XXII ENGEMA
Encontro Internacional sobre Gestão Empresarial e Meio Ambiente

ISSN: 2359-1048
Novembro 2020

SECTORIAL 'GREEN' INNOVATION POLICIES: EVALUATING CONTEXTUAL INFLUENCES BY COMPARING BRAZILIAN AND GERMAN AUTOMOTIVE INDUSTRY PROGRAMS

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1. Introduction

According to recent studies important changes are taking place in the automotive sector due to an increasing relevance of emerging technologies (Kuhnert, Stürmer, & Koster, 2018). Meanwhile car companies are investing in innovative technologies to remain competitive the whole industry is still suffering the impact of a persistent global economic crisis which has been strongly reinforced by Corona virus pandemic consequences. Success in new investments is indispensable to revert bad financial results collected in the last years (Kuhnert et al., 2018). Moreover climate changes are increasing the pressure over the industry, with many players rushing to adapt products and services to comply with regulations agreed to reduce CO2 emissions from vehicle combustion engines (Marx, de Mello, Zilbovicius, & de Lara, 2015). Additionally a completely new field of competition is surging in the mobility sector. Some car manufacturers have also become service providers to counteract digital companies that are forcing their entry into auto market as it represents fresh revenue for the future of their businesses (de Lara & Marx, 2018). The opportunity for new competitors means risk for traditional car manufacturers, which may lose profitability and their hardly conquered status of global market leaders in the sector. Countries like Brazil and Germany, which depend on automotive industry revenue generation and in their domestic employment capacity to ensure national prosperity and economic growth (Marx et al., 2015), have been supporting their technological transformation by implementing long-term innovation policies. The way these countries are managing the deployment of innovation policies within their national sectorial ecosystem can enhance the competitiveness of the companies operating inside (Edler & Fagerberg, 2017). Since "innovation policy as a distinct policy area is a relatively new addition to policy-makers' agenda" and there is still an important gap for academic contribution in this field of research despite its well-known influence in nations economic and social prosperity (Edler & Fagerberg, 2017), the following research question is addressed: *How contextual factors influence the definition and deployment of sectorial 'green' innovation policies?*

In order to answer this question this study has reviewed the innovation policy literature and, based on that, has proposed an analytical framework that has been applied for the achievement of the following secondary objectives: (i) identify the innovation strategies of Germany and Brazil for the development of their local national automotive industries; (ii) describe innovation policy instrument designs and the governance system they have been applying to achieve their particular objectives; and (iii) discover opportunities for cooperation efforts between them to improve their innovation policies and enhance their individual national plans outcomes. The study uses cases oriented comparative method (Ragin, 2014) to answer the proposed question and the related secondary objectives, including the last one which was inspired by Gluckman, Turekian, Grimes, & Kishi (2017) allegations that Science Diplomacy may be used to advance national needs. In the case of this one, suggestions are made for the improvement of institutional national capacity through cooperation between nations. The main contributions of this analysis is to illustrate how contextual factors influence in 'green' innovation policy program effectiveness and to provide framework that may guide the definition, the deployment, and even the cooperation for its development based on mutual understanding of nationwide sectorial innovation policies. Beyond that, it offers future directions for new researches in innovation policy field.

2. Theoretical Review

According to Gluckman et al. (2017) a country may invest in science diplomacy to put in place actions that can advance its national needs. For the authors, improving trading, developing innovation or agreeing standards and definitions are the most common economic motivations for a country to do that. But countries can also use science diplomacy to improve national capability (Gluckman et al., 2017) and that can be done both to achieve technical or institutional enhancements. Learning from other countries' good practices and successes is certainly a good strategy for improving national capacity. Understanding the way other countries combine policy instruments to produce innovation, may well justify investments in science diplomacy. Being a well-positioned nation regarding new technological developments can support the international power level of influence a country has over others (Akaev & Pantin, 2014). Nowadays the greater interconnection of nations and the growing speed of information and communication technologies (ICT) makes it vital for a country to keep up with the pace of the world innovation leaders (Akaev & Pantin, 2014).

Since innovation depends on a robust knowledge base and high level of interactions, its pay-off takes longer than it could be afforded by the private firms alone, and that's exactly why the state needs to exert a central role in regulating and bridging that to its markets (Edler & Fagerberg, 2017). The most common state interferences to contribute with markets for generating innovation are (a) for the public production of knowledge, (b) by subsidizing research and development (R&D) in private firms and (c) for the strengthening of incomplete property rights (IPR) regime (Edler & Fagerberg, 2017). For Edler & Fagerberg (2017) the success of innovation depends on "national innovation systems" which are compounded by "different factors, such as knowledge, skills, financial resources, demand, … which to a large extent have been regarded as being provided within the nation" (Edler & Fagerberg, 2017). Still according to them, one of the most important challenges that the state faces when promoting innovation through policy instruments is to counteract and reverse path dependence of prevailing technologies. Long-lasting technologies, such as combustion engines for vehicles, for instance, establishes economic, social, cultural, technical and political inertia that can only be overcome through intense, constant and assertive efforts to establish new technology logics within the market (Geels, 2004).

There are three types of policy instruments used to influence the dynamics of national innovation systems, according to Borras & Edquist (2013): (a) regulatory instruments - legal tools for the regulation of social and market interactions; (b) economic and financial instruments - pecuniary incentives (or disincentives) for social and economic activities; and (c) soft instruments - voluntary and non-coercive incentives. The authors still reinforce that the design of innovation policies must always start with a critical assessment of the problems that need innovative solutions. Only after that, an ultimate objective can be defined and translated into direct objectives addressing specific operational issues that could not be solved by the private organizations alone. Policy-makers also need to constantly reevaluate the efficiency of the instruments for the improvement of the innovation system (Borras & Edquist, 2013). They need to avoid adding new incentives (i.e. instruments) to the policy configuration in place before diagnosing its inefficiencies. Only changes that are able to improve its performance should be made (Borras & Edquist, 2013). According to Edler & Fagerberg (2017), the effectiveness of innovation policy instruments applied by a country to promote the development of new technologies depends on: (1) the correct definition of the problem that is addressed by the innovative solutions stimulated, (2) the mix and intensity of use of each policy instruments, which must be frequently measured by levels of inputs, outputs and verification of systemic bottlenecks (i.e. there isn't a standard recipe, the solution is contingent to context specific conditions), (3) continuous experimentation mainly at early stages of policy instruments implementation, (4) societal approval, which can turns the policy into a sustainable solution (i.e. a legitimate instrument) and, (5) capable policy-makers really focused and committed with the improvement of the instruments. The resistance against the development of disruptive innovation cannot be ignored by the government when designing an innovation policy. When analyzing the efforts of the UK government for promoting low carbon transition policies, Geels (2014) recognized an intense resistance by incumbent regime actors to fundamental change. The author confirmed the usage, by the incumbents, of "instrumental, discursive, material and institutional forms of power to resist climate change-related pressures and to reposition themselves for low-carbon futures without fundamental system change" (Geels, 2014). Policy-makers must not only focus on green technologies stimulus, like many have been ineffectively doing so far, but implement policy instruments capable of preventing fossil fuel to be burned (Geels, 2014). Therefore, the success of an innovation policy may depend more on instruments to fight the 'status quo' regime than on stimulus for new coming technologies because innovation policy selection process is path dependent (Edler & Fagerberg, 2017).

