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Patricia A. Morales*
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ABSTRACT

Our research focuses on the position of supplier SMEs within the global unconventional hydrocarbon value chain in the Vaca Muerta reservoir (Neuquén, Argentina), as well as their strategic decisions. Over a decade after the launch of large-scale unconventional projects, research is focusing on the role of small businesses within the regional production system and their integration into the global value chain. The objective of this work is to model strategic planning situations for decision making under the framework of game theory. An analytical-descriptive methodology was employed to investigate the primary challenges faced by SMEs. The results allow us to confirm that the strategic processes can be modeled to optimize decision-making. We conclude that game theory is closely linked to strategic management, providing a broad and integrative perspective.

JEL Code: M150

Key words: SMEs, game theory, modeling, decision making, strategies

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RESUMEN

Nuestra investigación se centra en la posición de las pymes proveedoras de la cadena de valor global de hidrocarburos no convencionales en el yacimiento de Vaca Muerta (Neuquén, Argentina) y sus decisiones estratégicas. Transcurrida más de una década desde la implementación de proyectos no convencionales a gran escala, se investiga la posición de las pymes en el complejo productivo regional, integrado en la cadena global. El objetivo es modelar situaciones de planificación estratégica para la toma de decisiones bajo el marco de la teoría de juegos. Se aplicó una metodología analítico-descriptiva con una recopilación de los principales problemas de las pymes. Los resultados permiten afirmar que los procesos estratégicos pueden modelarse para optimizar la toma de decisiones. Concluimos que la teoría de juegos está estrechamente vinculada a la gestión estratégica y proporciona una perspectiva amplia e integradora.

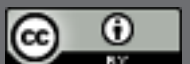
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Palabras clave: pymes, teoría de juegos, modelos, toma de decisiones, estrategias

* Faculty of Economics and Administration – National University of Comahue – Argentina - Master's Degree in Business Management - <https://orcid.org/0009-0003-7167-2322>

** Department of Administration Sciences – National University of the South – Argentina - PhD in Management Sciences -

*** Faculty of Economics and Administration – National University of Comahue – PhD in Engineering



1. INTRODUCTION

Research on how value is distributed in time and space has generated a diversity of contributions from the field of economic sciences, from Adam Smith and his contributions on the division of labor onwards (García & Scardino, 2021; Kano et al., 2020; Scardino & García, 2024). Starting in the '70s, a fundamental transformation occurred in the world economy due to the globalization of production processes (Santarcangelo et al., 2017). A clear and complex pattern of international commercial activity emerged, organizationally fragmented and spatially dispersed, where extraterritorial production sites located in developing countries are observed, strongly linked to leading multinational companies in the main markets of North America and Europe (Ambos et al., 2021; Borin & Mancini, 2019; Johnson, 2018; Kano et al., 2020). In this scenario, companies gradually modified their ways of producing and structured themselves into the so-called global value chains (GVC) (Kaplinsky & Readman, 2001). GVCs are understood as a sequence of activities carried out by companies and workers from the design of the product to its final use or consumption (Gereffi & Fernandez-Stark, 2011). Thus, new models of territorial organization and government emerged, with the common denominator that each basic phase, until the final production of a good or service, was carried out in the location where the resources and capabilities necessary to achieve it are available at competitive costs and quality (Carneiro, 2015; Gibbon & Ponte, 2005; Ponte & Sturgeon, 2014).

Economic development studies have focused on the impacts of the insertion of GVCs, in their different phases, in the regional processes of economic growth (Jiménez Barrera, 2018; Roitter & Sauchelli, 2021). The territory of the Province of Neuquén is inescapably related to hydrocarbon activity and its GVC (Landriscini & Orlandini, 2015; López et al., 2021). Oil and Gas production is the economic activity that contributes the most resources to the provincial budget (Giuliani et al., 2016). Due to this, the province has a significant history in the industry, which has made it possible,

since 2010, to adapt the regional production circuit to the new conditions of unconventional hydrocarbon exploitation (Cáceres, 2023; Landriscini & Carignano, 2019).

In the Vaca Muerta (VM) production circuit, agents are linked based on their interaction with the CGV (Scardino & García, 2024). Thus, first, large multinational operating companies and the Argentine company YPF¹, followed by a group of large companies, suppliers of highly specialized services, define the operating conditions for a group of local SMEs that provide complementary services to the first two groups (Landriscini & Orlandini, 2015). This relational structure between agents generates asymmetric conditions of power, especially for SMEs, which must become more competitive to meet the requirements of the new productive logic (Adriani et al., 2018; Nuñez, 2021). The reconversion of demand drives the need to optimize strategic planning processes by these SMEs (Guiliani et al., 2017). Decision-making, in the planning process (Manzanal et al., 2015), can be approached by modeling tools, such as decision trees under the framework of game theory (Milanesi, 2023).

Thus, this research aims to model real decision-making situations, especially in SMEs, under the TJ reference framework, without placing greater emphasis on mathematical solution methods. Likewise, this paper seeks to show that the game-strategic decision process is simpler when the discussion is focused on the understanding of what game must be played in the context, and what are the possible games, before understanding how to play them (Gorbaneff, 2002).

We frame our research in the field of applied science, which uses scientific knowledge from one or several specialized areas of science to solve practical problems (Bardales, 2021).

1. Yacimientos Petrolíferos Fiscales SAHome - YPF

As a contribution, this research is expected to provide empirical data grounded in the local context, which may be particularly valuable for public policy makers. This is relevant considering that, in many cases, such measures fail to produce the intended outcomes because they are designed without a comprehensive understanding of the actual circumstances. (Giudicatti et al., 2020). It also seeks to contribute with tools to help improve the decision-making task of SME entrepreneurs.

Regarding the contribution of theoretical background, this work seeks to generate a dialectical space between strategic administration, game theory and local territorial economic development, centered on SMEs as essential actors of the system (Bernabe & Meza, 2022; Piana & Cruz Tisera, 2017).

2. This study is organized as follows: it begins with the present introduction, followed by a review of the relevant literature and a description of the methodology employed. Subsequently, the results and their discussion are presented, and finally, the main conclusions are outlined.

