Will Rota 2030 deliver sustainable innovation? Comparing the ends and means of Brazilian and German auto industry innovation policies

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Abstract

Purpose – Due to dramatic transformation of the auto industry, governments are implementing innovation policies to ensure the domain of sustainable technologies. According to the literature, developing countries that depend on multinational subsidiaries must invest in complementary innovation to be part of their research and development (R&D) headquarters' long-term plans. This study analyses the Brazilian auto industry innovation policy (Rota 2030) to evaluate if it targets complementarity with the German's one (NPE). It also compares the institutional arrangements of the former against the latter to check for governance gaps.

Design/methodology/approach – It applies a case-oriented comparative method (Ragin, 2014) for the analysis of qualitative evidence on secondary data. It investigates evidence of complementarity between Rota 2030 and national platform for electric mobility (NPE) objectives and checks for governance gaps in Rota 2030 using NPE as a reference.

Findings – The results confirmed a loose fitting between the innovation policies mainly for a lack of determinism of Rota 2030 objectives. Governance gaps were also found on Rota 2030 policy formulation and operationalization.

Practical implications – It contributes for the improvement of Rota 2030, and its analytical frame may be used for the formulation or adjustment of other developing countries' innovation policies.

Originality/value – It contributes with innovation system and policy field development with a theoretical extension coming from the New Institutional Economics (NIE) (Menard, 2018). By examining the performance of "institutional arrangements" during the process of formulation and operationalization of innovation policies, it shows the importance of coordination for their effectiveness.

Keywords Innovation capabilities, Innovation policy, Policy formulation, Policy gaps, Policy governance, Sectoral innovation

Paper type Research paper

1. Introduction

Since the development of ethanol-powered engines and multi-fuel electronic injections, the Brazilian auto industry has not found its way back to innovation. Globalization has led the

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investment in research and development (R&D) to focus on multinational headquarters (Freeman, 1995, p. 7, Patel & Pavitt, 1991, Patel, 1995). As almost all the relevant car manufacturers installed in Brazil are multinational subsidiaries, developing locally sourced innovation in the sector has been a challenging mission.

Improving subsidiaries' innovation capabilities to meet local market requirements is not sufficient for their integration in R&D global projects (Tarraco, Bernardes, Borini, & Rossetto, 2019). They must prove their potential to add value to these projects (Tarraco *et al.*, 2019). By getting access to global projects, subsidiaries could enhance their competitiveness through material and knowledge inputs from global value chains (Ibusuki, Kaminski, & Bernardes, 2020). On the other hand, "it is important for DMNEs [multinational companies from developed countries] to integrate their activities in developing economies into their global value chains to increase operational efficiency, capitalize on market opportunities, and stimulate innovation" (Luo, Zhang, & Bu, 2019).

Ibusuki *et al.* (2020) compared the outcomes of Brazilian innovation policies for the aviation and automotive sectors. They found that the automotive industry did not promote significant interactions among research agencies, universities and firms to improve local innovation as the aviation industry did. It is possible to improve these findings by investigating the direction and effectiveness of the current innovation policy in the Brazilian automobile industry (Rota 2030) to generate sustainable innovation in the country.

It would be insightful to compare Rota 2030 objectives with those of a program developed inside the country of origin of any automaker that maintains relevant operations installed there. This study extends Bell and Figueiredo's (2012) innovation capability evolutionary framework by elaborating further assumptions. Such further assumptions would be on how the macro- and meso-level agencies of developing countries' policies may support the generation of locally sourced sustainable innovation, improving national economic, social and environmental development (Bell, 2009, Tarraco *et al.*, 2019). First, it investigates if Rota 2030 has decidedly addressed the integration of local innovation capabilities to produce global projects complementarity [1] for the corporations (Bell & Figueiredo, 2012, Immelt, Govindarajan, & Trimble, 2009). Second, it assesses the Rota 2030 efficiency to deliver on its promise. Such analysis applies a theoretical framework based on the meso-economic institutions brought from New Institutional Economics (NIE) literature (Menard, 2018). That extension contributes for the so-called evolution of the innovation system and policy field of research (Weber & Truffer, 2017, Flanagan & Uyarra, 2016). According to NIE, well-designed governance ensures higher coordination for interactions among the actors of a system (Menard, 2018), where mesoinstitutions are responsible for the translation, monitoring, adaptation and enforcement of "the rules of the game" (North, 1990). By following Menard, Jimenez and Tropp (2018), we also verified the governance gaps of Rota 2030.

To proceed with the investigations, we selected the current German auto industry innovation policy – NPE [2] – as a reference for the achievement of two main objectives: (1) evaluate if there are complementarities between the objectives of Rota 2030 and NPE and (2) evaluate Rota 2030 governance effectiveness by applying NPE governance as an analytic parameter (benchmarking).