Xu & Su (2016) analyzed changes on the mix of policy instruments used by China to promote innovation on new energy vehicle (NEV) technologies from 1991 to 2015, when the country started to achieve relevant market share in the total vehicle industry volume sold (about 1,4% in 2015, or 300.000 units in total). The authors analyzed the policy instruments and their outcomes in the following phases, within the period covered by the study:

- 'Phase 1' (from 1991 to 1998): Only product R&D subsidies were used by the government to stimulate innovation in the sector.
- 'Phase 2' (from 1999 to 2008): A mix of product R&D subsidies, technology planning and innovation demonstrations was used. With oil prices increasing by 2008, China took the opportunity of Beijing Olympic Games (starting at the same year) to showcase its ambition of heading the world production of new energy vehicles technologies.
- 'Phase 3' (from 2009 to 2014): China started to promote NEV purchase rebates first in public domain (public procurement) (2009), adding some private purchases rebates in the following year (2010). By 2012 the government announced a five-year specific innovation plan for electric vehicles and a broader middle/long-term plan for the entire NEV industry.
- 'Phase 4' (from 2013 to 2015): A robust program started to be implemented to stimulate the consumption of NEV vehicles. Private purchase rebates were expanded to other cities in 2013 and were finally replaced by a purchase tax waiver by 2014. Still in 2014, the government stated to regulate the price of electricity charging as well as to subsidize investment to develop infrastructure capacity. In the same year the government also removed some domestic trade barriers and deployed beneficial traffic policy for NEV. As from 2015 a much more complex mix of incentives started to be implemented in China including: operation subsidy for NEV, a third-round subsidy policy for NIV purchase (expansion of the existed rebates included), entry regulation for power battery and passenger car manufacturers, concrete national plan of charging infrastructure.

The conclusion of Xu & Su (2016) was that China, from the start to the last year analyzed by them, shifted their focus within two main domains. On one domain, policy strategy moved from instruments whose subject targets were centrally defined by the government, also called 'government-selection' instruments (e.g. R&D subsidies, demonstration events, product technology central planning, public procurement for purchasing vehicles for the government, etc.), onto 'market-selection' policy instruments, whose subject targets were established by the market (e.g. private vehicle purchase rebates, product standards, trading regulatory policy, etc.). On the other perspective, China government shifted the policy strategy from 'producer-orientation' instruments (e.g. product R&D subsidies, carbon credit trading system, etc.) to 'consumer-orientation' instruments (e.g. public information about vehicle fuel consumption, mandatory after-sales service, consumer benefits for using "greener" vehicles, etc.). The program, therefore, started, at its very beginning, using 'government-selection' combined to 'producer-orientation' policy instruments to promote innovation but, as innovations were becoming more matured and marketed, the government turned the stimulus onto 'market-selection' and 'consumer-orientation' instruments to improve the performance of the policy program (Xu & Su, 2016).

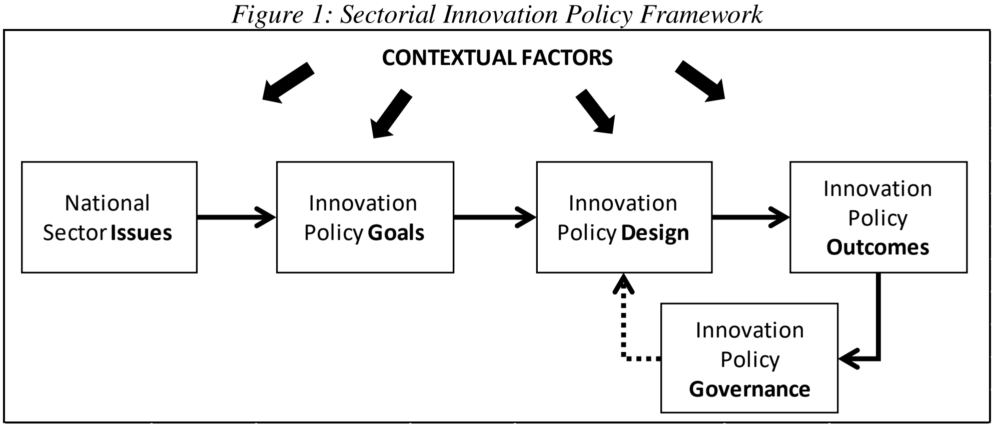
In other recent and well-cited study, Wesseling (2016) analyzed differences in plug-in electric vehicle (PEV) policies deployed in 13 countries. The bottom-line conclusion taken by the scholar was that "economic interest in the car industry shows and explains why car countries focus their policy on technology development, and non-car countries on technology diffusion" (Wesseling, 2016). Therefore for countries where the car industry was relevant to the economy this analysis found a positive correlation with RD&D (research, development and demonstration) subsidies and a negative one with sales incentives. Competitiveness between car producers may explain the incentives these countries apply in innovative products (Wesseling, 2016). On the other hand countries without a well-developed car industry were essentially oriented by environmental concerns and sales incentives to facilitate PEV diffusion, according to the study.

In the next topic detailed explanation is provided about how some of these scientific references' findings will be incorporated in the method of analysis.

3. Method

This study uses cases oriented comparative method to analyze the innovation policies applied for the development of the automotive sector in Germany and Brazil. This method of research provides adequate resources to evaluate the relation between a setting of observed variables (e.g. sector issues, innovation policy goals, innovation policy instruments design and innovation policy governance) and their consequence (e.g. innovation policy outcomes) in macrosocial units of analysis (e.g. countries) according to particularities of their contexts (Ragin, 2014). It provides "a basis for examining how conditions combine in different ways and in different contexts to produce different outcomes" (Ragin, 2014, p. 52).

Figure 1: Sectorial Innovation Policy Framework



Source: Authors

Through an analysis of documental data (i.e. official publications and specialists analysis) of the automotive sector innovation policy programs in place in both countries, the current study evaluate how context influences: (a) the definition of national sector issues,

(b) the establishment of innovation goals meant to overcome them, (c) the policy instruments designed to achieve such goals, (d) the outcomes resulting from their deployment and (e) the governance enforcing the rules and influencing the goals again. Figure 1 defines the structure of analysis (i.e. a framework built based on last topic theoretical review) applied here.

Edler & Fagerberg (2017) and Borras & Edquist (2013) findings and recommendations were used as a reference for the relationship established among the constructs related in the framework. The two domains categorization suggested by Xu & Su (2016) in their study ('government-selection' ↔ 'market-selection' / 'producer's-orientation' ↔ 'consumer's-orientation') were also plotted for a clear identification of the innovation policy instruments designs in place for each country program.