LITERATURE REVIEW

Global value chains today

The paradigm of global value chains is one of the most significant contributions of the last 30 years by the theory of economic analysis (Dussel Peters, 2018; Schteingart et al., 2017). Its study has allowed the understanding of the principal transformations of the global productive system, through a systemic approach that explains the relationships between nations and regions, productive links and actors (Gómez, 2017; Llorens, 2008). Likewise, it accounts for the roles that institutions, regulations, public and economic policies play in the model showing basically the effects of productive specialization and international insertion in national and regional economies (Cáceres, 2023; Porta et al., 2017).

The characterization of GVCs is an appropriate tool to understand the dynamics of insertion of companies, productive sectors, countries, and regions in the global production system (Gereffi, 1999; Gereffi et al., 2005; Kaplinsky, 2000; López & Ons, 2023). How a territory is inserted into a value chain can be determined by the intrinsic values of the region, that is, by its natural, heritage, historical resources, etc. (Mancini, 2016). It can also be determined from the introduction of a good or service originated in the same geographical space (Gómez, 2017). The case of the area of Neuquén territory is due to its reserves of hydrocarbon resources, especially VM, for its insertion into the CGV of unconventional hydrocarbons (Schteingart et al., 2017).

A fundamental aspect in the study of GVCs and their impact on regional SMEs is their governance² (Gereffi & Fernandez-Stark, 2011; Humphrey & Schmitz, 2001). It is defined as the set of provisions, power, and authority that establishes the way resources are distributed within a chain (Ponte & Sturgeon, 2014). The governance mechanism determines three essential guidelines that define what is produced, how it is produced, and how much and when it is produced (Bair & Palpacuer, 2015). Governance is decisive concerning the form of insertion of companies and regions into the GVC and how the value generated is distributed (Bianchi & Szpak, 2022). In this sense, leading companies, generally transnational, are in the critical nodes, which are the ones that have the most opportunities to capture greater benefits (Mancini, 2016; Sassen, 2007). This is why governance logic is substantial because it conditions the appropriation of the benefits generated by the sector and the possibilities of access and upgrading for weaker actors, such as SMEs (Caspari, 2003; Lee et al., 2011). Upgrading is understood as the process of updating, improving, scaling, expanding, and modernizing, among others, of the production process in all stages of the value chain (Ponte & Sturgeon, 2014). In this framework, public policies should have a leading role to maximize the benefits that could be obtained from SMEs' integration into GVCs. (Palpacuer et al., 2019).

2. governance is the original term in English.

The global unconventional hydrocarbon value chain in Vaca Muerta and the supplier SMEs

SMEs as local economic agents integrated into the global chain, are reached by dynamics determined by the governance of the CGV (Abe23, 2016). This insertion implies both opportunities to improve their condition, that is, scaling or upgrading, as well as obstacles that they must face (Gereffi & Sturgeon T., 2013). These obstacles are related to the asymmetries observed in the GVCs and the role of large companies in charge of coordinating activities and transactions (Sinkovics et al., 2021). In this context, SMEs must subordinate themselves to the rules of the leading companies. Consequently, their strategies and negotiation possibilities are largely conditioned by this transactional logic (Mancini, 2016).

The regional production circuit of Vaca Muerta and unconventional exploitation is no exception in this chain governance logic. (Landriscini & Carignano, 2015). The Neuquén basin is distributed over a total area of 124,000 km² and extends the provinces of Neuquén, La Pampa, Río Negro, and Mendoza. Vaca Muerta is the main formation of unconventional resources in the country, with an area of 30,000 km², with the largest territorial proportion in the province of Neuquén (Official Website of the Government of the Province of Neuquén, 2023). The geological characteristics of the Neuquén Basin have been known since the early decades of the 20th century; however, its potential in terms of technically recoverable resources was only recognized after 2010. (Villalba, 2020). The launch of its exploitation, until then unfeasible, is due to the conjunction of two factors that made it feasible. On the one hand, the possibility of technical modifications to the traditional hydrocarbon extraction process to bring them to the one used in unconventional reservoirs and on the other hand, an increase in the international price of crude oil (Villalba, 2020). The Vaca Muerta exploitation emerged as a megaproject due to its large dimensions, its expected impact on the national economy, and energy policies. The con-

ception of the megaproject included everything from planning the processes drilling to transportation to the refineries, including pipelines, specific inputs, and waste treatment plants.

In terms of infrastructure, new roads, housing complexes, health corridors, urban reorganization, and, therefore, the presence of many national and international firms with different contractual links stood out (Carbajales, 2023; Wyczykier & Acacio, 2022). Regarding the territorial link and the agents that work in the VM area, first, a group of large multinational companies that operate the concessioned exploitation areas is identified, which includes the renationalized YPF. These companies execute the strategies in their headquarters. In this group, a business oligopoly is observed, which, according to the Argentine Institute of Gas and Petroleum (IAPG), in 2018 75% of oil and gas production was generated by four and five companies, respectively (Sabbatella & Nunes Chas, 2020). Secondly, another group of large multinational companies is identified. These companies provide highly specialized technical services, have high technological development and travel capacity, and always depend on the locations of the operators. Finally, a third group is observed, made up of local SMEs that provide complementary services for those companies in the first two groups (Kozulj & Lugones, 2007; Landriscini, 2020; Landriscini & Carignano, 2015; Landriscini & Orlandini, 2015; Morales, 2017; Rubino, 2019; Scardino & García, 2024).

Strategic planning in SMEs, decision trees, and game theory

The importance of strategic planning lies in the organization's ability to make an appropriate reading of the environment, in line with its objectives, and make appropriate decisions in a global world (Delgado Litar-do et al., 2022). It is a continuous process that allows them to make present decisions based on a better understanding of the future (Scavone & Marchesano, 2020), which is critical for SMEs.

The fundamental factors that characterize the weaknesses in the strategic planning process in SMEs are the lack of formal procedures established by traditional schools (Fernández et al., 2022), how SMEs operate based on specific decisions and projects (Bortz & Gar-rido, 2022), on which they mark a long-term trajectory that includes times of stability and change. The quality of its human resources also stands out in this sense, with a gap between the demand and the training of the workforce (Dintrans et al., 2022). Another central aspect is related to the socio-cultural dimensions existing in the current context of SMEs in Latin America and the nexus of entrepreneurship as a precursor to the creation of small and medium-sized businesses (Moreno Muñoz, 2022). Therefore, comprehensive treatment of the strategic processes of these organizations becomes necessary.

