric/non-parametric statistics SPSS software	Delphi Method
Create proposal to support a sectoral policy for automotive industry.			
Validate proposed action to support a sectoral policy for automotive industry.			

Source: Prepared by authors.

The degree of consensus on a proposition using a traditional 5-point Likert Scale was verified using the Agreement Validation Index. The Coefficient of Variation was used to verify the mean and relative variability between the data sets and, finally, the degree of data dispersion around the centrality measure were identified when applying the interquartile range calculations.

4. Propositions, validations and research results

In this chapter, the research steps that supported the use of the Delphi method and the main results will be presented. Through a first questionnaire, presented in Table 5

Subsequently, the respondents were asked to, according to their perception, register on the Likert Scale presented in Table 5, the degree of agreement regarding statements related to public policies in the automotive sector. The data collected in the questionnaire were statistically analyzed using the Agreement Validation Index, the Coefficient of Variation and the Interquartile Range, as shown in Table 6.

Table 5. Perception of the local automotive industrial environment on public policies.

PERCEPTION OF THE LOCAL AUTOMOTIVE INDUSTRIAL ENVIRONMENT ON INOVAR-AUTO
Likert Scale Concordance Grade
Strongly Agree 5 — 4 — **Neutral** 3 — 2 — **Strongly Disagree** 1
1. The current business model of the Automobile Industry, based on the production and sale of vehicles, is still adequate to the current behavior and will be so for the next decade.
2. The creation of upper limits for the age of the circulating fleet would stimulate the demand for new vehicles.
3. Changing the IPVA collection to a model based on increasing values indexed to the age of the vehicle and emissions (older and more polluting vehicles pay more) would encourage a reduction in the age of the fleet
4. The unification of federal taxes on the sale of vehicles and parts (PIS/COFINS and IPI) into a single tax with a single rate and on the added value would bring benefits to the production chain.
5. The Brazilian Automotive Industry (IAB) supply chain is internationally competitive.
6. The creation and maintenance of R&D incentives contributes to the development of the IAB
7. The availability of credit for the purchase of new vehicles is a more important sales constraint than the price of the vehicle itself.
8. At least 70% of Tier1 suppliers are located within 200km of the Automaker.
9. Only through legal requirements would the quality level and the technological level be equivalent to those practiced in developed markets (USA, EU and Japan).
10. Macroeconomic factors such as interest rates and exchange rate have a great influence on price formulation
11. Alignment with European and North American safety and emissions standards would bring positive scale effects and create export opportunities for developed markets
12. The high automation rate of the automakers' production process is a reality and contributes to productivity at internationally competitive levels
13. The automation rate of supplier operations is high and offers a satisfactory scale effect
14. The level of quality and technology of national products follow European, North American and Japanese standards

Source: Prepared by the authors.

The Table 6 presents the initial perception of the Sul Fluminense automotive hub executives on the IAB competitiveness factors, these results showed a strong agreement with the propositions of the questionnaire,

Table 6. Compilation of the Sul Fluminense Automotive hub diagnosis results.

COMPILATION OF RESEARCH RESULTS BY THE DELPHI METHOD																
SPECIALISTS		Sul Fluminense Automotive hub Automakers Executives perception regarding Inovar-Auto Policy														
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
GRADES ASSIGNED	Car Automaker 1	1	4	5	5	4	2	5	4	2	1	4	4	5	1	4
		2	5	4	5	4	3	4	5	2	1	5	5	4	1	5
		3	5	5	4	5	2	5	5	2	1	5	5	4	1	5
		4	5	5	4	5	2	4	5	2	2	5	5	4	1	5
	Car Automaker 2	5	4	4	4	4	1	4	5	2	2	4	5	4	1	5
		6	4	5	4	5	2	4	5	2	1	5	5	4	1	5
		7	4	4	5	5	1	5	4	2	2	4	5	4	1	5
		8	4	4	4	4	2	4	5	1	1	5	5	4	2	4
		9	4	5	5	4	1	4	4	1	1	4	5	4	2	5
	Car Automaker 3	10	5	5	5	5	1	5	4	1	1	4	5	4	1	5
		11	5	5	4	5	2	5	5	1	1	4	5	5	2	5
		12	5	5	4	4	2	4	4	2	1	4	5	5	2	5
		13	4	5	5	4	2	4	5	2	1	4	5	5	2	5
		14	5	4	5	4	2	4	4	2	2	4	5	4	1	5
	Commercial Vehicle Automaker 1	15	5	4	5	5	2	4	5	2	2	5	5	4	1	5
		16	5	4	5	4	2	5	5	1	1	5	5	4	1	5
		17	5	5	5	5	2	5	5	1	1	5	5	5	1	5
		18	5	5	4	5	2	5	4	1	1	5	5	5	1	5
		19	4	5	5	4	1	4	4	1	1	4	5	4	1	5
		20	4	5	4	5	1	4	4	2	1	5	4	4	1	5
	Commercial Vehicle Automaker 2	21	4	4	5	5	2	4	4	1	1	4	5	4	1	5
		22	4	5	5	4	2	4	5	1	1	4	5	4	1	4
		23	4	5	5	5	2	5	5	2	1	5	5	4	2	5
		24	5	4	4	5	2	4	5	1	2	5	5	5	2	4
		25	4	5	4	4	1	4	5	1	1	4	5	4	1	5
	Heavy Machine Automaker	26	4	5	4	5	1	4	5	1	2	4	5	5	2	4
		27	4	5	4	4	1	4	4	1	2	4	4	5	2	4
		28	5	5	4	5	1	5	4	1	2	4	4	5	2	4
		29	4	4	4	5	1	5	5	1	2	4	4	5	1	4
		30	4	5	5	5	1	5	4	1	1	4	4	5	1	5
STATISTICAL DATA PROCESSING		CVI	0.88	0.93	0.9	0.91	0.32	0.88	0.91	0.28	0.26	0.88	0.96	0.88	0.26	0.94
		Var	0.25	0.23	0.26	0.25	0.31	0.25	0.25	0.25	0.23	0.25	0.16	0.25	0.23	0.20
		Mdn	4	5	4.5	5	2	4	5	1	1	4	5	4	1	5
		SD	0.50	0.48	0.51	0.50	0.56	0.49	0.50	0.50	0.48	0.49	0.41	0.49	0.48	0.45
		CV	0.11	0.10	0.11	0.11	0.34	0.11	0.11	0.35	0.36	0.11	0.08	0.11	0.36	0.09
		Q1	4,0	4,0	4.25	4.25	1.75	4.25	4.75	1.25	1.25	4.75	5,0	4,0	1.75	4.25
		Q3	4.25	4.75	4.75	5	2	4.75	5	1.75	1.25	5	5	4.25	2	4.75
		IR	0.063	0.19	0.12	0.18	0.14	0.12	0.05	0.4	0	0.05	0	0.06	0.14	0.12