German automakers have been among Brazil's leaders in producing automotive vehicles for several years (ANFAVEA, 2020). For this reason, we chose NPE as a reference for an innovation policy typical of a global automaker that operates in the country, reflecting areas of potential complementarity of innovation that could be addressed by Rota 2030. By driving Germany to the top of the global electric vehicles production race, besides China (Schöttle, 2018), scholars can credit it as a flagship policy. Such a policy promotes the electrical powertrain trend followed by most (if not all) automakers representing a relevant market share in developed markets (PwC, 2020, McKinsey & Company, 2020, KPMG Automotive Institute, 2020). Beyond being a good reference for the innovation complementarity investigation, NPE, being implemented in Germany since 2010 with relative success (German National Platform for Electric Mobility, 2018), also reinforces its election as the parameter for the analysis.

To achieve the objectives, we performed a comparative case analysis between Rota 2030 and NPE by reviewing official reports, press and scientific publications.

Next, the study continues with a literature review that enabled the consolidation of the constructs included in a framework (Figure 1) adapted from Bell and Figueiredo (2012) and tested here.

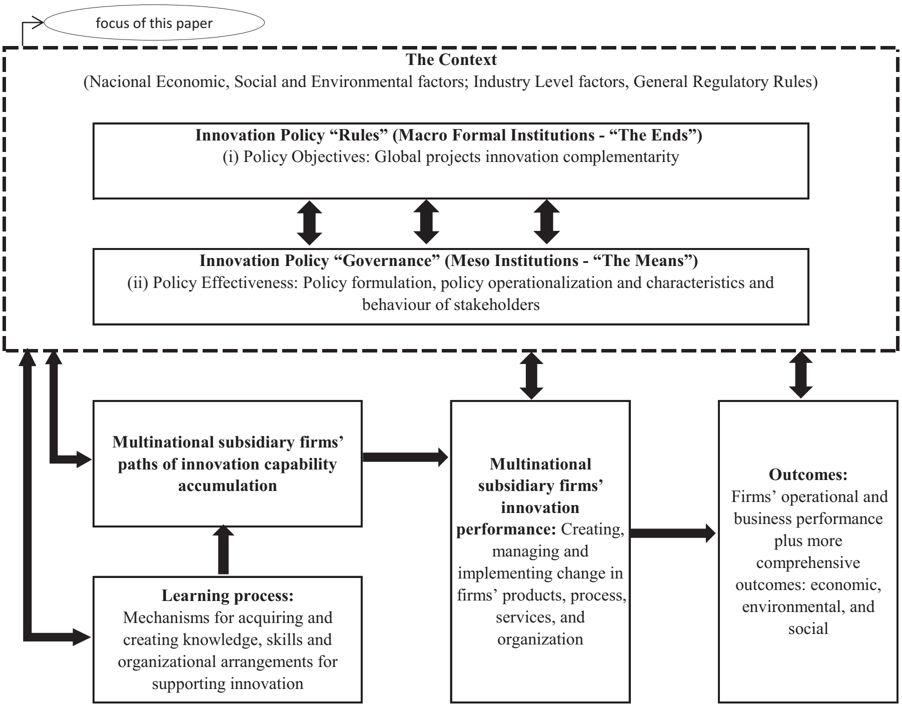
2. Literature review

2.1 The evolution of innovation capabilities in auto industry subsidiaries of developing countries – a "microlevel" perspective

The case of Hyundai, which used to be an assembler of Ford and became the producer of its vehicles in less than three decades, is emblematic of the auto industry (Kim, 1998, Bell, 2009). Kim (1998) synthesized this evolution as a cyclical dynamic involving the following learning stages:

(1) *Preparation* for the acquisition of external knowledge – a stage characterized by "learning-before-doing" activities;

(2) *Acquisition* of knowledge, which can have the form of "imported technology" in initial phases, may progressively be superseded by locally produced technology, depending on the firm's "absorptive capacity" (Cohen & Levinthal, 1990);



Source(s): Adapted from Bell and Figueiredo (2012)

Figure 1. Analytical framework

(3) *Assimilation* of technology by specific teams of technicians inside a firm's operation– initially characterized, at "importing technology" phases, by "learning by doing" activities, eventually shifting to "learning by research" behavior, but that would be only for firms capable of producing their technology;

(4) *Improvement/Application* of the assimilated technology is also characterized by "learning by doing" activities at initial phases, eventually leveraging to "learning by research" activities at mature phases.

Kim (1998) evidenced that innovation capability improvements depend on the level of development of specific kinds of knowledge by some firm technicians. Three out of four stages (1, 3 and 4) were internal and subject to the development of non-R&D capabilities, also called "design and engineering" (D&E) capabilities (Bell, 2009) or operational capabilities (Zawislak, Fracasso, & Tello-Gamarra, 2018). Only during stage (2), the firm would be obtaining the technology from external sources. Therefore, "the quality of the learning linkages needs to be deliberately changed over time for the firm to attain progressively higher levels of innovation capability," going from learning for production to learning for innovation, gradually moving from intracorporate to local knowledge sources (Bell & Figueiredo, 2012).