According to Ragin (2014) the use of exemplar cases in the analysis is an important condition to apply comparative method study. The pertinent data concerning the preconditions of specific outcomes and the similarities and differences between the instances of each case are all valuable evidences to explain their causes (Ragin, 2014). In line with this methodological recommendations, Brazil and Germany were chosen as the focused cases of this analysis for the following reasons (de Lara & Marx, 2018; Marx et al., 2015):

(a) In both countries the automotive sector is very relevant for their economies: in Brazil it represents about 4% of its national GDP (ANFAVEA, 2019, p. 7) and in Germany it represents about 5% (Chazan, 2019). That justifies governments' concerns about producing innovative competitive products in order to remain or even increase their shares of market fighting for the strengthening of their economies;

(b) There are exemplar contrasts between these countries industries contexts. Germany is a developed country clearly investing to support the relevance of its national traditional Automakers (e.g. Volkswagen Group) and Auto parts manufactures (e.g. Bosch) in the global automotive industry and to ensure incumbent and new national companies positions as global mobility service providers ahead of current technological changes facing the sector. Brazil is a developing country without any Brazilian local representative fighting globally in the sector, but where manufacturing plants from the most important global automakers have been operating to take advantage of its high potential market;

(c) There are also exemplar differences between national industrial strategies. Germany is pressured by climate-changes commitments and by global competition coming from inside the sector (e.g. other countries-based market-leading Automakers) or from outside it (e.g. disruptors such as Tesla) and it is mainly investing in disruptive green technologies such as electrical propulsion engines. Brazil, on the other hand, is a very closed automotive market, with a huge domestic demand for low price compact vehicles, mainly equipped with dual-fuel combustion engines (which functions both with gasoline and/or ethanol, in any mixture), a local matured technology (ethanol combustion engines technology) that has been the base for incremental innovation investments targeting its climate-changes committed objectives.

In the next topic the study introduces the innovation environment, the automotive sector context and the innovation policy programs conducted by each nation government ('Rota 2030' program in Brazil and 'National Platform for Electric Mobility – NPE' program in Germany) to afterwards proceed with a comparative analysis in order to understand common contextual influences over the innovation policy effectiveness in these two distinct scenarios.

4. Results Analysis

4.1. Innovation Competitiveness in Brazil

Brazil ranked 71st in the Global Competitiveness Index 2019 (Schwab, 2019), one position higher than one year before, and it was 8th in Latin American and Caribbean region. Its best performances in the subcategories of Global Competitiveness Index 2019 (Schwab, 2019) were at 'Market Size' (10th), 'Innovation Capacity' (40th), Financial System (55th), 'Business Dynamism (67th) and 'ICT Adoption' (67th). In all the other subcategories Brazil ranked below its overall position (71st). Its worst positions in the subcategories (Schwab, 2019) were at: Product Markets (124th), Macroeconomic Stability (115th), Labor Market (105th) and Institutions (99th). Brazil 2019 general performance in the ranking was the worst compared to all the other BRICS countries (Russia: 43th, India: 68th, China: 28th and South Africa: 60th).

Although a long-term plan (2016–2022) was established by the Brazilian Minister of Science, Technology, Innovation and Communication (MCTIC, 2016), to improve country's competitiveness, it has not been seriously taken by the new government that assumed the country in January this year (2019). This plan was signed in a very turbulent political period when the former Brazilian president Dilma Roussef was about to be impeached by the congress. She was replaced by her vice-president, Michel Temer, from the largest central party of Brazil, who faced continuing strong economic crisis being also involved in political scandals during his mandate. In November 2018, still in a time of increasing political, social and economic instability, a new president was elected. Since January of 2019, when assumed responsibility over the country, Jair Bolsonaro, belonging to a conservative party, has taken different directions and priorities from previous governments, which were from his oppositions. Still now, more than one year after his start, there isn't any clear information available (no new plan nor progresses on the old one) about the way this government will address and manage Science and Technology issues.

4.1.1. The automotive industry in Brazil

Brazil is the 9th producer and the 8th consumer nation of automotive vehicles globally (ANFAVEA, 2019). According to ANFAVEA (2019), the 'Association of Manufacturers of Automotive Vehicles of Brazil', there are 26 Automakers, 582 Auto Parts companies and 4.016 Dealers currently operating in Brazil (ANFAVEA, 2019). Although maintaining a production capacity of 5,050 million units locally, the sector only produced 2.386.758 vehicles in 2018, when it employed about 110.000 people in the country. The automotive market was severely hurt by the economic crisis that has been affecting the growth of sector since 2014 (Daudt & Willcox, 2018). Not more than 21% of vehicles produced in the country were exported in 2018 (ANFAVEA, 2019). In this same year, 2.099.605 units were sold (registered) inside domestic market, where almost 2.000.000 out of them were equipped with dual-fuel engines (gasoline/ethanol fuel automatically adjustable engines) (ANFAVEA, 2019). About 35,4% of the units sold inside Brazil in 2018 were equipped with 1.000 cm^3 combustion engines (ANFAVEA, 2019), what helps to define it as a low-cost entry product market for automotive vehicles (Marx et al., 2015). The main accepted explanations for the impressive growth of sales that happened in the country in the period comprised from 2004 (when 1.215.549 units were registered) to 2013 (when the record figure of 3.115.223 units registered was achieved) (ANFAVEA, 2019) were: (a) the real increase of the average income of the Brazilian people (that achieved 46,3% in this period) that caused the emergence of the 'C level' social class in the country, (b) the credit expansion promoted by the government in the period and (c) the tax incentives applied to reduce the price of the vehicles (Daudt & Willcox, 2018). All of that helps to explain predominant consumption of compact and low cylinder engines' vehicles in this market still today. Furthermore, the discovery of pre-salt oil reserves in the first decade of this century and the development of ethanol engines since the 1970s helped to the establish dual fuel combustion engine technologies as country's natural preferred solutions for lower CO2 emission targets (Marx et al., 2015)

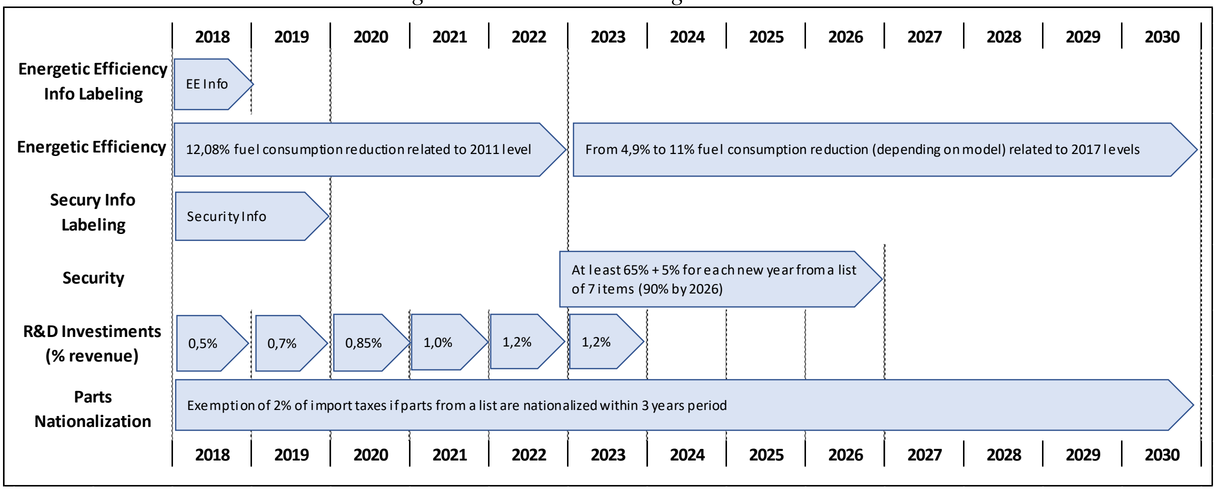
The automotive industry has had, for a long time, about 4% relevance in Brazil's GDP and it corresponds of about 22% of the GDP of the whole transformation industry there (ANFAVEA, 2019). Despite the economic importance of the sector, Brazil have not developed any national capital competitive Automaker (not even capable of competing for the domestic market). In Auto Parts subsector, things are not very different though, no Brazilian capital player has had global relevance so far and, even in the domestic market, the national capital representatives only represent about 30% of the this industry total capital (Sindipeças & Abipeças, 2019). Just to give an information about the strength of traditional international players in Auto Parts market, American and German capital representatives summed together almost half of the total capital inside the sector in 2018 in Brazil (Sindipeças & Abipeças, 2019). Based on that, it can be said that Brazilian automotive market is almost completely run by international companies' subsidiaries. Apart from its size, its economic relevance, the source of the investments and the type of product consumed, Brazilian automotive market has another important characteristic: it is very economically closed (Daudt & Willcox, 2018). Import vehicles are heavily taxed in a way that the nationally produced vehicles are protected from any relevant external competitiveness.