Source: Prepared by the authors.

which can be evaluated by the Agreement Validation Index greater than 0.9 in more than 70% of the questions. The Coefficient of Variation was below 10% in 70% of the results, and for the Interquartile Range, 93% of the results were below 20%. Very satisfactory results based on the research literature (Wynd et al., 2003; Okoli & Pawlowski, 2004; Alexandre & Coluci, 2011; Miguel, 2012; Dalmoro & Vieira, 2014; Beatty, 2018).

After sample compilation of the Sul Fluminense Automotive hub diagnosis results, the evaluation of the answers was carried out by applying the statistical calculations, shown graphically in Figure 5 (Concordance Validation Index), in Figure 6 (Coefficient of Variation) and in the Figure 7 (Interquartile Range).

After the conclusion of the first phase, with the feedback provided to the 30 executives from the southern Rio de Janeiro automotive hub and ANFAVEA, an assessment of sectoral policies already implemented in countries such as China, the United States, Japan, Germany and South Korea. From this combination, a set of seven propositions was elaborated as a way of guiding the development of actions to promote an industrial policy aimed at the IAB.

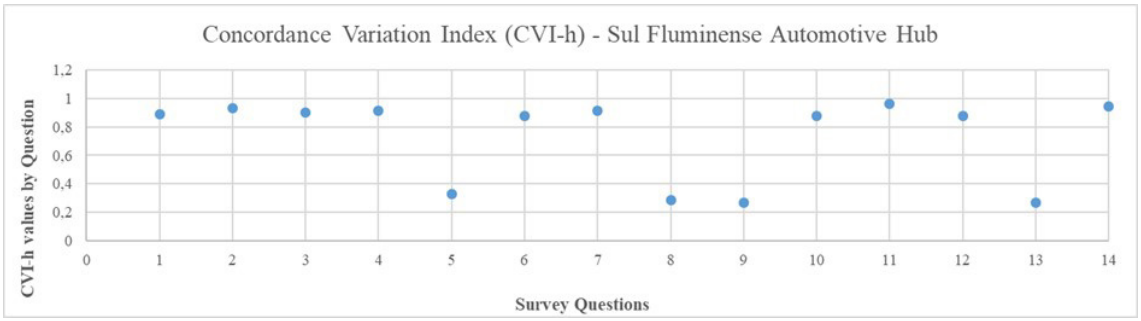

Figure 5. Compilation of results for the CVI-h Index among Sul Fluminense Automotive Hub companies. Source: Prepared by the authors.