Kim (1998) suggested that importing technologies and developing them within the country were not excludable but complementary activities of the evolutionary process of innovation, especially for the "catching-up firms" located in developing countries. Starting from technology's imitation was an almost necessary step for a firm to strive for excellence by creating and developing its processes and products. Kim (1998) also observed the context influence of the transition achieved by Hyundai. There was in Korea plenty of qualified labor, a competitive working culture and a government supporting local firms' innovative attitude. These findings corroborate Bell and Figueiredo's (2012) original framework, which considers the influence of exogenous factors on the introduction of locally sourced R&D.

2.2 Obstacles on the path of innovation of auto industry subsidiaries – a "microlevel" perspective

The intensification of globalization in the last decades has caused a surge of transnational companies in the automotive industry. Technological development has generated such growth that reduced the production and transaction costs making room for other economies of scope and scale (Langlois, 2003).

In opposition to the standardizing's economies, a certain level of diversification was necessary due to variations in consumer taste, regulations and climate issues. Therefore several developing countries started to compete for the direct investments of automakers for product and production development (Freeman, 1995).

Nevertheless, against the expectations of emerging countries to improve the retention of R&D investments, some studies confirmed that multinational innovation capabilities were not as globalized as their new products and processes (Patel & Pavitt, 1991). The patents registered out of the countries of origin of multinational companies amounted to 4.4% of the total from 1985 to 1990, which is 0.9% less than the previous equivalent period (Patel, 1995). Converging to it, the R&D expenditure of Brazilian automotive subsidiaries out of their corporate chains was 5.3% of the total in 2011 and 3.9% in 2014 (Ibusuki *et al.*, 2020). That was evidence that the Brazilian innovation policy from 2013 to 2017 – Inovar-Auto – was ineffective (Ibusuki *et al.*, 2020).

2.3 The national system of innovation – a "macrolevel" perspective

From the end of Second World War to the 1970s, scholars and experts have primarily centered the first generation of innovation policies on correcting "market failures" caused by the difficulty of appropriation of the returns of R&D investments by private firms. By investing in open innovation through public universities and research centers and implementing "Intellectual Property Regimes" (IPRs), governments took the lead in mitigating the most evident uncertainties tied to these investments (Edler & Fagerberg, 2017).

Nelson and Winter (1982) claimed that the economic growth of industries and countries could not be explained alone by the increase in production outcomes. The innovation, supposedly justifying the gap, was derived from the dynamics of interactions among heterogeneous economic agents that promoted variety creation, selection or continuation (Nelson & Winter, 1982). Consequently, national governments had more specific responsibility for diagnosing and repairing the "national system of innovation failures" by getting the right balance of variety creation and variety selection to strive for growth (Edler & Fagerberg, 2017).

The governments of some emerging countries (e.g. Korea) realized the opportunity. They established the structure (e.g. innovation parks and D&E training centers) and incentives (e.g. venture capital and subsidies) for the development of non-R&D capabilities within domestic firms, promoting their interaction with local sources of R&D capabilities (Bell, 2009). Those governments encouraged the generation of various products and ways of production and the diffusion of standard generic technologies within their domestic industries. They enjoyed sustainable periods of growth by unblocking the potential complementarity of the imported and local innovation capabilities (Freeman, 1995).

2.4 Policy targets for the development of the "catching up" industries in emerging countries – a "macrolevel" perspective

Since many factors influence the dynamics of institutions, innovation policies are better understood when focused on particular sectors and time (Schumpeter, 1942, Nelson, 2008). By assessing the main targets of industrial innovation policies for the emerging countries of our time, Bell (2009) suggested that their governments should

(1) Rebalance the incentives from R&D activities to non-R&D capabilities activities found inside the firms and

(2) Overcome the paradigm of "importing versus developing technology locally" and assume the potential of complementarity of innovation capabilities.

However, even recognizing that setting the right goals is a critical step, the process still requires effective governance to deliver on the promise.

2.5 The governance of innovation policies in the auto industry – a "mesolevel" perspective

The NIE suggests separating the "institutional environment" (North, 1990) from the "institutional arrangements" at the intermediate level. Such a separation is required to deploy and assess the interactions they stimulate with the economic agents (Menard, 2018, Vinholis, Saes, Carrer, & de Souza, 2021). These "meso-institutions designate the set of devices (entities) and mechanisms (procedures) that translate the general rules, adapt them and make them operational, providing guidelines to operators and users, and feedback to the decision-makers" (Menard *et al.*, 2018).