In a context shaped by the local productive circuit, which is integrated into a global value chain (GVC), the agents involved must necessarily operate within hierarchical networks of actors whose dynamics are defined on a global scale. (Mancini, 2016), SMEs need to have an adequate strategic planning process. To execute this strategy with a long-term perspective, they need tools that help model its development (Carreras et al., 2018; Valencia González & Pinzón Muñoz, 2024).

The analysis and evaluation of strategic projects involves a sequence of stages. The extensive detailed approach to decision trees (DTA, Decision Tree Analysis) or binomial grids is a very useful tool for the analytical resolution of the problem of sequential decisions and data analysis (Milanesi, 2022). Decision trees are used to graphically represent the sequence of decisions that need to be made, the different possible scenarios, and the contingent results of each decision (Riascos & Molina, 2016).

Regarding the valuation of revenue streams, it is interesting to consider the real options approach, which provides strategic flexibility to models that include the valuation of cash flows. Unlike traditional valuation

methods, such as NPV (Net Present Value) or similar (G. Milanesi, 2013).

When planning their strategies, entrepreneurs must constantly think about the possible movements of other players to anticipate their possible reactions (González et al., 2017). This is because each decision made and its movements, in turn, imply a risk and a reaction from third parties. The quantification of this risk and the consequences generates the need to have the projection of possible scenarios in which the effects of one's own decisions and those of the other players can be graphically evaluated (Milanesi, 2023).

It is in contexts like these where the incorporation of game theory (Game Theory) with its different models can be useful, to be applied in administration and strategic direction. Game theory (GT) enables a better understanding of the decision-making process from different positions. It also allows you to graph reality and the generation of new lines of business strategies (Bernabe & Meza, 2022; Da Costa et al., 2005; Dixit & Nalebuff, 2022; España García & Correa Velasco, 2017; González Franklin J. et al., 2017; G. Milanesi, 2021; Vallejo Hoyos, 2015). There is a history of research on GT and GVC, especially cooperative game models, in other countries and other global production complexes. These works highlight the functionality of the GT to demonstrate the bargaining power between the parties, especially for strategic considerations related to possible allocations of profits between members of the value chain (Hennet & Arda, 2008; Skovsgaard & Jensen, 2018).

The main attributes of GTGT include the actors, who are responsible for making decisions—generally guided by expected payoffs and influenced by risks or varying states. Another key element is the timing of these decisions; that is, whether all actors decide simultaneously or sequentially. Finally, the strategies are identified, representing the optimal moves or choices made by the actors, which are closely linked to the information available to each of them.

Another element is the moment at which the strategies are executed. Finally, there are the payments or results, which correspond to the quantification of the flows derived from each strategy, with the assumption that each agent decides based on maximizing its value (Aguado Franco, 2006; G. Milanesi, 2021; GS Milanesi & Tohmé, 2015).

Regarding the form of representation of a game, it can be in extensive form that corresponds to the decision trees mentioned above or in matrix form as decision matrices (Reay & Andrews, 2002). The solution of a game is a result of optimal and possible decisions for a given trajectory or strategy (Monsalve, 2002).

Another concept of GT that evolved is rationality. Initially, this was approached from the perspective of the neoclassical school of economics, which is characterized by the notion of unlimited rationality embodied in the concept of *homo economicus*³. This is a philosophical notion that indicates that human beings are guided by rational thinking and thus always choose strategies that lead them to maximize economic results (O'Boyle, 2021). The GT assumes rational behavior for all parties; that is, all players assume rational behavior from the other party as well (Milanesi, 2021). This idea of rationality evolved, and in 1955 Herbert Simons, winner of the Nobel Prize in Economics in 1978, introduced the concept of limited rationality to refer to the restricted reasoning capacity of people based on the limited resources with which they count, basically, information and time (Tuñón, 1978). With the advent of the 21st century and the growing complexity of decision-making scenarios, the initial assumption of unlimited rationality has been increasingly challenged. In this context, the contributions of Daniel Kahneman and Amos Tversky—pioneers of the concept of bounded rationality and recipients of the Nobel Prize in 2002—are particularly relevant. Their research focused on heuristics and cognitive biases in decision-making processes, especially those related

to probability judgments and the use of a limited set of confidence rules (Contreras Sosa, 2003).

A fundamental concept in GT is equilibrium as a solution to a game. It is called the Nash equilibrium, after the creator of this idea and winner of the Nobel Prize in Economics in 1994 (Muley Escribano, 2021). The concept of equilibrium emerged as an attempt to describe the behavior of individuals or actors, representing a set of strategies in which none of the players can unilaterally improve their situation by altering their own decisions. That is, each actor always makes the best set of decisions based on what the other actor can make (Pérez et al., 2023).

3. METHODOLOGY

This section describes the methodology addressed for the development of the empirical work that is presented (Campo-Redondo & Labarca Reverol, 2009). The structure of the sample and the rationale for the choice of variables to answer the research questions and objectives are explained. Likewise, the technique implemented for data collection and subsequent analysis is presented (Freire Espinosa, 2018).

3.1 Characterization of the units of analysis, sample structure, data compilation, and justification for the choice of variables.

To carry out the empirical study, an analytical-descriptive methodology was adopted through a compilation of the main problems of supplier SMEs regarding their insertion into the GVC in VM. A mixed approach was used for validation. Regarding the quantitative method, situations were modeled as games, extensive form, and matrix representation. Regarding the qualitative method, the data collection process was based on the Focus Group technique, which served as the foundation for the development of the models (Sacoto-Regalado & Cabrera-Duffaut, 2020).