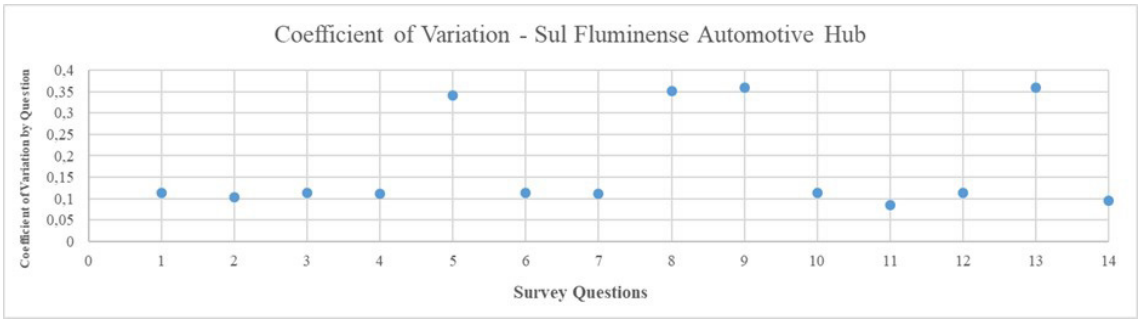

Figure 6. Compilation of results for the coefficient of variation among Sul Fluminense Automotive Hub companies. Source: Prepared by the authors.

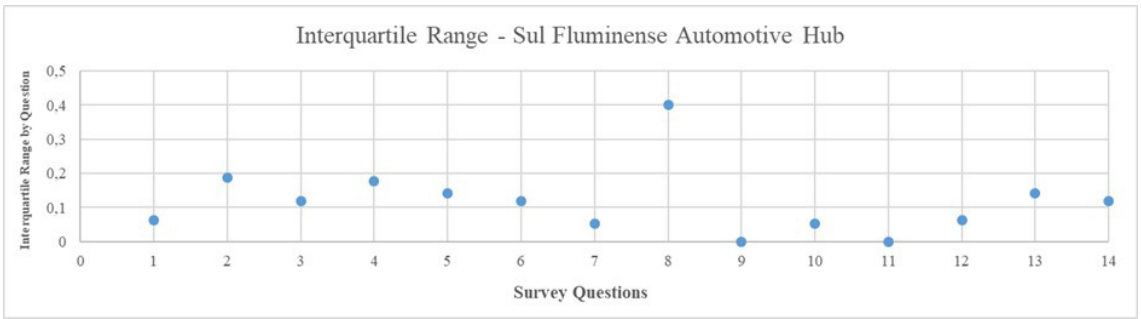

Figure 7. Compilation of results for the interquartile range among Sul Fluminense Automotive Hub companies. Source: Prepared by the authors.

Proposition 1 - Create a vehicles scrappage program in order to replace the fleet older than 10 years by more safe, economic and ecofriendly vehicles;

Proposition 2 - Align the Brazilian vehicular emissions standards (CONAMA PROCONVE) with the related European and North American requirement levels;

Proposition 3 - Align CONTRAN rules with European and North American vehicle safety standards;

Proposition 4 - Change the tax over vehicle property "IPVA" model in order to implement a progressive taxation according to age and emission level;

Proposition 5 - Optimize the direct taxation on the sale of motor vehicles (PIS, COFINS, IPI and ICMS);

Proposition 6 - Create mechanisms in order to improve national auto parts chain competitiveness and its modernization;

Proposition 7 - Implement a strategic Automotive R,D&I program as a mechanism for create local shared infrastructure and encouraging the creation of new local companies in the automotive sector.

Based on these propositions, a new questionnaire was created containing 32 questions. This questionnaire was made available preliminary to 20 respondents (researchers, executives and consultants) through Google Forms as a test. After feedback and small adjustments were made, the questionnaire (Table 7) was distributed through an electronic link using messaging applications, e-mail and professional social networks.

Table 7. Key factors for creating a sustainable industrial policy.