Policymakers define innovation policies. They also implement them through specific instruments designed and coordinated by agencies or bureaus formed by diverse stakeholders (Edler & Fagerberg, 2017). Due to the complexity involving their dynamics (Nelson, 2008, Weber & Truffer, 2017, Flanagan & Uyarra, 2016), there may be gaps (1) in the policy formulation, (2) in the operationalization of the policy and (3) related to the characteristics and behavior of stakeholders (Menard *et al.*, 2018).

(1) Gaps in policy formulation

Scholars and experts address innovation policies according to their objectives. Still, there may be gaps in their formulation because of sociotechnical or economic path dependence (Geels, 2004, Edler & Fagerberg, 2017, Wesseling, 2016); the capture by influential groups (Geels, 2014); the lack of understanding of the innovation process by policymakers (Edler & Fagerberg, 2017, Bell, 2009) or the lack of clear targets (Ibusuki *et al.*, 2020).

(2) Gaps in operationalization of the innovation policy

Scholars, experts and people in charge carry out the innovation policies through incentives and constraints that must be (re)allocated according to policy plan and progress and local context transformation (Nelson, 2008, Edler & Fagerberg, 2017). Their deployment may be ineffective due to the lack of flexibility for the necessary adjustments (Nelson, 2008, Xu & Su, 2016, Edler & Fagerberg, 2017, Ibusuki *et al.*, 2020); measurement or execution difficulties (Edler & Fagerberg, 2017) or the lack of capacity or proactivity of the institutions in charge of deploying them (Ibusuki *et al.*, 2020).

(3) Gaps related to the characteristics and behavior of stakeholders

Innovation policies impact various stakeholders in terms of supply and demand in the sector. They must have mechanisms to ensure the allocation of their rights and voices to improve legitimacy and prevent negative externalities (Menard *et al.*, 2018). There may be gaps in such policies due to the lack of quality of stakeholder representation (Serger, Wise, & Arnold, 2015); the capture of stakeholder representation by specific interest groups (Geels, 2014) or conflicts generated among the stakeholders' representation (Serger *et al.*, 2015).

2.6 Analytical framework

The authors synthesized the constructs reviewed in this section and their interrelations in Figure 1 framework, which highlights the paper's focus.

3. Method

This study applies a qualitative approach to assess the evidence found in secondary sources. The two investigations are deductive (theory driven) and apply the comparative case analysis method (Ragin, 2014). The first investigation looks for complementarity between the object of analysis and a reference to confirm a theoretical prescription. The second investigation looks for the similarity between the object of analysis and a parameter for assessing the former. Thus, both analyses assume NPE as ideal for describing the case variations according to the expected outcomes: complementarity in the first and similarity in the second analysis. The research is also normative as it extends NIE theory to the field of innovation systems and policy, consolidating the concepts in a framework.

The comparative case method applied provides "a basis for examining how conditions combine in diverse ways and in different contexts to produce different outcomes" (Ragin, 2014, p. 52). To comply with the method's requirements, we illustrate the contextual factors that affect the object of analysis and the parameter in Table 1, characterizing the industry in Brazil and Germany. Table 1 displays several heterogeneous and typical pushes (supply of labor and financial, science and technology, and energy resources) and pulls (demand factors) influences. It also shows the environmental regulations that influence the challenges faced by the parent country and subsidiaries firms to develop complementary innovation (Bell, 2009, Luo *et al.*, 2019).

Context	Brazil (Rota 2030)	Germany (NPE)
Auto industry relevance	• 3% of national GDP (ANFAVEA, 2020, p. 7) • 1.3 million direct and indirect employees in 2020 (ANFAVEA, 2020, p. 7)	• 5% of national GDP (Chazan, 2019) • 820,000 employees in 2017 (Ahlswede, 2019)
Auto industry orientation	Mainly domestic market (Daudt & Willcox, 2018, p. 192)	Global and domestic markets (German National Platform for Electric Mobility, 2018, p. 17)
Auto industry product profile	Compact and low-power engine vehicles in the substantial majority, fueled by ethanol and petrol (multifuel) (ANFAVEA, 2020)	Medium vehicles' predominant demand, fueled by petrol or diesel in the vast majority (Ahlswede, 2019)
National fuel production	Brazil is a significant oil exporter, and it is the biggest ethanol producer in the world (Daudt & Willcox, 2018)	Germany is not a relevant oil or ethanol producer, and it has been strategically reducing its petrol imports since 1970s (Federal Ministry of Economic Affairs and Energy, 2020)
Vehicle emission standards	Are challenging passenger vehicles targets (BR) (Diário Oficial Da União, 2018), according to the mix of products manufactured locally (g CO2/km) • 80 (~2022); • 50 (2023~2024); • 40 (2025~2026); • 30 (2029~2031)	Are aggressive passenger vehicles targets (EU) (European Union, 2020), according to the mix of products manufactured locally (g CO2/km) • 95 (~2024); • 15% reduction or 80.75 (2025~2029); • 37.5% reduction or 61.75 (2030~)
Auto industry origin of the capital	Automakers and auto parts operating in Brazil are, in their overwhelming majority, subsidiaries of multinational corporate companies (Daudt & Willcox, 2018, p. 186)	Automakers and auto parts operating in Germany are local, global and national corporations. They are traditional exporters, with subsidiaries and manufactories installed worldwide (Dicken, 2015, p. 501-02)