4.1.2. Brazil Innovation Policy for the Automotive Sector: 'Rota 2030'

'Rota 2030' program was launched in December 2018 by the Brazilian government as a continuation of 'Inovar-Auto' program (Mello, Marx, & Motta, 2016), that was in place from 2012 to 2017. According to the law ruling 'Rota 2030', its objective is "to support the technological development, the competitiveness, the innovation, the vehicular security, the environment protection, the energetic efficiency and the quality of automobiles, trucks, buses, chassis equipped with engines and auto parts" (Brazilian_Federal_Congress, 2018). The main goals of the program (Brazilian_Federal_Congress, 2018) are: (i) increase the energetic efficiency, the structural development and the availability of driving assistance technologies in the vehicles traded inside the country; (ii) increase the investments in research, development and innovation in the country; (iii) stimulate the production of new technologies and innovation, in line with global technological trends; (iv) increase the productivity of mobility and logistic industries; (v) promote the usage of biofuel and alternative ways of propulsion and add value to the Brazilian energetic matrix; (vi) ensure the technical capacity and professional qualification in mobility and logistic sector; and (vii) ensure the expansion or the maintenance of employment level in mobility and logistic sector.

In order to enroll in the program, the Automakers and the Auto Parts manufacturers located in Brazil must fulfill the requisites of: (a) new vehicles labelling of standardized information about their energetic efficiency and security levels, (b) minimum vehicular energetic efficiency levels, (c) minimum vehicular structural development associated with driving assistance technologies (Ministry_of_Economy, 2020). The energetic efficiency levels contemplated by the program may be revised by CONAMA (Conselho Nacional do Meio Ambiente) from time to time (Imprensa_Nacional, 2018). After the enrollment, which only allows access to Brazilian market, all the listed companies must comply with minimum level of investments in research and technology (R&D), increasing it from 0,5% (in 2018) up to 1,20% (in 2023) of their annual sales revenue (Brazilian_Federal_Congress, 2018; Kutney, 2019). R&D investments made in alternative propulsion allows a participant to collect 30% of rebate over certain due taxes, meanwhile investments made in the strategic areas defined result in 45% deductions in same taxes (Brazilian_Federal_Congress, 2018). If an Auto Maker does not accomplish with the R&D investments targets in time, the company is fined, being eventually banned from the program if recurrent. 'Rota 2030' also contemplates incentives for the nationalization of the production of automotive parts that are imported. It rules that any Auto Maker and/or Auto Parts manufacturer, conjointly or individually, is/are able to have 2% import tax exemption if they commit with the nationalization of the referred items within 3 years' time (Brazilian_Federal_Congress, 2018). Figure 2 bellow details 'Rota 2030' program timeline herein referred. It is notably basic, from the perspective of the technological impacts expected in the automotive sector in the near future globally.

Figure 2: 'Rota 2030' Program Timeline



Source: Authors - based on Brazilian_Federal_Congress (2018) and Kutney (2019)

The program is enforced by an inter-ministerial group specially created by Brazilian government, composed by members of the Minister of Science, Technology, Innovation and Communication (MCTIC) and of the Minister of Economy (Ministry_of_Economy, 2020). This team is responsible for 'Rota 2030' accountability, checking participants' results against targets and allocating (dis)incentives. No relevant program follow-up information were found up to July of 2020, when this study was concluded (Ministry_of_Economy, 2020).

4.2. Innovation Competitiveness in Germany

Germany ranked 7th in the Global Competitiveness Index 2019 (Schwab, 2019), four positions lower than one year before. In Europe it was overtaken by the Netherlands and Switzerland and ranked 3rd in 2019 (Schwab, 2019). For the second year in a row, Germany is the world leader in the subcategory Innovation Capability. Germany's other strengths lie in infrastructure (8th), macroeconomic stability (1st), market size (5th) and highly educated labor force (5th). Germany's greatest weakness in the Global Competitiveness Index 2019 is the relatively low level of ICT adoption (36th) (Schwab, 2019).

Despite several demands from some political parties in Germany, no separate state ministry for digitization was founded yet. Many experts criticize the inadequate action and accuse the government of paying too little attention to technological change in all areas. Overall, Germany finds itself in a relatively stable political situation. However, the right-wing party is gaining more and more space and is drawing the attention of the political discussion towards refugee issues. On the other hand, there is a strong movement towards more environmentally friendly living with the Green Party. The "FDP" party, which is mainly committed to digitization policies, is currently receiving little attention, and even the strongest party in Germany, the "CDU", has more to do with the preservation of voters than with digitization. As a result, Germany has lost four places in a worldwide comparison within only one year and has achieved a weak value especially in ICT adoption. This report should serve as a warning signal to politicians as well as companies to focus more on ICT in order to also defend the leading position in innovation capability.

4.2.1. The automotive industry in Germany

The German automotive industry generated sales of 426 billion euros in 2017. Of this, 36 percent was generated inside Germany (Ahlswede, 2019b). As a result, the share of revenue generated abroad amounted to around 64 percent (Ahlswede, 2019b). The largest share of exports went to Europe in 2017, but Asia and North/South America were also customers for many cars from Germany. The automotive industry is of outstanding importance for Germany as a business location. The number of employees in this sector rose from around 702,000 in 2010 to around 820,000 in 2017 (Ahlswede, 2019b). The automotive industry is responsible for a total of one-fifth of all industrial sales (Bormann et al., 2018). In a difficult environment, in connection with Diesel Gate or Brexit, the automotive industry in Germany can look back on an average year of 2018. The tense global political situation is having an impact, with only a 0.8 percent increase in sales. In 2017, the increase in sales still amounted 4 percent (Ahlswede, 2019c). The pending court rulings in connection with the Diesel Gate and the imminent switch to electro mobility are creating problems for the industry. This makes it even more important to push ahead with the transformation to electric vehicles and to promote innovations in the industry.