KEY FACTORS TO CREATE A SUSTAINED INDUSTRIAL POLICY
Likert Scale Concordance Grade
Strongly Agree 5 — 4 — **Neutral** 3 — 2 — **Strongly Disagree** 1
Environment: In this section, statements will be made about environmental impacts related to the age of the motor vehicle fleet, technological aspects and their impacts, energy efficiency and regulatory aspects.
1. The insertion of more efficient and less polluting vehicle models (cars, light commercial vehicles, trucks and buses) in the Brazilian market will only occur through the regulatory obligation through the adoption of strict standards of emissions and consumption.
2. The creation of maximum limits for the age of the current fleet would stimulate the demand for new vehicles.
3. The adoption, by Brazil, of emission and consumption standards following the same criteria/parameters adopted by the USA, European Union and Japan would be a facilitator for Brazilian exports.
4. The insertion of more efficient and less polluting vehicle models (cars, light commercial vehicles, trucks and buses) in the Brazilian market without the respective removal of more polluting vehicles does not actually bring environmental gains.
KEY FACTORS TO CREATE A SUSTAINED INDUSTRIAL POLICY
Likert Scale Concordance Grade
Strongly Agree 5 — 4 — **Neutral** 3 — 2 — **Strongly Disagree** 1
Vehicle Safety: In this section, statements will be made about the impacts of replacing the fleet of motor vehicles on vehicle safety.
1. The insertion of safer vehicle models (cars, light commercial vehicles, trucks and buses) with technologies such as stability control (ESC), advanced driver assistance systems (ADAS) and other vehicle safety assistive technologies, will only occur through regulatory obligation through the adoption of strict safety standards
2. The adoption by Brazil of vehicle safety standards following the same criteria/parameters adopted by the USA, European Union and Japan would be a facilitator for Brazilian exports.
3. The insertion of safer vehicle models (cars, light commercial vehicles, trucks and buses) in the Brazilian market without the respective removal of less safe vehicles does not actually increase road safety.
4. The adoption by Brazil of vehicular safety standards following the same criteria/parameters adopted by the USA, European Union and Japan would bring gains of scale and consequent reduction in the costs of vehicular systems.
Tax: In this section, statements will be made about the tax and fiscal impacts related to the replacement of the fleet of motor vehicles and related topics (technological level and regulation).
1. Considering that the major suppliers of auto parts and systemists installed in Brazil are multinationals with global supply, that the production processes implemented by them in Brazil have the same technological level as those applied in other major markets, the elimination of the import tax on auto parts would bring greater competitiveness for the automotive sector..
2. The reduction in the rates of direct taxes on the sale of vehicles would have the net effect of reducing the prices effectively practiced by the automakers in the market and, as a consequence, more sales.
3. Changing the IPVA collection to a model based on increasing values indexed to the age of the vehicle and emissions (older and more polluting vehicles pay more) would stimulate the reduction of the age of the fleet.
4. The unification of federal taxes on the sale of vehicles and parts (PIS/COFINS and IPI) into a single tax with a single rate and on the added value would bring benefits to the production chain.
Credit: In this section, statements will be made about the impact of credit on the sale of vehicles and as a tool to stimulate the automotive sector.
1. The credit for the purchase of new commercial vehicles, especially trucks, is a sales limiter equally applicable to fleet owners and autonomous truck drivers.
2. New business models, such as car servitization (car as a service) are a viable alternative to the scarcity of credit for the purchase of new cars.
3. The use of subsidized credit programs, along the same lines as programs for housing, would be an alternative for stimulating and reducing the cost of financing the acquisition of new vehicles.
4. The simple generalized offer of subsidized credit is not a viable instrument in the long term.
Exchange: In this section, statements will be made about the impacts of the exchange rate on the automotive sector.
1. The devaluation of the Real against the US Dollar and the EURO created an opportunity for the export of automotive goods and services, making Brazil more competitive in the global automotive sector.
2. The depreciated Real boosted foreign investment in the Brazilian automotive sector, as it became cheaper to develop and manufacture in Brazil.
3. The depreciated Real puts pressure on the value of commodities, especially metallic commodities, which brings great volatility to the Brazilian automotive market.
4. The devaluation of the Real against the US Dollar and the EURO created a natural barrier to imports, which strengthens the local ecosystem of the automotive sector.

Source: Prepared by the authors.

Table 7. Continued...

KEY FACTORS TO CREATE A SUSTAINED INDUSTRIAL POLICY
KEY FACTORS TO CREATE A SUSTAINED INDUSTRIAL POLICY
Likert Scale Concordance Grade
Strongly Agree 5 — 4 — Neutral 3 — 2 — Strongly Disagree 1
Supply Chain: In this section, statements will be made about the impacts of replacing the fleet of motor vehicles in the supply chain of the automotive sector.
1. Considering that the major suppliers of auto parts and systemists installed in Brazil are multinationals with global supply, it can be assumed that the production processes implemented by them in Brazil have the same technological level as those applied in other major markets, which makes our supply chain Highly competitive local supplies.
2. The creation of maximum limits for the age of the current fleet would stimulate the demand for new vehicles and consequently the demand for parts and components.
3. The lack of predictability of production/sales volumes directly affects supply chain costs.
4. The technological level of local suppliers constitutes an important gap in the supply chain of the Brazilian automotive sector.
Industrial Processes: In this section, statements will be made about the technological impacts on industrial processes in the automotive sector.
1. The industrial processes of companies installed in Brazil (assemblers, manufacturers and auto parts) are highly technological and competitive.
2. The Brazilian automotive industry makes extensive use of tools and elements of the so-called "Industry 4.0" as a way to gain productivity in its manufacturing processes.
3. The industrial processes of multinational companies installed in Brazil (assemblers, manufacturers and auto parts) are at the same technological level as the main global markets.
4. The mandatory local execution of a minimum number of manufacturing activities for auto parts suppliers would strengthen the local ecosystem with the creation of critical mass, which would make the supply chain more competitive.
Research, Development and Innovation (RD&I) Ecosystem: In this section, statements about the R, D&I ecosystem of the automotive sector will be made.
1. The automakers, auto parts manufacturers and systemists installed in Brazil have a robust research, development and innovation infrastructure locally, capable of locally developing, testing and validating state-of-the-art technologies.
2. In Brazil, there is a culture of bringing the productive ecosystem closer to universities and research centers
3. The creation of R, D&I infrastructure shared between universities, research centers and industry would enhance the technological densification of the automotive industry and create new opportunities for the sector.
4. The creation of a program and a specific fund for the automotive sector, with a focus on nascent companies, would be an alternative for the development of a genuinely Brazilian automotive industry.