Source(s): Elaborated by the authors

Table 1. Contextual scenario of the innovation policies (cases)

The data used for the analysis are primarily documental and come from official governmental sources, such as constitutional laws, official reports, ministries and bureaus' minutes. Nevertheless, some relevant press and scientific documents also contributed to the data source triangulation and improved the evidence's quality whenever different perspectives were essential to enhance validity. The analysis of the evidence presents the authors' consensual synthesis of their findings with all their sources and references.

4. Analysis and results discussion

Based on Table 2, there may be complementarity between NPE and Rota 2030 objectives, but it could not be found due to Rota 2030 lack of determinism. Rota 2030 objectives could be classified as of an exploratory program, looking for innovations in several areas, industries and technologies, without a sharp vision of where the auto industry should be by 2030, according to their intentions. One indication of how they could be more complementary to NPE objectives was Volkswagen's decision to invest in a biofuel R&D center in Brazil (Volkswagen Latin America, 2021).

It is possible to explain Rota 2030 diffuse objectives from how they were formulated (Table 3). Unlike Germany, Brazilian policymakers have not had the same historical relation with scientific matters by focusing on innovation opportunities (Freeman, 1995). When the Ministry of Industry, Foreign Trade and Service (MDCI) created the High-Level Group 2030

	Program objectives/Goals	NPE/Rota 2030 complementarity analysis
NPE	"[. . .] launched in 2010 on the initiative of the Federal Government, industry, trade unions and representatives of civil society to facilitate close cooperation in the pursuit of their common goals" (German National Platform for Electric Mobility, 2018). "Germany has set itself a number of ambitious policy goals to be attained by 2020": • To make German industry the leading global supplier • To establish Germany as the leading global market • To have one million electric vehicles on the road in Germany Electric mobility is becoming increasingly important internationally. The market is growing rapidly all over the world, particularly in countries with the preconditions required for its development" (German National Platform for Electric Mobility, 2014) "It also seeks to maintain and increase current employment levels across the entire value chain" (German National Platform for Electric Mobility, 2018)	NPE is a straightforward program, targeting the development of a single technology (electrical propulsion for vehicles) in one specific industry (automotive). Rota objectives refer to several areas of development ("safety, environmental protection, energy efficiency and quality") in many industries ("automobiles, trucks, buses and engine-equipped chassis"). Its goals even allow investments in alternative technologies for an area of development ("biofuel and other alternative propulsion"). Rota could focus its efforts on biofuel technology for automotive vehicles to take advantage of decades of development related of this technology, the national production and sourcing of biofuels and its extensive local market for small compact vehicles. It could dominate this technology, exporting it to other developing markets with similar demand profiles. According to Volkswagen, which announced a long-term investment in an R&D center in Brazil to develop products based on biofuel and ethanol, "the use of biofuel is a complementary strategy to support the industry in emerging markets for offsetting carbon emissions" (Volkswagen Latin America, 2021)
Rota 2030	Its objective is "to support the technological development, competitiveness, innovation, vehicular safety, environmental protection, energy efficiency and quality of automobiles, trucks, buses, engine-equipped chassis and auto parts" (Brazilian Federal Congress, 2018). Its main goals are to "(i) increase the energy efficiency, structural development and availability of driving assistance technologies in the vehicles traded inside the country (ii) increase investment 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 logistics industries (v) promote the use of biofuel and other alternative propulsion and add value to the Brazilian energy matrix (vi) ensure technical capacity and professional qualification in the mobility and logistics sector (vii) ensure the expansion or maintenance of employment levels in the mobility and logistics sector (Brazilian Federal Congress, 2018)"	

Source(s): Elaborated by the authors

Table 2. Program objectives and complementarity analysis

(GAN 2030) to formulate the policy's objectives, it invited only the industry representatives. The Ministry of ST&I (Science, Technology and Innovation) or academic associations were not present (Ministry of Economy, 2017, Diário Oficial Da União, 2017).