3.economical man

3.1.1. Characterization of the units of analysis

According to an official report published in February 2022, the SMEs included in the CGVHC in the Argentine basins have productive capacities higher than the average of the universe of this type of organization in the country, and in general, they are consolidated companies in their sectors of activity (CEP XXI and SEPYME - Secretariat of Small and Medium Enterprises and Entrepreneurs - Ministry of Productive Development of the Nation., 2022). For the most part, SME suppliers show a high level of subordination to the large operating companies, the core of the network, and the large multinational companies providing specialized services (Rubino, 2019). This subordination is manifested through hierarchical relationships and strong couplings, added to a low capacity of SMEs to move outside their geographical area of operation (Giuliani et al., 2016; Landriscini, 2020; Landriscini & Orlandini, 2015; Morales, 2017; Rubino, 2019). Since 2012, there has been a change of scenario due to unconventional exploitation on a larger scale, the re-nationalization of YPF, and its leadership in the exploitation of Vaca Muerta (Landriscini & Carignano, 2015). The challenge for these SMEs was to find how to respond to the demands of the new context, which required strategies to increase technological and organizational capacity, productive efficiency, functional hierarchy and fundamentally strengthen the poor negotiation ability of local agents from the GVCH (Cirimello, 2022). In the profile of local SMEs, an important technical-operational imprint stands out as their great strength and among their weaknesses is the lack of knowledge in business management (Landriscini & Carignano, 2019; Morales, 2017).

Given the structure of the production circuit and the integration into the Global Value Chain for High Complexity (GVCHC), innovation emerges as a key factor for the scaling of SMEs. In this regard, interaction with the external environment becomes essential. Possible forms of such interaction include alliances between SMEs, participation in associations, chambers, and

similar organizations, the development of business networks, and involvement in institutional programs, among others (Landriscini & Carignano, 2015). The local government implements programs for strengthening and development of the Neuquén value chain, all of which are coordinated by the ADENEU SME Center, as the enforcement authority of the “Buy Neuquén Law” (García & Scardino, 2021).

The GVCH within the Neuquén basin does not operate as a local enclave, but rather extends to other provinces of Argentina, such as Buenos Aires, Santa Fe, Córdoba, Entre Ríos, among others (CEP XXI and SEPYME - Secretariat of Small and Medium Enterprises and Entrepreneurs - Ministry of Productive Development of the Nation., 2022). However, our study focuses on regional SMEs. In 2020, there were about 700 local supplier SMEs, with an average age of more than 5 years, operating in the Añelo – VM area, and in the period 2023-2024, approximately 1,000 regional SMEs were reported among all those that supply the demand from VM⁴ (SME-ADENEU Center - Economic Development Agency of Neuquén., 2023).

3.1.2. Sample structure and data compilation.

Among the 1,000 local SMEs, a subset of 350 SMEs is certified under the framework of Provincial Law No. 3032 on the Preference Regime in the Acquisition of Goods and Services of Neuquén Origin for the Hydrocarbon and Mining Industry, known as the Law of the “Compre Neuquino”. The ADENEU SME Center, as both an institutional reference and a regulatory authority, maintains a comprehensive and up-to-date registry of these economic units, which served as the basis for the sample design.

The selection of the units was carried out through the simple random sampling procedure, that is, in a random and equitable manner (Almaguer et al., 2022).

4. The new Compre Neuquino law covers more local companies - Centro PyME-ADENEU

In this way, everyone had the same probability of being chosen. After the selection, the SME entrepreneurs were contacted by telephone and email, and Focus Group sessions were organized based on the affirmative responses of willingness to participate. The Focus Group technique is increasingly used due to its important contribution to the difficult stage of the research that results from the in-depth collection of primary data (Feixa et al., 2020).

The sessions were conducted following the same structure, each involving an average of ten to twelve participants, and were repeated with new groups until theoretical saturation was reached. (de Moura et al., 2022). Another objective of the focus group technique is to record emotional processes such as moods, feelings, beliefs, experiences, and reactions in key actors (Sacoto-Regalado & Cabrera-Duffaut, 2020). In its execution, the application of strict controls and steps is essential, which were rigorously respected in this work, to guarantee quality information and a broad understanding of the study topic (Ivankovich-Guillén & Araya-Quesada, 2011).

Based on the selected theoretical framework, a structured guide was designed and systematically applied in each session. Specific roles were assigned for general and operational coordination, moderation, and observation. The observers were responsible for recording voice tones, gestures, and other non-verbal cues that might otherwise go unnoticed. All sessions were supported by audio and video recordings, with the participation of both a lead facilitator and an assistant. Additionally, a suitable meeting space was selected to foster an environment conducive to open exchange. Entrepreneurs from the sample were contacted, and those who expressed availability and willingness to participate were confirmed. Each session was conducted with an average of ten to twelve SME entrepreneurs, accompanied by the full operational and technical team.

For data analysis, the audio recordings were first transcribed, followed by a systematic review of the moderator and observer reports

3.1.3. Rationale for the choice of variables

The selection of variables constitutes a critical aspect of the empirical analysis, as it enables the examination of the behavior of the target companies (Henseler, 2017). The information to understand the behavior of the variables was obtained through the focus group questionnaires. For the design of the questions, the reference bibliography was taken as a basis, to support a relevant choice of the variables that lead to the achievement of the stated objectives (Saenz Lopez & Tamez González, 2014).

The survey gathered company data on key aspects such as power asymmetries, exchange relationships, bidding processes, certification and contracting procedures, the definition of terms and conditions, negotiation capacity, as well as the main strengths and weaknesses of local SMEs. To classify the most representative variables, a semantic categorization process was conducted. In this process, participants' references to the most frequently mentioned issues were grouped and related to the previously established theoretical framework (Ruiz Bueno, 2018). Repetition frequencies were then measured.