Source: Prepared by the authors.

After sample compilation of the key factors for creating a sustainable industrial policy results in IAB ecosystem, the evaluation of the answers was carried out by applying the statistical calculations, shown graphically in Figure 8 (Concordance Validation Index), in Figure 9 (Coefficient of Variation) and in the Figure 10 (Interquartile Range).

Based on the results of the 2nd Delphi round, which involved 472 IAB experts (executives, consultants, researchers, etc.) between october and december 2021, the initial propositions were revised to 6, their details and respective expected results, as shown in Table 8 were submitted to the same population of 472 individuals for validation in a third and final round of Delphi.

Based on the results of the 2nd Delphi round, a validation in a third and final round of Delphi were applied. After sample compilation, the evaluation of the answers was carried out by applying the statistical calculations,

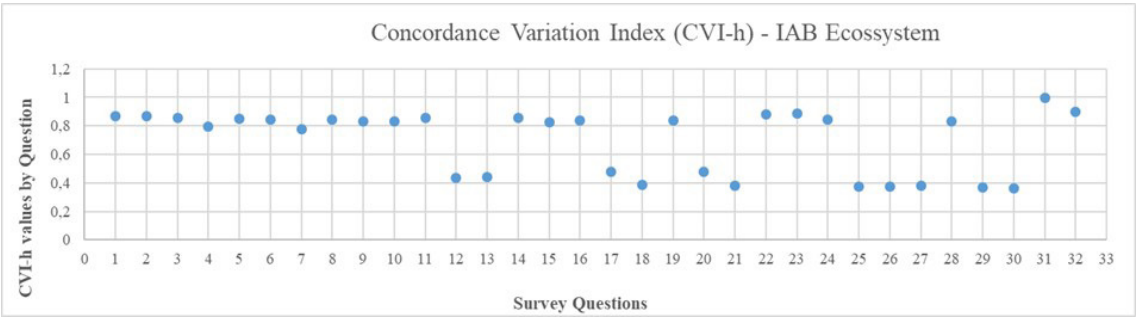

Figure 8. 2nd Delphi round sample CVI-h. Source: Prepared by the authors.

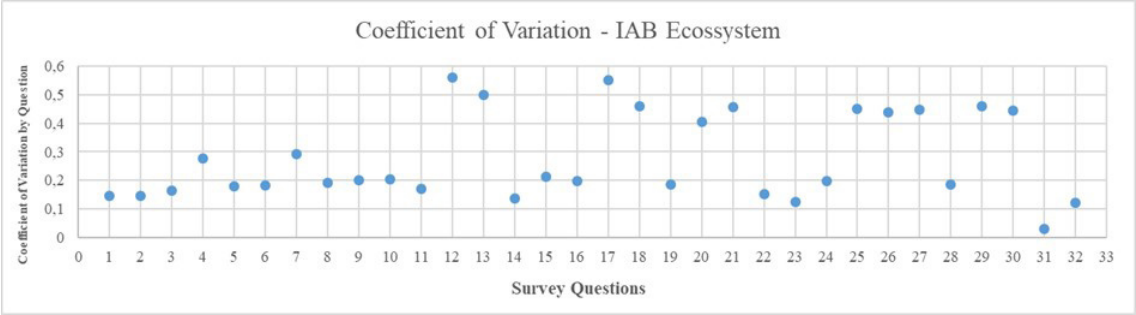

Figure 9. 2nd Delphi round sample CV. Source: Prepared by the authors.

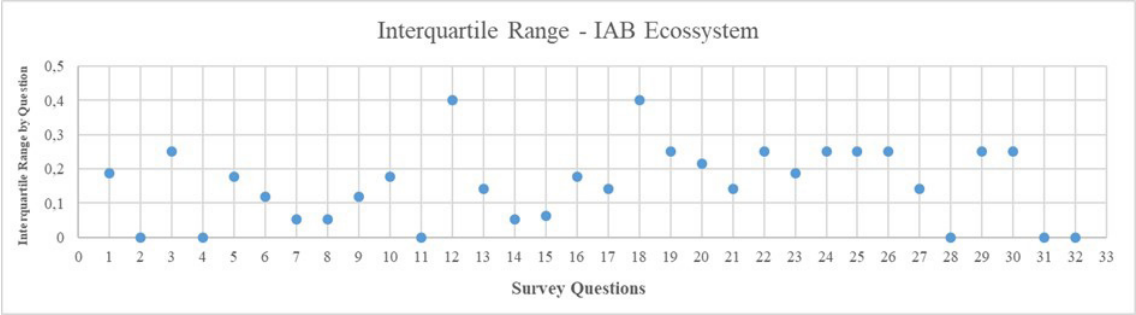

Figure 10. 2nd Delphi round sample IR. Source: Prepared by the authors.

Table 8. Propositions validation.