The analysis of gaps in the operationalization of Rota 2030 (Table 4) shows it is a long-term innovation policy with enough flexibility for the necessary adjustments (three cycles of

(1) Policy formulation	NPE (similarity parameter)	Rota 2030 (object of analysis)	Rota 2030 gaps
Sociotechnical and economic path dependence	"In view of the great importance of the automobile and the overriding importance of the automotive industry for Germany's economy, politicians, trade unions and even to some extent environmental NGOs have primarily viewed electric cars as the solution to traffic-related environmental problems" (Richter & Haas, 2020)	"The program was elaborated to forecast the future of the mobility and of the logistic in Brazil and to enlarge the global insertion of Brazilian automotive industry through the expansion of automotive vehicles and parts exportation" (Ministry of Economy, 2020b)	German government shared a clear and objective vision with the stakeholders to promote a long-term shift of its entire automotive value chain to innovative technology. The Brazilian government also recognized its dependence on auto industry but has not had a sharp vision about its future. What is the sociotechnical transition necessary to sustain the auto industry in Brazil?
Capture by influential groups	"[. . .] some scholars argue that stakeholders such as the automotive and supplier industries have been particularly successful in pushing their interests through" (Richter & Haas, 2020). But "the three major German automotive manufacturers (BMW, Daimler, VW, Stuttgart, Germany) have pursued different goals with regard to propulsion technology" (Richter & Haas, 2020)	"The original Rota 2030 legislation was approved almost without changes in relation to the provisional measure, but some congressmen got the inclusion and approval (with no presidential veto) of two important regulatory amendments which increased program's tax waiver" (Kutney, 2019)	No one has found proof of capture by any specific group for the formulation of NPE. In the case of Rota, the government established a reduction of three points on a tax applied for multi-fuel hybrid vehicles (amendment imposed by the sugar cane bench) as well the extension of tax benefits (up to 2025) to auto companies operating in the Northeast region (Kutney, 2019)
Understanding of the innovation process by policy-makers	"Germany's economic strength is largely based on the efficiency of German industry, and particularly on its innovative strength [. . .]. All of the federal ministries work together on this strategy ['High-tech Strategy'], and have coordinated their respective measures" (Federal Ministry for Economic Affairs and Energy, 2021)	In 2017, the Ministry of Industry (MDCI) created the GAN 2030 (High-Level Group), which counted on the support of six working groups integrated by representatives of the industry and government for the formulation of the program policy (Ministry of Economy, 2017)	Politicians and the government have been historically involved in promoting innovation in Germany (Freeman, 1995). Brazil has improved, but it still does not involve scientists in innovation policy discussions and formulation. The GAN 2030 formed by the MDCI only consulted industry members to formulate Rota 2030

(continued)

Table 3.
Gaps on policy formulation

(1) Policy formulation	NPE (similarity parameter)	Rota 2030 (object of analysis)	Rota 2030 gaps
Clear targets	"Germany aims to become a leading supplier and – with one million electric vehicles on the road – a leading market for electric mobility by 2020. It also seeks to maintain and increase current employment levels across the entire value chain" (German National Platform for Electric Mobility, 2018). It targets 3 million electric vehicles by 2025 (German National Platform for Electric Mobility, 2018)	Rota aims addressing "the low competitiveness of the national automotive industry [. . .], the technological lag [. . .], the risk of transference of R&D activities to other centers [. . .], the risk of loss of investment in the country [. . .], the existence of idle capacity in the industry [. . .] and the risk of loss of knowledge related to the development of technologies that apply biofuels" (Ministry of Economy, 2020b)	Despite the complexity of the transition that Germany has been managing for its entire auto industry, its targets are clear and straightforward. Rota 2030 defined specific output targets, but they are still fuzzy and multidirectional. Like NPE, Rota 2030 should be clear about what technology it wants to master and how many new products it must produce and sell per year

Table 3. **Source(s):** Elaborated by the authors

five years). It also has a robust organizational structure institutionally capable of addressing the financial resources provisioned for its purpose (about R$200 million per year of the first cycle). The main issue was the lack of proactivity of the participants in charge of managing the program. There is a delay in the program, and no follow-up report could be conciliated and disclosed. In contrast to NPE, which generated four reports in its first five years, no one noticed any sense of urgency to push the Rota chronogram.

Issues were also found in the representation of the stakeholders in Rota 2030 (Table 5). The government is overrepresented, and the Ministry of Economy has a superpower for defining the program's direction and speed. The Ministry of Economy maintains the Chair of the program, 30% of the Managing Board and 67% of the follow-up group; the Ministry of ST&I and Communication has 20% of the former and 33% of the latter. The lack of representation of the Science community, which does not have a Chair in the program, and the lower representation of the industry show that Rota 2030 may have problems of legitimacy.

5. Final considerations

The study's primary objectives were to assess the complementarity between the NPE and Rota 2030 innovation policies and verify any gaps in governance that could prevent the Brazilian innovation policy from fulfilling its promise. Comparative case analysis confirms that Rota 2030 has less-than-ideal complementarity with the NPE due to its diffuse objectives: to simultaneously address innovation in several technical areas of many industries and consider developing more than one technology for the same area. Rota 2030 has acted as an exploratory innovation policy due to the lack of coordination in formulating its rules (macro institutions) and its effective deployment by governmental bodies (meso institutions).