4. RESULTS AND DISCUSSIONS

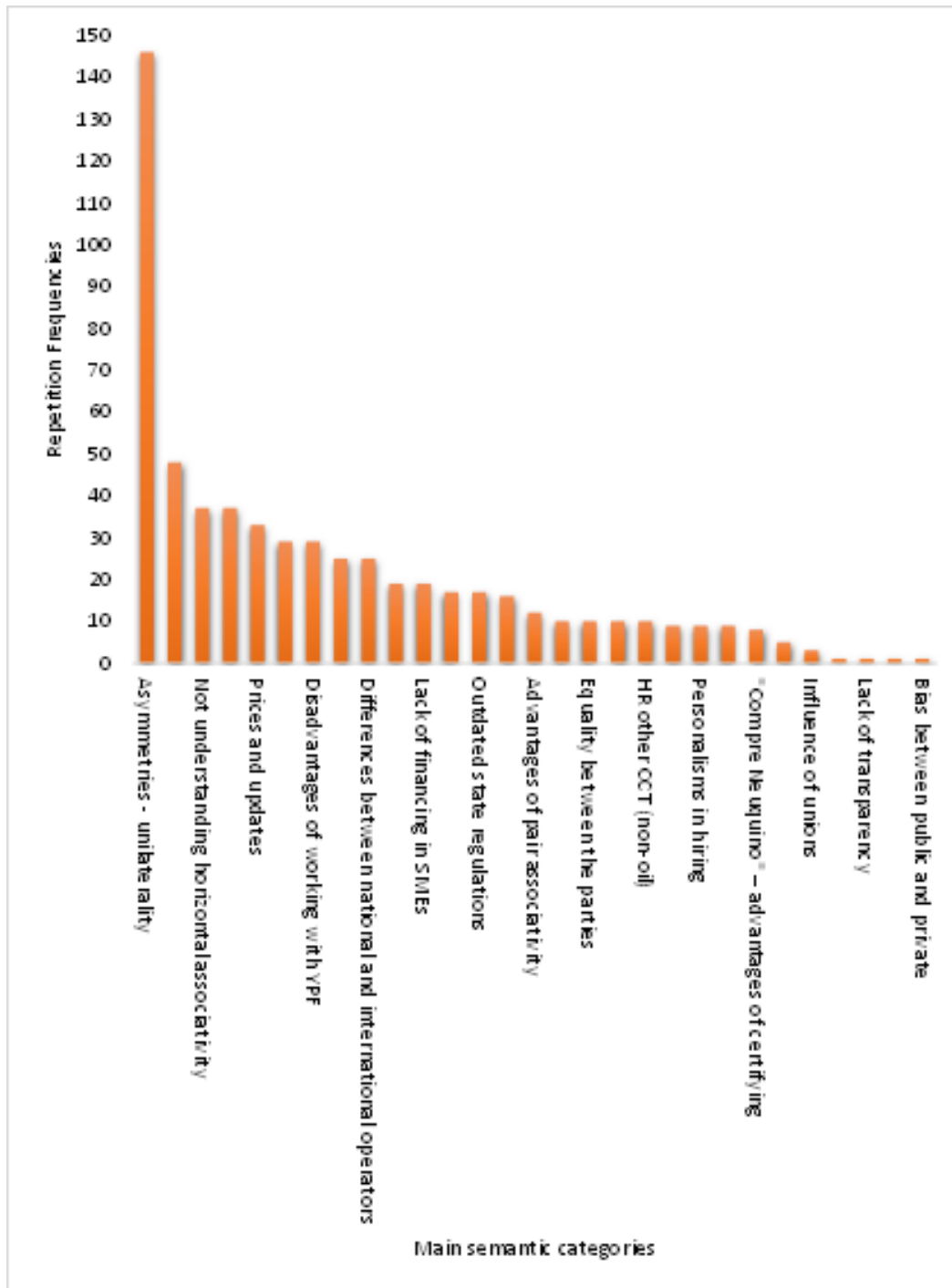
4.1. Main results Focus Group

In line with what was explained in the previous section, 24 categories were defined, the data obtained were classified, and the corresponding repetition frequencies were measured, as seen in Graphic N°1.

The categories that had the highest frequencies were asymmetries – unilaterality, lack of management knowledge, not understanding horizontal associativity,

payment chain, prices and updates, high demands in tenders, disadvantages of working with YPF, HR problems/high turnover, differences between national and international operators, certification processes delay, lack of financing in SMEs. All that confirms what was stated in the theoretical framework about power asymmetries, low or scarce negotiation possibilities, strong coupling, etc., for SMEs inserted in the GVCHC.

Graphic 1– Frequency of repetition of semantic categories



Source: Authors' own elaboration

4.2 Case modeling

Based on what was analyzed in the theoretical framework and the data obtained from the two Focus Groups, real situations were designed as case studies (Quiroz et al., 2020) to apply scientific knowledge to solve practical problems. An attempt is made, through the cases, to present strategic decision-making employed by supplier SMEs in an environment similar to the one described. The aim was to model situations as games, with SMEs and operating or specialized service companies acting as the players. Additionally, elements such as innovation and associativity among SMEs were considered as influential factors in these interactions. Through the models, an optimal solution is sought from a set of possible options to optimize resource allocation, identify limitations, and achieve objectives.

Case No. 1 (adapted with own data from Vergara Cáceres, 2010)

The situation of a specialized services company that seeks to subcontract to an SME certified under the regime of Provincial Law 3,338 “Compre Neuquino” is presented. The company needs the provision of a specialized calibration service for measuring instruments at the primary points where the operation begins, in the city of Añelo.

In this way, the players are formed like this:

Player 1 (J1): local SME supplier of the CGVHNC in the regional circuit.

Player 2 (J2): specialized services company, Upstream link, of the first group of companies in the CGVHNC business structure.

Description of the game situation:

- The situation begins when J2 internally verifies the need for the specialized service and contacts J1. They never worked together before. J1 aims to establish a commercial relationship with J2 and other companies in the core of the chain, because it seeks to position itself and establish long-term commercial relationships that ensure continuity. To provide calibration services and certify all the requirements of companies under the “Compre Neuquino” regime, J1 made a significant initial capital investment in specialized, high-tech equipment, technical training of personnel, stock of supplies, and projects a recovery horizon that needs to be achieved.
- J1 budgets the service and first calculates that it costs \$1,000 in total unit cost. At that amount, J1 must assign a profit margin to obtain the price that it will be finally proposed to J2.

J1 must make a decision and, to that end, strategically analyzes the situation; that is, it considers both its own position and that of J2, as well as the state of the industry and other relevant variables. As a small company that has recently incorporated a highly specialized service related to unconventional exploitation in an upstream link into its portfolio, J1 seeks to grow and strengthen its position in the sector, particularly in VM. Furthermore, it needs to recover the significant investment it has made. In this context, J1 also considers that J2 is a well-established multinational company, recognized in the industry for its high operating standards, and through which J1 could achieve technological upgrading and acquire valuable experience. Ultimately, J1's objective is to secure a service contract. In this context, J1 analyzes how to make its first strategic decision, that is: how much to quote the service for J2, as outlined in Table 1.