PROPOSITIONS VALIDATION		
Proposition	**Step**	**Expected Result**
Likert Scale Grade		
Strongly Agree 5	← 4	**Neutral** 3 → 2	**Strongly Disagree** 1
1.Creation of a scrapping and replacement program for the fleet of motor vehicles divided into three stages.	1.Full scrapping of the fleet over 15 years old. This stage would last up to three years; 2.Full scrapping of the fleet over 12 years old. This stage would last up to two years; 3.Full scrapping of the fleet over 10 years old. This stage would last up to three years	1.Withdraw approximately 35 million motor vehicles over 10 years of age from circulation; 2.Reduce, according to the estimates by Penna et al. (2013), vehicle pollutant emissions by 70%; 3.Create a demand for replacement of the scrapped fleet with a replacement rate for trucks of up to 70% and an overall average of 30% (combining commercial vehicles and automobiles); 4.With the creation of demand, reduce the idle capacity of the industry and improve the predictability of production volumes; 5.Stabilization of the production chain saw; 6.Enable new productive investments through demand creation; 7.Increase in the recycling value chain.
2.Creation of financing instruments for fleet replacement	1.Granting of scrap bonuses with an amount equal to 80% of direct federal taxes for the purchase of new internal combustion vehicles; 2.Granting of scrap bonuses with an amount equal to 100% of direct federal taxes for the purchase of new electric and hybrid vehicles; 3.Creation of a line of credit along the same lines as housing financing programs, but with different terms and conditions for the acquisition of trucks and automobiles. The term should be limited to 48 months for internal combustion automobiles and 120 months for internal combustion trucks; 4.Special credit line for the purchase of electric and hybrid vehicles; 5.Minimum term of 10 years.	1.Creation of credit conditions that make it possible to replace the fleet and adopt new propulsion technologies; 2.Offer better credit conditions for self-employed truck drivers; 3.Incremental volume of new vehicle sales; 4.Incremental volume in the collection of direct federal and state taxes.

Source: Prepared by the authors.

Table 8. Continued...

PROPOSITIONS VALIDATION		
Proposition	Step	Expected Result
3.Adoption of technical standards (emissions, vehicle safety, energy efficiency and the like) in line with US and European standards. The adoption of these rules must be mandatory from the institution of the scrapping and replacement of the fleet program.		Elimination of regulatory barriers and development of new markets for vehicles produced in Brazil.
Likert Scale Grade		
Strongly Agree 5	 4	**Neutral** 3  2 **Strongly Disagree** 1
4.Review of Federal and Regional Taxes	1.Unification and optimization of PIS/CONFINS and IPI with different rates between internal combustion automobiles regardless of power (which would include cars, trucks and SUVs), electric and hybrid cars regardless of power (which would include cars, trucks and SUVs), light commercial vehicles (which would include SUVs and trucks up to 7 tons total gross weight), trucks (over 7 tons total gross weight), buses (all categories) and electric and hybrid commercial vehicles regardless of power and total gross weight;	1.Reduction of the final value of the acquisition of new vehicles;;
	2.Adoption of a maximum unified federal tax rate of 15%;	2.Stimulate the acquisition of electric and hybrid vehicles
	3.Creation of a contribution to the promotion of the local research, development and innovation ecosystem in the automotive sector with a 2% rate on vehicle sales;	3.Compensate for the reduction in direct tax rates per unit sold (PIS/COFINS, IPI and ICMS) through incremental sales volumes of new vehicles;
	4.Adoption of a final maximum ICMS rate of 15%;	4.With the change in the IPVA, it is expected to encourage the reduction of the age of the circulating fleet in the long term and also to correct a discrepancy that exists today, charge more for new vehicles and encourage the ownership of old vehicles;
	5.Adoption of IPVA based on the calculation of emissions/km traveled+age coefficient+fixed rate per power, where age coefficient is increasing;	5.Increase the competitiveness of the supply chain; saw. Create a source of funds to finance the local automotive research, development and innovation ecosystem.
	6.Extinction of the ex-tariff and the regime for parts not produced locally;	
	7.Adopt an import tax rate of 5% for auto parts aimed at industrialization and 15% for auto parts aimed at commercialization;	
	8.Create a contribution to the promotion of the local research, development and innovation ecosystem in the automotive sector with a 5% rate on auto parts imports.	
5.Creation of a supplier modernization program	1.Reduce and/or eliminate taxation on equipment and technologies applied to industrial processes (including robots, iot, connectivity and digitalization, analytics, etc);	1.Modernization of the supplier pool with world-class technologies;
	2.Intensify cooperation between SENAI, SEBRAE, EMBRAPII and SINDIPEÇAS through a specific line of credit for modernizing the automotive production chain with a focus on small and medium-sized national companies;	2.Increase in the capacity, quality, productivity and competitiveness of national suppliers;
	3.Create a working capital line with a contract with automakers.	3.Insertion of the national industrial park in the global supply chain.
Likert Scale Grade		

Source: Prepared by the authors.

Table 8. Continued...