When looking for sources of misalignment between the institutional arrangements, incentives and resources mobilized (Menard *et al.*, 2018) in an industrial innovation policy, our analysis found gaps in the process of formulation of Rota 2030 rules, their operationalization and at the level of representation of its stakeholders. It illustrated how governments generate and deploy this type of policy, highlighting opportunities to improve its governance and

(2) Operationalization of the policy	NPE (similarity parameter)	Rota 2030 (object of analysis)	Rota 2030 gaps
Flexibility for the necessary adjustments	NPE main phases • 2010–2014: market preparation phase: R&D and showcase projects • 2015–2017: market ramp-up phase: commercialization of vehicles and infrastructure • 2018–2025: mass market phase: Germany becoming leading supplier and lead market (German National Platform for Electric Mobility, 2018)	"[Rota] was thought as a long-term public policy of 15 years, divided in 3 quinquennials cycles. For each cycle, a policy review will be conducted, and there will be a reorientation of the goals and instruments" (Ministry of Economy, 2020b). This initiative probably resulted from lessons learned from Inovar-Auto (Mello, Marx, & Motta, 2016)	Rota 2030 followed a similar chorogram to NPE's (15 years divided into three quinquennial phases). That gives time for intermediate reviews of the results against targets for making the necessary adjustments for the next cycles. Unlike NPE, Rota 2030 has not yet released any report due to delays, and NPE produced four reports during its first phase
Measurement or enforcement difficulties	The NPE structure is • Steering committee • Editorial team • 6 working groups: vehicle technology, battery technology, charging infrastructure and power grid integration, regulation, standardization and certification, information and communication technologies and general framework (German National Platform for Electric Mobility, 2018). NPE has just achieved 1 million vehicles in road (Chambers, 2021)	Rota 2030 structure is • Management Board • Follow-up group • 5 institutions for 6 priority programs: BNDES (provisions and financing); EMBRAPII (mobility and logistics R&D programs); FINEP (product, process and service development projects); FUNDEP (tooling/propulsion, biofuels and vehicular safety); SENAI (competence development); (Ministry of Economy, 2019b) No report released yet. (Ministry of Economy, 2021)	NPE has metrics for tasks on high and low levels and a structure with clear roles and responsibilities for members who implement or control them. Since the beginning of the program, it has released five reports, where specific plans are defined to overcome difficulties. Rota also has a structure, with its members' roles and responsibilities, but the inputs and outputs metrics were not implemented yet (they postponed the deadline)

(*continued*)

Table 4.
Gaps on the operationalization of the policy

(2) Operationalization of the policy	NPE (similarity parameter)	Rota 2030 (object of analysis)	Rota 2030 gaps
Capacity or proactivity of the institutions in charge of implementing them	"The Federal Government's joint agency supports the NPE for electric mobility (GGEMO). The office of the NPE's Chairman (based at acatech – National Academy of Science and Engineering) competes for the platform, supports the Chairman in his work, and coordinates the NPE's communication" (German National Platform for Electric Mobility, 2018, p. 77)	"[. . . it was] formalized the five institutions chosen by the Managing Board of Rota 2030 to handle the allocation of the resources to be provided by the 'Regime of non-Produced Auto parts'. The estimation is of R$200 million per year, or R$1 billion for the first cycle of five years of Rota 2030" (Ministry of Economy, 2019b)	In NPE, lower-level positions inform difficulties over their capacities for higher positions to unblock that or empower them to do so. Rota's structure looks appropriate and capable of delivering the results, but the sense of urgency of higher levels positions is different from NPE. Even with representatives of the industry there, the level of commitment of the participants has not been determinant

Note(s): BNDES – Brazilian Development Bank; EMBRAPII – Brazilian Company of Research and Industrial Innovation; FINEP – Funding Authority for Studies and Projects; FUNDEP – Research Development Foundation; SENAI – National Service for Industrial Training

Source(s): Elaborated by the authors

Table 4.

effectiveness. The empirical application and validation of NIE concepts in the framework developed contributed to the innovation system and policy studies by normalizing the relationships between institutional arrangements and the institutional environment at the meso- and macrolevels.

The applied framework may assess other industries' innovation policies for generating innovation capabilities in multinational subsidiaries in developing countries, leading to further theoretical and practical insights. That could support the knowledge improvement about the features of the most efficient institutional arrangements, both for the formulation and the operationalization of innovation policies. There is also an opportunity to explore the influence of different stakeholders' constellations representation in innovation policies, counsels, boards or committees, in charge of formulating or implementing them (Serger *et al.*, 2015). New scientific fronts can also assess the effectiveness of mesointuitions for promoting the cyclical learning momentum to improve innovation capabilities by enhancing the interactions among R&D and non-R&D capabilities and ensuring their right balance (Kim, 1998, Bell, 2009). Recent studies have provided insights into how scholars and experts could test this empirically (e.g. Vinholis *et al.*, 2021, Zawislak *et al.*, 2018).