The three largest German automobile manufacturers are the Volkswagen Group, Daimler AG and the BMW Group. The Volkswagen Group produces 11 million vehicles in 2018, well ahead of Daimler AG (3.3 million) and the BMW Group (2.5 million) (Ahlswede, 2019a). Measured by the number of vehicles produced, the Volkswagen Group is the largest automobile manufacturer in the world. In 2017, Volkswagen's share of total global motor vehicle production amounted to around 10.7 percent (Ahlswede, 2019a). The state has always played an important role in the German automotive industry. One of the latest effects for the automobile companies has been the climate change objectives decided by the EU, which seeks to reduce the carbon emissions by 40% compared to 2007 until 2020 (Dicken, 2015, p. 603) and 52,5% more up to 2030 (European_Union, 2020). In order to achieve these ambitious goals, automobile manufacturers cannot continue to focus on gasoline and diesel engines without having to pay high penalties. A shift to greener propulsion techniques is required. Electro mobility is an important element of a climate-friendly energy and transport policy and apart from supporting Germany strategy of reducing oil importation as the country is not a relevant producer of petrol or alternative fuel (Federal_Ministry_of_Economic_Affairs_and_Energy, 2020). Electro mobility still helps Germany to shape their industrial society sustainably with innovative products and systems that are in demand worldwide (Federal_Ministry_of_Economic_Affairs_and_Energy, 2011, p. 5). German industry is called upon to secure its technological leadership in the field of electric mobility and to establish the "Made in Germany" brand for electric vehicles, systems and components on the world market (Federal_Ministry_of_Economic_Affairs_and_Energy, 2011, p. 6). This change does not only apply to car manufacturers, but also involves the state. Due to Germany's dependence on the automotive industry, a successful transformation to electric drive technologies is in the interests of securing Germany as a business location. The government therefore must provide the best possible environmental conditions to companies and promote the development of environmentally friendly propulsion technologies. Another task of the government will be to adjust the population to change and, for example, to set purchase incentives to encourage change to some extent (Langer, 2013). In the development of car sharing and electric mobility, Germany plays the role of a pioneer. The strength lies above all in the extensive technical know-how of the German automakers (Henzelmann, Frei, Schönberg, Wunder, & Neuenhahn, 2017, p. 7). On the other hand, if one looks at economic policy impulses and regulatory framework conditions, one finds Germany in a pursuit position (Henzelmann et al., 2017, p. 9). The German government sees early international harmonization of regulations, norms and standards as a decisive factor in successfully positioning its key technologies in the field of electro mobility on the world market. By 2020, at least one million electric vehicles should be on the roads, and by 2030 at least six million by 2030 (Federal_Ministry_of_Economic_Affairs_and_Energy, 2011, p. 10). In order to further strengthen the German business location, innovations are essential. This is reflected in a high focus on R&D funding, which is expected to rise to 3.5% of GDP by 2020, well above the European average. In addition, the coalition is currently working on tax incentives for companies that invest above-average shares of their GDP in their company's R&D.

4.2.2. Germany Innovation Policy for the Automotive Sector – 'National Platform for Electric Mobility (NPE)'

> The NPE was founded in 2010 on the initiative of the Federal Government, industry, the trade unions and representatives of civil society to facilitate close cooperation in pursuit of their common goals. Germany aims to become a leading supplier and – with one million electric vehicles on the road – a lead market for electric mobility by 2020. It also aims to maintain and increase current employment levels across the entire value chain. (German_National_Platform_for_Electric_Mobility, 2018).

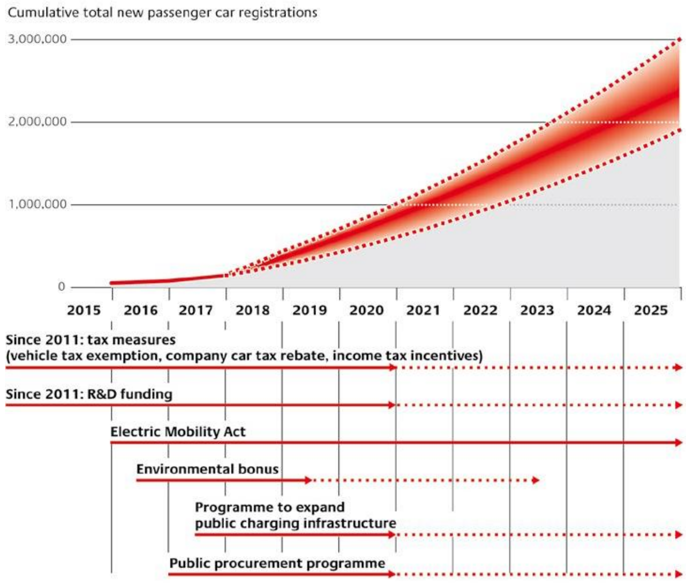
Table 1 – 'NPE' Policy Instruments description

Policy Instruments	Detailed Description
R&D funding	Further R&D expenditure in the field of vehicle technology will be required between 2018 and 2020, when the combined expenditure of industry and the public sector should be of about €1 billion. Technological solutions continue to be developed, business models are being adapted and additional research into new technologies is being accelerated. Further optimisation is required in areas such as product life cycle assessments, materials, functional integration and high power charging. In order for Germany to become a leading global competitor, further efforts are also necessary with regard to material, cell and battery technology and battery production.
Environmental bonus	Introduced by the Federal Government in conjunction with the automotive industry under the "Regulation for the Promotion of Electric Vehicle Sales" is a purchase grant worth €4,000 for battery electric vehicles and €3,000 for plug-in hybrids. The grant may be claimed for vehicles with a net list price of up to €60,000. The total available funding is capped at €1.2 billion, split 50/50 between the Federal Government and the automotive industry.
Charging infrastructure funding programme	The Federal Government is investing €300 million between 2017 and 2020 to expand the public charging infrastructure under the "Funding Regulation for Electric Vehicle Charging Infrastructure in Germany". The aim is to install a total of at least 15,000 charging stations throughout Germany, including 5,000 fast charging stations and 10,000 standard charging stations. Approximately €200 million is available for the fast charging infrastructure and about €100 million for the standard charging infrastructure. This funding will provide an important stimulus for the installation of a charging infrastructure capable of meeting demand.
Motorway charging infrastructure	In conjunction with motorway services company Autobahn Tank & Rast GmbH, the Federal Government will provide fast charging points and parking spaces for electric vehicles at all 400 motorway service stations by the end of 2018.
Immediate Action Programme Clean Air 2017–2020	A package of measures worth up to €1 billion aimed at improving air quality in towns and cities. €393 million has been allocated to transport electrification measures. Under this programme, the Federal Government will provide targeted support for the purchase of electric vehicles by people in Germany's most polluted towns and cities.
Electric Mobility Act	It defines the different types of electric vehicle as battery electric vehicles (BEV), plug-in hybrid electric vehicles (PHEV) and fuel cell electric vehicles. It allows local authorities to give preferential treatment to electric vehicles, especially with regard to parking spaces and charges and the use of restricted road spaces such as bus lanes.
Support for local authorities and fleets	The Federal Government is providing targeted cross-departmental support to help local authorities and fleet operators increase the number of electric vehicles at a local level. The aim is to grow the market for electric vehicles and the associated infrastructure in the strategic area of local mobility and logistics.
Monetary incentives and measures to remove legal obstacles	The use of electric vehicles is also being promoted through tax incentives. The electricity provided by employers for employees to charge their electric cars is no longer treated as a non-cash benefit. Employees receive a reduced income tax rate on the benefit gained from their employer allowing them to charge their electric vehicle and the free or discounted use of chargers, as well as subsidies to use them.
Vehicle tax exemption	The vehicle tax exemption for battery electric vehicles has been extended to ten years and will now last until 31 December 2020.
German Standardisation Roadmap Electric Mobility 2020	It has been completed and approved. This document sets out the scope of the national and international work required in the field of norms and standardisation up to the start of the mass market phase. The work outlined in the Standardisation Roadmap is being actively supported and developed.
Simplification of the regulations for driving electric light commercial vehicles	A derogation (until 31 December 2019) means that holders of Category B driving licences can drive electric vehicles of up to 4.25 tonnes rather than the usual limit of 3.5 tonnes. This makes it possible for electric commercial vehicles to compete with conventional vehicles in terms of load capacity, without being subject to the provisions of the "Professional Driver Qualification Act" which would require their drivers to possess a Category C1 driving licence.