PROPOSITIONS VALIDATION		
Proposition	Step	Expected Result
Strongly Agree 5 ← 4	Neutral 3	→ 2 Strongly Disagree 1
6.Strengthening of the national Research, Development and Innovation ecosystem	1.Creation of collaborative R, D & I centers in existing automotive hubs in Brazil. These centers would have public-private management involving suppliers, automakers, universities, scientific and technological institutions, in addition to funding agencies;	1.Increased local R, D&I activity;
	2.Establish as a focus of public support the support to national companies, especially non-reimbursable (BNDES, FINEP, SENAI and Research Support Foundations) and subsidized (BNDES and FINEP) funds;	2.Cost reduction of R, D&I activities;
	3.Creation of the Equity Investment Fund (FIP) aimed exclusively at promoting national companies that are emerging in the automotive sector;	3.Capacity building of the local ecosystem for the development of critical technologies;
	4.Eliminate direct taxation on any acquisitions intended for the execution of research and development (inputs, equipment or specialized services).	4.Fostering the development of genuinely Brazilian companies.

Source: Prepared by the authors.

shown graphically in Figure 11 (Concordance Validation Index), in Figure 12 (Coefficient of Variation) and in the Figure 13 (Interquartile Range).

4.1. Obtained results

During the research, throughout the process of construction and validation of the propositions that would guide the creation of an industrial policy for the automotive sector, some findings stood out due to their importance and the potential impacts on the entire structure of the automotive chain installed in the Brazil. From them, the propositions were created and validated, and their results obtained are described and commented below:

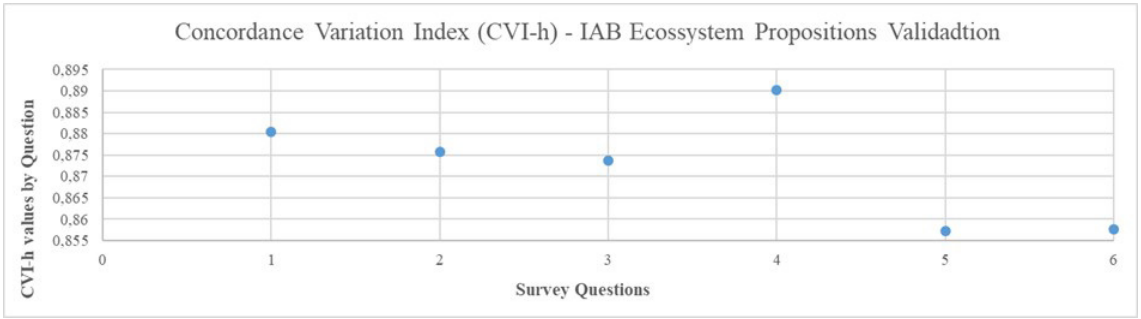

Figure 11. CVI-h proposition sample validadtion. Source: Prepared by the authors.

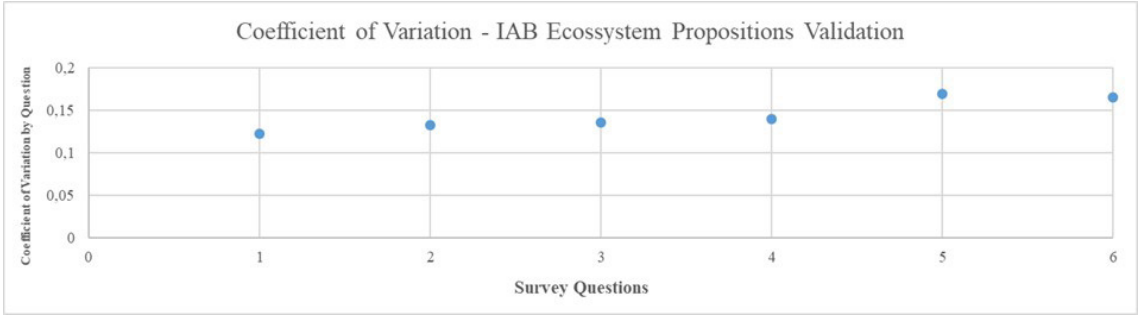

Figure 12. CV proposition sample validadtion. Source: Prepared by the authors.

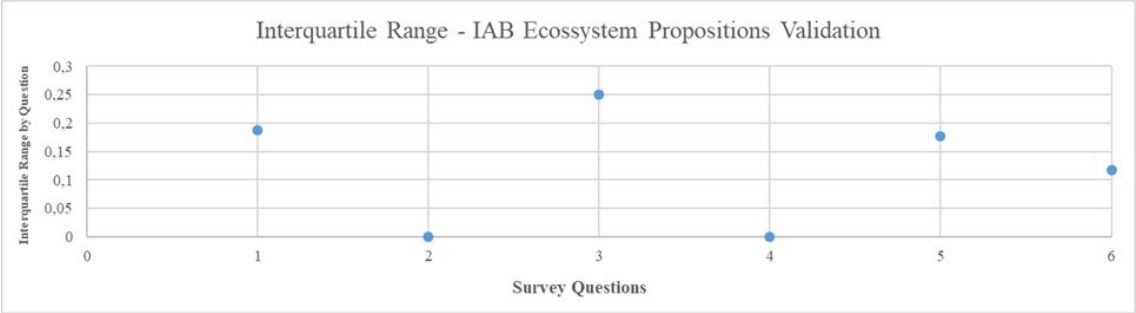

Figure 13. IR proposition sample validadtion. Source: Prepared by the authors.