Table 1- Decision alternatives for J1

	Decision alternatives	Observations	Result
Profit margin and pricing possibilities	A1: \$1,250	If J1 offers a very low price, J2 is likely to accept quickly . However, likely, it will then try to haggle the price, and the profit for J1 would be little or none.	J1 decides for A2
	A2: \$1,500		
	A3: \$2,000		

Source: Author's elaboration.

- Consequently, after analyzing the alternatives, J1 decides on A2. This is a strategic decision-making process according to what J1 considers the best alternative according to its expectations and J2's expectations. .
- After this definition by J1, both players agree to a meeting in which the service budget will be presented. This gives rise to Game 1, which is outlined in Table 2.

Table 2- Alternatives Game N°1 between J1 and J2

	Possible alternatives	Detail	Choice
J1	M1: budget \$1500, and J2 accepts	It is a suboptimal price among those analyzed by J1, but it is optimal for a negotiation space of the type expected, since the first price is usually counter-offered.	M1:1
	M2: budget 1500, and J2 does not accept and does not counteroffer		M2: 3
	M3: offers a quote of \$1500, and J2 makes a counteroffer		M3:2
J2	M1: accepts the quote of \$1500	J2 has an incentive to hire the supplier because he needs the service and is also on the CN supplier registry, but it will seek to pay the lowest price due to the implication on its cost structure. In these terms, J2 decides that it is best to make a counteroffer to J1's proposal.	M1:2
	M2: does not accept the quote and does not present a counteroffer		M2: 3
	M3: Reject the first offer of \$1500 in principle and make a counteroffer		M3:1

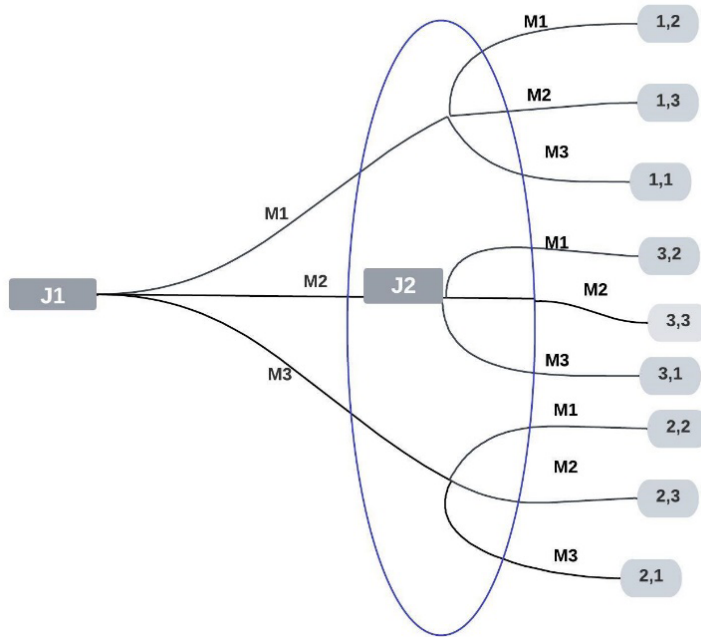
Source: Author's elaboration.

Table 3-Matrix representation of game No. 1 between J1 and J2:

		Player 2		
		M1	M2	M3
Player 1	M1	1,2	1,3	1,1
	M2	3,2	3,3	3,1
	M3	2,2	2,3	2,1

Source: Author's elaboration.

Illustration 1— Extensive representation (decision tree) of game N°. 1 between J1 and J2:



Source: Author's elaboration.

Considering all the elements involved in the strategies of both players the most convenient alternative is when J1 chooses M3 and J2 chooses M3, that is, the situation of the counteroffer at the original price proposed by J1. This situation is an equilibrium in TJ's terms, because strategically neither of the two players initially plans to modify their decision. After all, the incentives to maintain it are greater than changing it. This is also due to the integration of additional decision factors. In the case of J1, the company requires that its service be contracted to enter the industry and establish its position, particularly considering that, in a budgeting process, the initial price is typically subject to negotiation. Furthermore, Player 1 views the price difference between the optimal and suboptimal outcomes as a necessary investment to achieve its strategic objectives within the game. Simultaneously, J2 requires an expert service provider, and the local company — Player 1 — has a proven track record and holds the certifications mandated by the relevant regulatory standards. At this

stage, J2 must formulate a counterproposal; this represents Decision 2, which is also strategic, as it involves considering not only its own position but also that of J1. To make this decision, J2 analyzed its strategy in three possible options. It mainly considers that it is a service that corresponds to the production stage, with a considerable impact on the cost structure and with the aggravating factor that the recovery horizon in non-conventional exploitation is longer related to conventional exploitation.

After this analysis, J2 must decide between three possible options for his counteroffer, accordingly to Table 4.

Table 4-Alternatives for J2

Counteroffer Possibilities	Alternatives	Basic information	Results
	M1. Offer \$1300	Original J1 Offer of \$1500	A new negotiation for decision No. 3
	M2. Offer \$1350		
	M3. Offer \$1400		

Source: Author's elaboration.