Source: German_National_Platform_for_Electric_Mobility (2018)

Table 1 details each of the 'NPE' innovation policy instruments in place to deliver the manifested objectives. Only the volume of publications made available by the 'NPE' committee in its official website is sufficient to explain how serious Germany is taking these sectorial goals. According to one of the reports published by 'NPE', Germany has already invested €2.2 billion in R&D in the field of electric mobility development up to September 2017, and one third of the patterns in this field already comes from the country (German_National_Platform_for_Electric_Mobility, 2018). They have also developed an entire value chain for battery manufacturing domestically, with the only exception of battery cell production, a challenge that has already been addressed by 'NPE' program (German_National_Platform_for_Electric_Mobility, 2018). Figure 3 below shows the timeline of the program policy instruments configured to deliver the expected outcomes.

Figure 3: 'NPE' Program Timeline



Source: German_National_Platform_for_Electric_Mobility - NPE (2018)

Germany government expects to achieve 1 million electric vehicles registration (in cumulated figures) util 2020 with the support of 'NPE' stimulus. And, if their forecast can prove accurate, it must hit 3 million registrations by 2025. Reports found in 'NPE' website makes clear how this program design and governance is translated into effective outcomes.

4.3. Comparative Analysis

By classifying the evidences of the two cases using the framework proposed by this study (Figure 1), a detailed understanding of the influence of the contextual factors over the sectorial innovation policy programs is noted (Table 2). There are, naturally, clear evidences of the influence coming from all the contextual factors listed for the definition of the most important 'National Sector Issues'. Brazil's economic position as oil and ethanol global producer and exporter summed to the fact that its auto industry is dominated by multinational subsidiaries from other nationalities oriented to its domestic market has much to do with its option for an incremental innovation program addressing bi-fuel efficiency improvements preserving ethanol consumption level. On the other hand Germany's economic position as a traditional global exporter of vehicles and auto parts and its condition of fuel importer, explains much of its efforts to shift the combustion expertize of its industry value chain into electric technology one to maintain its competitiveness in the sector. Thus investing in a disruptive innovation policy program has been a natural decision for German government and Industry since that means retaining (or even improving) its competitive position globally. On the other hand the environmental and safety standards commitments, established by European

Community in the case of Germany and by local government in the case of Brazil, only add timing pressure for the deployment of each country innovation program.

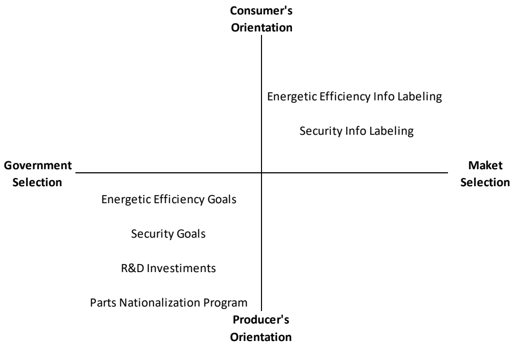
Table 2 – Comparative Analysis through the application of the analytical framework proposed

Contextual Factors		BRAZIL	GERMANY
Industry Relevance		• 4% of national GDP (ANFAVEA, 2019, p.7) • 1,3 millian employees in 2018 (ANFAVEA, 2019, p.7)	• 5% of national GDP (Chazan, 2019) • 820,000 employees in 2017 (Ahlswede, 2019b)
Industry Orientation		Domestic Market (Daudt & Willcox, 2018, p.192)	Global and Domestic Markets (German_National_Platform_for_Electric_Mobility, 2018, p.17)
Innovation Capacity [1]		40th position (The Global Competitiveness Report 2019): • Interaction and diversity (4th) • Research and development (2nd) • Commercialization (5th)	1st position (The Global Competitiveness Report 2019): • Interaction and diversity (76th) • Research and development (29th) • Commercialization (63th)
Safety and Environmental Standards		Challeging passanger vehicles targets (BR) (Imprensa_Nacional, 2018), as for product mix (g CO2/km): • 80 (~2022), • 50 (2023~2024), • 40 (2025~2026), • 30 (2029~2031)	Agressive passanger vehicles targets (EU) (European_Union, 2020), as for product mix (g CO2/km): • 95 (~2024), • 15% reduction or 80.75 (2025~2029), • 37.5% reduction or 61,75 (2030~)
Industry Product Profile		Compact and low power engine vehicles in the great majority, fuelled by ethanol and petrol (multi-fuel). (ANFAVEA, 2019)	Medium vehicles predominant demand, fuelled by petrol or diesel in the great majority. (Ahlswede, 2019b)
Companies' Capital Origin		Auto and Parts Makers operating in Brazil are in the great majority subsidiares of Multinational Coorporate Companies. (Daudt & Willcox, 2018, p. 186)	Auto and Parts Makers are globally competitive local corporations. They are traditional exporters, with subsidiaries and manufacturies installed all arond the world (Dicken, 2015, p. 501-502)
National Fuel Production		Brazil is an important oil exporter and it is the biggest ethanol producer of the world (Daudt & Willcox, 2018).	Germany isn't a relevant oil or ethanol producer and itt has been strategically reducing its petrol imports since 1970s (Federal_Ministry_of_Economic_Affairs_and_Energy, 2020).
Innovation Policy Program	National Sector Issues	• Industry must keep its economic relevance to support GDP. • The technological lag between local and global auto industry may compromise the local appeal for nacional products. • Risk of unemployment of manufacturing workforce must be mitigated. • Ethanol (and Petrol) demand may reduce if market is dominated by eletric vehicles. • Environment and Safety commitments must be achieved (BR). (Daudt & Willcox, 2018).	• Industry must keep its economic relevance to support GDP. • German Auto Industry traditional global position is under threat (a technological transition is in place globally). • Germany can loose its position as a global leading Auto exporter. • Risk of unemployment of manufacturing workforce must be mitigated. • Environment and Safety commitments must be achieved (EU). (German_National_Platform_for_Electric_Mobility, 2018)
	Innovation Policy Goals	Moderate and long term (incremental innovation) according to Rota 2030 targets (Brazilian_Federal_Congress, 2018; Kutney, 2019): • Improving Ethanol engines efficiency. • Improving Safety Standards. • Few alternative propulsion incentive.	Agressive and medium term (disruptive innovation) according to NPE targets (German_National_Platform_for_Electric_Mobility, 2018): • Developing national technology for electrical engines. • Developing new safety technologies products; • Converting the whole local combustion value chain into electric. • Developing a nationwide electrical auto charging infrastruture.
	Innovation Policy Design	• Very simplistic program structure, with the predominance of government subsidies for R&D incremental developments. It is till pushing supply industry to produce new techonologies. (Brazilian_Federal_Congress, 2018; Kutney, 2019)	• An ambitious program structure in a mature level of deployment, with most of the instruments already allocated for pulling new product being released from time to time. (German_National_Platform_for_Electric_Mobility, 2018).
	Innovation Policy Outcomes	No outcome reported. No information found about the current level of deployment. (Ministry_of_Economy, 2020).	A well defined target, with the outcomes being reviewed, discussed and disclosed frequently in a open website portal. (German_National_Platform_for_Electric_Mobility, 2018)
	Innovation Policy Governance	There is no clear public transparency of the outcomes and enforcement of program rules. No follow-up report has been released by the government so far. There is a lack of participation of relevant stakeholders, such as the community and trade unions representatives, on a program counsel. All money invested comes from government. (Ministry_of_Economy, 2020)	There are representatives of the Industry, of the trade unions and of the impacted community in a board defined by Germany government. There is a website portal exclusivelly created to report definitions, follow ups and progresses of the program. Industry has been also participating with investments, together with government. (German_National_Platform_for_Electric_Mobility, 2018)