- **Impacts of technological misalignment:** it was found during the Delphi research and through the analysis of policies adopted in other countries, mainly the USA, Germany, China, Japan and South Korea, that the fact that the vehicles produced and sold in Brazil do not meet the standards of the global market such as emissions, safety and other technological aspects that limit the expansion of the local industry. This limitation is due to the fact that Brazilian production does not meet the minimum safety and emissions requirements required by the aforementioned markets, as the automakers only perform the minimum required by Brazilian legislation, restricting the Brazilian car to Brazil and a few Latin American markets. This strategy ignores the obvious gains in scale that a globalized production chain can provide. The research showed that it is not part of the automakers' strategy to create an export hub in Brazil, which could compete with modern European, North American and Asian factories;
- **Global chains:** there was a clear distinction on the part of large auto parts multinationals in terms of operations in the Brazilian market. Despite operating in global markets, these companies operate differently in Brazil, adopting low-performance and low-technology operations, apparently ignoring the scale gains of global networks. However, as seen in the previous item, the origin of the problem lies in the automakers' strategy. Evidence points to a policy of doing the minimum required by Brazilian legislation regarding products (cars), excluding the country and its production chain from the global map, just as the country is already excluded from the R&D map of automakers;
- **Incentive to old cars:** it was found that the entire market structure and tax structure in Brazil support the existence of a fleet where 43% of vehicles are more than ten years old. This structure is evidenced, for example, with the IPVA (motor vehicle property tax) collection model, whose effective value decreases as the age of vehicles increases. It was found that there is no concern on the part of government agents regarding the long-term effects of pollution from more than 30,000 old vehicles and the social expenses resulting from these emissions. There was great potential in changing the IPVA collection model, for the environment, direct public revenues, well-being and public health;
- **R&D ecosystem:** there was a serious lack of interest on the part of multinationals in the automotive sector in developing or collaborating with the creation of a local R&D ecosystem and for large amounts to be sent to the headquarters, such as the purchase of services or intellectual property. It was also evidenced that the resources destined by development programs and funds from development banks are often used to locate components already developed by the headquarters. It was also evidenced the almost inexistence of projects in partnership with Brazilian research centers or universities, except in specific cases related to biofuels, which suggests the serious need to review the policies of public development agencies, as well as tax benefits with a view to creation and effective strengthening of the Brazilian technological ecosystem;
- **Fleet replacement:** fleet replacement has been shown to present two major long-term opportunities, creating demand and reducing pollutants, both of which have a major impact on society and mandated by the government. With the creation of demand, the entire production chain related to the automotive sector moves (auto parts, service providers, machinery suppliers, banks, etc.), the need for new investments arises, jobs are generated and feed the economy. With the reduction of atmospheric pollutants, public health expenses are reduced and there is an improvement in the quality of life, with the removal of old vehicles, these are scrapped and feed the circular economy that reduces the need for mining inputs and directly affects the environment;
- **A great opportunity:** was found that the replacement of the fleet is a great opportunity for the Brazilian government to sign a pact with automakers to generate quality jobs, place Brazil on the global map of the automotive sector as an export hub, thus reducing the dependence of the domestic market on long term, to create a modern industrial

park of global products, and above all to create the long-awaited R&D ecosystem that would guarantee the creation of new technology-based companies, new business models, greater interaction with academia and the expansion of local industry.

5. Conclusion

The identification in the literature of policies based on fleet replacement, especially in countries that represent more than 60% of the world's vehicle production (Germany, China, South Korea, United States and Japan) made it possible to evaluate the adaptation of the models adopted by these countries to the Brazilian reality. It was found that the government, in the light of new developmentalism, plays a central role in the elaboration, creation, development and application of measures that leverage the development of national industry. And in the Brazilian case, governments from the second half of the 20th century onwards were unable to create and maintain a strong and competitive national automotive industry.

The main contribution of this research was obtained with the validation of the six propositions for the construction of an industrial policy based on the replacement of the fleet of vehicles with more than ten years of age. The government's role as an inducer of the automotive industry was characterized through the theoretical framework of new developmentalism and the government's role in national competitiveness in the recovery of markets affected by the 2008 economic crisis, in addition to, indirectly, through the responses given to the questionnaires whose respondents represent approximately 90% of the national production of motor vehicles (trucks, buses, light commercial vehicles and automobiles).

It is concluded that only the replacement of the fleet without the adoption of technological alignment mechanisms, promotion of the competitiveness of national industries, financing mechanisms, readjustment of the tax burden or the creation of an innovation ecosystem that favors cooperation and the emergence of new companies , will create just one more market reserve for the companies already installed.

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