This study has also made some managerial contributions. It evidenced opportunities for adjusting Rota 2030 objectives to improve the complementarity related to the headquarters of the multinational companies operating in Brazil. That would attract further long-term foreign investments in R&D, similar to what Volkswagen has made recently.

Another contribution was the illustration of the misalignments of the institutional arrangements to deploy Rota 2030. We have shown many opportunities to correct deviations from the intended purposes. Since some countries have cumulated relevant experiences for the formulation and implementation of innovation policies, the Brazilian government may learn from policymakers and other stakeholders' capabilities. The Rota 2030 Managing

(3) Characteristics and behavior of stakeholders	NPE (similarity parameter)	Rota 2030 (object of analysis)	Rota 2030 gaps
Quality of stakeholder representation	• Chair members (3): government (67%) and academy (33%) • Steering committee members (16): government (19%), automakers and associations (38%), auto suppliers and associations (19%), electric utility (6%), e-mobility solutions (6%), union (6%) and academic associations (6%) (German National Platform for Electric Mobility, 2018, p. 78)	• Chair members (1): government (100%) • Managing Board members (10): government (50%), automakers association (10%), auto parts association (10%), venture capitalists association (10%), union (10%) and academic association (10%) (Diário Oficial Da União, 2019)	In Rota 2030, the government is overrepresented and the industry is sub-represented in the Management Board. The Academy should also have at least a Chair of the program. Scientific findings and discussions should be driving the direction and the speed of an innovation program as Rota 2030
Capture of stakeholder representation by specific interest groups	"Due to its structure, the representation of stakeholders, and their participation in the decision-making bodies, the NPE provided a forum for industrial interests to shape the course of transport policy. As such, it reaffirmed the existing power relations between industrial and environmental and consumer-oriented interests" (Richter & Haas, 2020)	The government represents 50% of the Managing Board and 100% of the Rota 2030 follow-up group (with 2 members from the Ministry of the Economy and 1 member from the Ministry of ST&I and Communication) (Ministry of Economy, 2019a). The Ministry of Economy has superpower for deciding the course of Rota. The Ministry of Economy cumulates alone the Chair, 30% of the Managing Board and 66% of the follow-up group	Although the main interests of NPE representatives converge in supporting the transition of the industry to e-mobility, there is still a heterogeneity of interests among them. In the case of Rota, the overrepresentation of the Ministry of Economy is an issue for Rota that must focus on long-term innovation, not only on financial results. The low representation of the Ministry of ST&I and the Academy is a concern
Conflicts generated among the stakeholders representation	"The car industry [. . .] has thwarted any profound change. Also, the trade unions are [. . .] slowing down a switch from fossil fuel-based cars to electric vehicles. [. . .] the Federal Ministry of the Environment, the electricity industry and start-ups are pushing for an ecological modernization utilizing electric vehicles. [. . .] environmental and consumer protection associations and the Association of German Transport Companies sought to address issues beyond electric vehicles such as smaller, energy-efficient cars and more rigid CO2 standards" (Richter & Haas, 2020)	"The enrollment [. . .] requires a mandatory counterpart of minimum investments in R&D proportional to the net revenue of the company, which must be stepwise" (Roa, 2019). "The current legislation brings concepts about the types of R&D activities that managers may frame into the program, but many companies have difficulties mapping the maximum potential of production translating their activities into the related concepts" (Roa, 2019). Continental subsidiary in Brazil is facing issues to handle market fluctuations, and it is reacting to Rota requirements, asking for postponement (Olmos, 2020)	In NPE, the conflicts involving the different interests are more explicit because it is in place since 2010. There have been 5 reports, and many articles in the press and scientific studies about it. Rota started in 2019, and it has not yet released its first report; thus, it is not easy to understand the divergences of interests. Nevertheless, it is noticeable that the program has been trickier for auto parts than for automaker participants. The formers have a narrower product and process scope for R&D investments, and some of them are national capital companies with lower financial resources

Source(s): Elaborated by the authors

Table 5.
Gaps related to characteristics and behavior of stakeholders

Board members may also apprehend better ways of implementation with more experienced groups, such as the NPE Steering Committee.

This study assumed NPE as a typical innovation policy of a leading multinational automotive company operating in a developing country. We considered NPE the reference for our complete analysis. Once we recognize that the representativeness of the chosen policy for the deployment of electric mobility by German manufacturers may not reflect other nations' efforts to support the technological transition of their multinational companies in the automotive sector (e.g. USA and Japan), the evaluation of Rota 2030 against other policies would certainly bring further insights for discussing these empirical findings.

Notes

1. Global projects' complementarity is either referred (1) to the development of complete new global products or services, which manufacturers can add to a multinational company's global portfolio (Immelt *et al.*, 2009) (2) or to develop new components applied to global products or services (Bell & Figueiredo, 2012).
2. National platform for electric mobility.

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