J2: Regarding the possible prices, the counteroffer has as its upper limit the price originally proposed by J1. Within this limit, J2 projects three scenarios in its cash flow, based on the best alternative for its own position — that is, the lowest of the three prices. Likewise, it takes into account the costs associated with providing a quality service in terms of labor and supplies, and, above all, that any of these scenarios implies a reduction from the original price. A new negotiation space is thus generated, giving rise to Decision 3. Table 5 Alternatives Game N°2 between J1 and J2

	Possible alternatives	Reference information	Choice
J2	M1: offer \$1300	Original J1 Offer of \$1500	M1:1
	M2: offer \$1350		M2: 2
	M3: offer \$1400		M3:3
J1	M1: accept the price of \$1300	A minimum and acceptable profit margin	M1:3
	M2: accept the price of \$1350		M2:1
	M3: accept the price of \$1400		M3:2

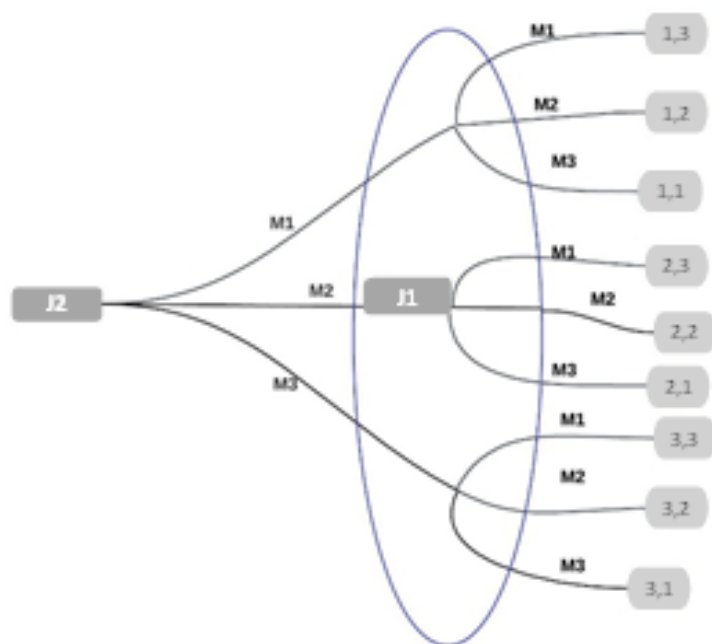
Source: Author's elaboration.

Table 6- Matrix representation Game N°2 between J1 and J2

		Player 1		
		M1	M2	M3
Player 2	M1	1,3	1,2	1,1
	M2	2,3	2,2	2,1
	M3	3,3	3,2	3,1

Source: Author's elaboration.

Illustration 2- Extensive representation of Game No. 2 between J1 and J2



Source: Author's elaboration.

In the output of this game, an equilibrium is evident that when J2 counteroffers an intermediate amount, in this case \$1350, which is not the maximum profit for J1 nor a maximum cost for J2. The generation of a model represents a process of solving a problem or at least its intention to solve it (Ascanio et al., 2023). The matrix representation (Table 3 and Table 6) adds simplicity and clarity the information that is presented in dual form in a double-entry table. The extensive form or decision tree (Illustration 1 and Illustration 3) allows you to visualize the sequences of the players' movements and the information they have. The use of both alternatives contributes to the comprehensive visualization of the problem (Aguado Franco, 2006; G. Milanesi, 2021).

Case No. 2 (Adapted from (Franco & Lara, 2017) with their own data)

Provincial Law 3338 aims to strengthen and implement the hydrocarbon production complex. It promotes

the execution of supplier development programs and enhances the preference allocation scheme known as "Compre Neuquino" (CN) for certified Neuquén companies in the sector. The regulation includes a polynomial formula that enables many more SMEs to obtain the certificate identifying them as Neuquén Companies. This polynomial formula weights variables such as the company's domicile, income coefficient, formation of social capital, number of jobs it creates, and the number of bases and offices within the provincial territory.

In the data collection stage for this work and its subsequent analysis, the variables "Compre Neuquino" system, associativity, and membership in a chamber of SMEs or similar are frequently repeated from different perspectives. Some actors consider that the certification process is expensive and somewhat cumbersome. Others, however, believe that it likely encourages them to increase their level of activity,

engage in economies of scale, share information, establish strategic partnerships, and so on. Description of the game situation:

In the described context, an attempt is made to model the cost-benefit alternatives for SMEs deciding to certify as a Neuquén Company through a dynamic game within a decision tree. In this way, they can innovate and participate collectively in the SME improvement system of CVH suppliers. The details of the decision tree are provided in Table 7.

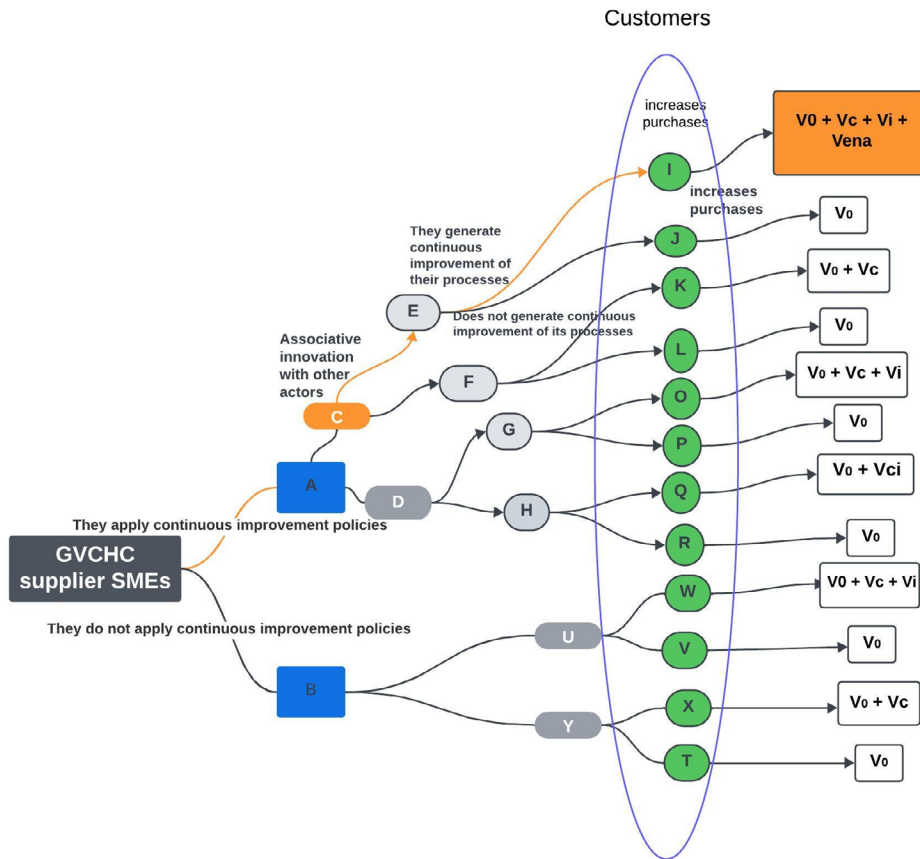
Table 7- References to the decision tree of case No. 2

Description	Reference
Sales at the moment zero for SMEs before entering the CN system.	V_o
Increase in sales by decision of the contracting companies, to favor a specific SME because they already know it, but it does not have the CN certificate.	V_c
Increase in sales by individually incorporating new products or services aimed at non-conventional exploitation.	V_i
Increase in sales due to certification as a Neuquén Company and by entering the registry of suppliers of the VM cluster and CN. In this instance, it is assumed that certified SMEs register lower costs due to associativity and reduction of cycle times.	V_{ena}

Source: Author's elaboration.