Source: Authors

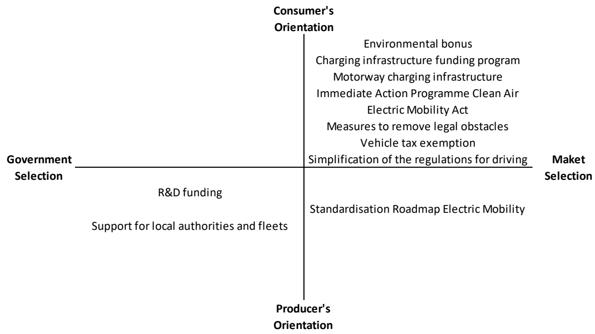
Following the same rational, the context is not just the influencer of 'National Sector Issues' and 'Innovation Policy Goals', but it has direct and indirect influence over the effectiveness of the whole program, once established, whatever can be their objectives. Brazil lower innovation capacity, for instance, always put the country in disadvantage against Germany even if both were targeting the same goals, or if they were applying the same instruments, once the 'Innovation Policy Design', the 'Innovation Policy Outcomes' and the 'Innovation Policy Governance' also depend much on the innovation policy experience cumulated by a government and the innovation culture of local industry's labor. By checking Brazil's and Germany's 'Innovation Capacity'[i] scores at "The Global Competitiveness Report 2019" (Schwab, 2019) (i.e. 40th and 1st, respectively) and reviewing policy programs implementation information available, the influence of human skills, knowledge and experience in this area became even more evident. German labor is very well prepared, capable and used of developing new technologies and this makes a difference on the way the policy instruments are designed, deployed, measured and governed. On this topic Brazil is very far from Germany, despite targeting much simpler objectives related to an incremental innovation plan it has not achieved much progress to transform 'Rota 2030' plan into effective actions yet.

Figure 4 - 'Rota 2030' Policy Instruments (Brazil)



Source: Authors - based on Xu & Su (2016)

Figure 5 - 'NPE' Policy Instruments (Germany)



Source: Authors - based on Xu & Su (2016)

When plotting the policy instruments in use in each program on Xu & Su (2016) matrix it revealed the level of maturity of German program (Figure 5) when compared to Brazilian one (Figure 4). The great majority of policy instruments of 'NPE' are located in the quadrant of 'Consumer's orientation' and 'Market-selection' (i.e. new products 'pulling' incentives) compared to 'Rota 2030' that have most of them allocated in 'Producer's Orientation' and 'Government Selection' one (i.e. new products 'pushing' incentives). The complexity and the level of the investments injected on 'NPE' program are justified by German government ambition of transitioning, in a disruptive way, its entire auto industry into electric mobility producers. In the case of Brazil, its program is only targeting incremental innovation through ethanol and bi-fuel engines efficiency improvement. Compared to 'NPE', 'Rota 2030' program is simplistic and outdated from a global auto industry outlook perspective. Moreover, its governance isn't as efficient as it could be. The lack of indicators and reports of program results signs an underexplored potential.

5. Conclusion

This study main objective was to evaluate how contextual factors influence sectorial 'green' innovation policy program effectiveness. By comparing Brazil and Germany Automotive Industry programs it shows that, meanwhile nation's and its local industries' interests drive and constrain the definition of 'National Sector Issues' and, as a consequence, the 'Innovation Policy Goals' contributing to other socio-technical system findings (Geels, 2004, 2014; Marx et al., 2015), the design and deployment of the program (i.e. 'Innovation Policy Design', 'Innovation Policy Outcomes' and 'Innovation Policy Governance') mainly depends on the innovation capacity of the government and local industries (i.e. Automotive, Auto Parts and Fuel industry, in this case) to manage and deliver its promises, reinforcing the findings of Edler & Fagerberg (2017). This analysis brings several contributions to the literature, such as the proposal and test of a framework that, apart from mapping and establishing the relationship among the relevant variables related, it enables the analysis of contextual influences on them. Second, it integrates Xu & Su (2016) matrix for an analysis and deeper understanding of program's current 'Innovation Policy Design', which provides further evidence of the influence of a country and its local industry innovation capacity on the way the program has been designed (i.e. the simplistic policy instrument design of 'Rota

2030’ contrasting the complex and advanced one of ‘NPE’ program in Figure 4 and 5, respectively) . Third, it brings special attention to ‘Innovation Policy Governance’ construct, not only because it makes it possible the measurement of the way the objectives of a program are being evaluated and enforced, but also because it supports the analytical comprehension of how such experience influences goals changes and/or improvements either for program improvement or for any policy instrument reform for the enhancement of its effectiveness. It, therefore, provides empirical evidence of the relation between innovation capacity and the ‘Innovation Policy Governance’ construct. As a suggestion for future researches ‘New Institutional Economics’ (NIE) theories could be used to analyze how ‘meso-institutions’ (sectorial innovation policy programs, in this case) translate, allocate rights and implements them in a way that sectorial technological transitions can be well incentivized and monitored (Menard, 2018). As a managerial contribution, based on Gluckman et al. (2017), Brazil could use science diplomacy to improve nation’s innovation capacity by taking advantage of the presence of several Germany automotive manufacturing plants locally to engage with German Government and Auto Industry representatives to engage in learning from them. There are important opportunities for complementarities between Brazil and Germany automotive technological development objectives that could mobilize scientific diplomatic relationship through the sector. Germany could benefit from developing and assembling hybrid vehicles equipped with ethanol fuel engines to ensure CO2 European targets compliance in the short and medium term (European_Union, 2020). Brazil could absorb German technical expertise through its subsidiary automotive companies installed in the country for the development of electrical vehicle parts, components and infrastructure locally. The eventual progress of a prior-signed trade agreement between Mercosur and European Union may allow lower taxes for the importation of electrical vehicles from Europe to Brazil and a certain volume of ethanol could be imported by European countries without taxation (European_Commission, 2019).

References

Ahlswede, A. (2019a). Größte Automobilhersteller in Deutschland in den Jahren 2013 bis 2018 nach der Anzahl hergestellter Fahrzeuge. Statista. Business Data Platform Retrieved from https://de.statista.com/statistik/daten/studie/246827/umfrage/automobilproduktion-deutscher-hersteller/

Ahlswede, A. (2019b). Statistiken zur Automobilindustrie Deutschland. Statista. Business Data Platform Retrieved from https://de.statista.com/themen/1346/automobilindustrie/

Ahlswede, A. (2019c). Umsatz der Automobilindustrie in Deutschland in den Jahren 2005 bis 2018. Statista. Business Data Platform Retrieved from https://de.statista.com/statistik/daten/studie/160479/umfrage/umsatz-der-deutschen-automobilindustrie/

Akaev, A., & Pantin, V. (2014). Technological Innovations and Future Shifts in International Politics. *International Studies Quarterly, 58*(4), 867-872. doi:10.1111/isqu.12124

ANFAVEA. (2019). Brazilian Automotive Industry Yearbook - 2019. Report Retrieved from http://www.virapagina.com.br/anfavea2019/

Bormann, R., Fink, P., Holzapfel, H., Rammler, S., Sauter-Servaes, T., Tiemann, H., . . . Weirauch, B. (2018). The future of the German automotive industry : transformation by disaster or by design? Wiso Diskurs. Friedrich-Ebert Stiftung. Report Retrieved from http://library.fes.de/pdf-files/wiso/14450.pdf

Borras, S., & Edquist, C. (2013). The choice of innovation policy instruments. *Technological Forecasting and Social Change, 80*(8), 1513-1522. doi:10.1016/j.techfore.2013.03.002

Brazilian_Federal_Congress. (2018, 2018). LEI Nº 13.755, DE 10 DE DEZEMBRO DE 2018 - Programa Rota 2030 - Mobilidade e Logística. Law Retrieved from http://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2018/Lei/L13755.htm

Chazan, G. (2019). Car industry woes weigh on Germany's prospects. Financial Times. August, 1st of 2019. Electronic Newspaper Retrieved from https://www.ft.com/content/0e477fae-b383-11e9-8cb2-799a3a8cf37b

Daudt, G. M., & Willcox, L. D. (2018). Indústria automotiva - Visão 2035: Brasil, país desenvolvido: agendas setoriais para alcance da meta. 1 ª ed. Rio de Janeiro : Banco Nacional de Desenvolvimento Econômico e Social, 2018. p. 183-208. Eletronic Book Retrieved from http://web.bndes.gov.br/bib/jspui/handle/1408/16241

de Lara, F. F., & Marx, R. (2018). Comparative positioning between Brazilian subsidiaries and European matrices on Electromobility and carsharing technologies. *Research in Transportation Business and Management, 27*, 67-74. doi:10.1016/j.rtbm.2018.08.001

Dicken, P. (2015). *Global Shift – Mapping the Changing Contours of the World Economy.* (7th ed.). New York: Guilford Publications.

Edler, J., & Fagerberg, J. (2017). Innovation policy: what, why, and how. *Oxford Review of Economic Policy, 33*(1), 2-23. doi:10.1093/oxrep/grx001

European_Commission. (2019). Key elements of the EU-Mercosur trade agreement. June, 28th of 2019. Press release Retrieved from https://trade.ec.europa.eu/doclib/press/index.cfm?id=2040

European_Union. (2020). CO2 emission performance standards for cars and vans (2020 onwards). Web Retrieved from https://ec.europa.eu/clima/policies/transport/vehicles/regulation_en

Federal_Ministry_of_Economic_Affairs_and_Energy. (2011). Regierungsprogramm Elektromobilität. Report Retrieved from https://www.bmwi.de/Redaktion/DE/Downloads/P-R/regierungsprogramm-elektromobilitaet-mai-2011.html

Federal_Ministry_of_Economic_Affairs_and_Energy. (2020). Petroleum and Motor Fuels. Web

Geels, F. W. (2004). From sectoral systems of innovation to socio-technical systems - Insights about dynamics and change from sociology and institutional theory. *Research Policy, 33*(6-7), 897-920. doi:10.1016/j.respol.2004.01.015

Geels, F. W. (2014). Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory Culture & Society, 31*(5), 21-40. doi:10.1177/0263276414531627

German_National_Platform_for_Electric_Mobility. (2018). Progress Report 2018 – Market ramp-up phase. Report Retrieved from http://nationale-plattform-elektromobilitaet.de/en/the-npe/publications/

Gluckman, P. D., Turekian, V. D., Grimes, R. W., & Kishi, T. (2017). Science Diplomacy: A Pragmatic Perspective from the Inside. *Science & Diplomacy, 6*(4).

Henzelmann, T., Frei, D., Schönberg, T., Wunder, T., & Neuenhahn, C. (2017). Urbane Mobilität 2030: zwischen Anarchie und Hypereffizienz - Autonomes Fahren, Elektrifizierung und die Sharing Economy bestimmen den Stadtverkehr von morgen. Report

Imprensa_Nacional. (2018). RESOLUÇÃO Nº 492, DE 20 DE DEZEMBRO DE 2018. Retrieved from https://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/56643907

Kuhnert, F., Stürmer, C., & Koster, A. (2018). *PWC - Five trends transforming the Automotive Industry*. Retrieved from https://www.pwc.com/gx/en/industries/automotive/publications/eascy.html

Kutney, P. (2019). Indústria automotiva toma o rumo da Rota 2030 - Automotive Business. Eletronic Magazine Retrieved from http://www.automotivebusiness.com.br/noticia/29055/industria-automotiva-toma-o-rumo-da-rota-2030

Langer, R. (2013). *Innovationslobbying – Eine Analyse am Beispiel der Elektromobilität*. Wiesbaden: Springer VS.

Marx, R., de Mello, A. M., Zilbovicius, M., & de Lara, F. F. (2015). Spatial contexts and firm strategies: applying the multilevel perspective to sustainable urban mobility transitions in Brazil. *Journal of Cleaner Production, 108*, 1092-1104. doi:10.1016/j.jclepro.2015.09.001

MCTIC. (2016). ESTRATÉGIA NACIONAL DE CIÊNCIA, TECNOLOGIA E INOVAÇÃO 2016|2022. Ministério da Ciência, Tecnologia, Inovações e Comunicações. Brasília - 2016. Report Retrieved from http://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/Publicacoes/ENCTI/PlanosDeAcao.html

Mello, A. M., Marx, R., & Motta, F. G. (2016). A preliminary analysis of Inovar Auto Impact on the Brazilian automotive industry R & D activity. *Revista de Administração e Inovação, 13*(1), 47-62.

Menard, C. (2018). Research frontiers of new institutional economics. *Rausp Management Journal, 53*(1), 3-10. doi:10.1016/j.rauspm.2017.12.002

Ministry_of_Economy. (2020). Rota 2030 - Mobilidade e Logística. Website Retrieved from http://www.mdic.gov.br/index.php/competitividade-industrial/setor-automotivo/rota2030

Ragin, C. C. (2014). *The Comparative Method: Moving Beyond Qualitative and Quantitative Strategies*. Oakland, California, USA: University of California Press.

Schwab, K. (2019). Global Competitiveness Report 2019 - World Economic Forum. Cologny/Geneva, Switzerland. Report Retrieved from https://www.weforum.org/reports/global-competitiveness-report-2019

Sindipeças, & Abipeças. (2019). Brazilian Auto Parts Industry Performance 2019. Report Retrieved from https://www.sindipecas.org.br/area-atuacao/?co=s&a=desempenho-do-setor-de-autopecas#.V7HCq5grKUk

Wesseling, J. H. (2016). Explaining variance in national electric vehicle policies. *Environmental Innovation and Societal Transitions, 21*, 28-38. doi:10.1016/j.eist.2016.03.001

Xu, L., & Su, J. (2016). From government to market and from producer to consumer: Transition of policy mix towards clean mobility in China. *Energy Policy, 96*, 328-340. doi:10.1016/j.enpol.2016.05.038

[i] 'Innovation Capacity' (Schwab, 2019) is composed by the following metrics: (1) Interaction and diversity (Diversity of workforce, State of cluster development, International co-inventions, Multi stakeholder collaboration), (2) Research and development (Scientific publications, Patent applications, R&D expenditures, Research institutions prominence) and (3) Commercialization (Buyer sophistication and Trademark applications).