It is presented first in the decision tree, and then the references are specified.

Illustration 3- Decision Tree Case 2



Source: Author's elaboration.

Companies have two strategies that, in turn, identify them as SMEs A and SMEs B, and are the 2 main branches of the decision tree:

- **A:** They do apply a policy of innovation and process improvement as a competitive advantage and to position themselves as a supplier to the CGVH in the Neuquén basin. They promote continuous improvement in their processes, permanently focused on the new needs generated by the non-conventional exploitation modality in VM.
- **B:** They do not apply a positioning policy and are committed to maintaining their participation in the industry market with their traditional offer.

In turn, SMEs A consider 2 strategies:

- **AC:** apply an innovation policy for process improvement in association with other actors and within supplier promotion programs
- **AD:** apply an individual innovation policy without sharing either information or support from other actors

In turn, AC SMEs can:

- **ACE:** generate innovations
- **ACF:** do not generate them

AD SMEs can also:

- **ADG:** generate innovations
- **ADH:** not generate innovations

Now concerning clients, which are the centrally core companies, they can:

- **ACEI:** increase purchases or,
- **ACEJ:** Do not increase purchases.

In the ACEI decision branch, the company has the possibility of increasing sales by decision of the client, attracted by the continuous improvement of its processes and by the advantage of participating in supplier and associative improvement programs such as the “Compre Neuquino”, unlike the ACEJ decision. Likewise, in the ACEI branch, the SME may have the possibility of increasing $V_o + V_c + V_i + V_{ena}$, which does not happen in the ACEJ decision.

Clients about the ACF branch can apply two strategies, ACFK, which corresponds to increasing their purchases, or not doing so in ACFL. The ACFK decision generates an increase in billing due to the decision of the client $V_o + V_c$, and this does not happen in ACFL.

As for clients, SMEs AD have two ADGO strategies that correspond to an increase in their purchases and ADGP. In the ADGO branch, the SME has the possibility of achieving the combination $V_o + V_c + V_i$, unlike ADGP.

In turn, clients of AD companies can increase their ADHQ purchases and not ADHR. The first, ADQQ generates an increase in $V_o + V_c$, and in ADHR, but it does not produce any increase in V_o .

Regarding SMEs B, they have two possibilities: to generate innovations casually or randomly, BU, or not to generate them BY. In that sense, customers can increase their BUW purchases, or not. The BUW decision produces an increase $V_o + V_c + V_i$ and the BUW produces no increase in V_o .

As for the other branch—clients in this case—the decision relates to whether these SMEs increase their BYX purchases or not opt for BYT. In this regard, customers may choose to increase their BYX purchases or not. A decision in favor of BYX results in an increase of $V_o + V_c$, whereas opting for BYW produces no increase in V_o .

As a conclusion of this modeling process, and as illustrated in Figure 3, the optimal decision for the SME supplier in terms of cost-benefit is ACE, as it consistently consolidates competitive advantages in a shorter timeframe, with lower development costs and a higher sum of added value for its clients. This, in turn, leads to an expansion of sales represented by $V_o + V_c + V_i + V_{ena}$.

At this stage, the aim is to highlight the benefits that associativity can generate among SMEs; however, as a complement, the estimation of expected revenue streams could be further refined using a real options approach to incorporate strategic flexibility into the model

4. CONCLUSIONS

This research aimed to develop methods for modeling real situations faced by SMEs that provide CVHC within the TJ framework, and to demonstrate that the game-theoretic decision-making process is optimized when the importance of identifying which game to play—prior to understanding how to play it—is properly recognized. For this, an analytical-descriptive methodology was implemented to get a compilation of the main problems that SME suppliers have in their relationship with the operating companies and specialized services companies settled in the Vaca Muerta reservoir.

The results presented allow us to affirm that TJ is related to strategic management, primarily because both comprise a decision-making process that considers interdependence from other players. This

interrelation often leads to optimized outcomes in terms of increased productivity and cost reduction, among other benefits. SME entrepreneurs are aware that behind each of their decisions lies both risk and the potential reaction of other actors or players in the market. This awareness prompts the consideration of various scenarios, which depend on the decisions made by the other parties involved. It is precisely in this context that the TJ framework proves valuable, as it facilitates the analysis of different alternatives based on the choices made by each party operating within the same scenario—or playing the same game.

Likewise, the results suggest that the interactions between SMEs and operating companies, when graphically and sequentially modeled to evaluate most alternatives and strategies of the counterpart, can lead to mutually beneficial outcomes. Where one obtains a profit that is not the maximum, and the other a cost that is not a minimum either. Furthermore, the results indicate that the association between companies to innovate, to gain productivity, can be positive and upscaling for all parties.

Methodologically, a qualitative research technique was employed using focus groups, while the cases were modeled within the framework of game theory, which is typically applied in a quantitative manner. The aim was to incorporate elements such as emotions, feelings, desires, and attitudes observed in the participants to enrich the analysis.

This study is not without its limitations, which also present valuable opportunities for future research. First, it could be beneficial to incorporate additional scenarios that could be modelled and to assess flows using the real options approach. Second, the present research focused on SMEs supplying the GVCHC in the Neuquén and VM reservoirs; extending this analysis to other productive sectors or regions in emerging economies could yield insightful and potentially generalizable results. Finally, the governance mechanisms

GVCHC could be explored in greater depth to mitigate—if not entirely eliminate—the observed asymmetries.

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