COMPANIES' PRODUCTIVE INTERNATIONALIZATION PROCESS ANALYZED VIA GAME THEORY

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Abstract

This paper intends to study the firm's strategic decisional process on entering a foreign market in a context of global competitiveness. First, we give a brief historical background in order to correctly explain the mechanism of a firm's internationalization. Second, we define an objective function for the firms, the Expected Benefit Return (EBR). We derive the optimal quantities and the EBR in different market structures. These EBRs were defined as the payoff function for a game theory application. Therefore, we calibrate the Nash Equilibrium for the game. The results attest for an optimal decision to become international when the national firm decides to follow the competitors (international oligopoly) that pioneer the market, and then imitate by reverse engineering or promote alignable differences to overcome first-move advantages.

Keywords: Internationalization. Firm. Competition. Game Theory.

Resumo

Este artigo tem como objetivo estudar o processo estratégico de tomada de decisão das firmas ao entrar em um mercado estrangeiro em um contexto de competição global. Primeiro, fizemos um breve histórico para explicar corretamente o mecanismo de internacionalização das firmas. Depois, definimos uma função objetivo para as firmas, chamada de Retorno de Benefício Esperado (EBR, sigla em inglês). Derivamos as quantidades ótimas e a EBR em diferentes estruturas de mercado. Estas EBRs foram definidas como a função de *payoff* para aplicação da teoria dos jogos. Em seguida, calibramos as funções otimizadas para obter o equilíbrio de Nash deste jogo. Os resultados mostraram que a decisão ótima da firma nacional é se internacionalizar seguindo seus competidores (oligopólio internacional) que entram primeiro no mercado. com isso, o firma nacional imita por engenharia reversa ou pela promoção de diferenças alinháveis para sobrepujar as vantagens em ser o primeiro por parte do oligopólio internacional.

Palavras-chave: Internacionalização. Firma. Competição. Teoria dos Jogos.

1 Introduction

Globalization is indeed a rich phenomenon, it shaped a new economic, social and political paradigm, it established a new environment for firms, consumers, and governments; it is the heart of a study that intends to predict the future dynamics of the world economy. How firms reacted to this current economic challenge? How were the market structures affected by a new nature of global competition? Are the transformations over or is it only the incipient stage of the chain? Those are questions that have been on the agenda of various researchers for the past decades, however, no argument satisfactorily answered them. One could believe that those questions will be perpetuated as the center of the economic discussion.

A company internationalization process is only one piece of the puzzle, but certainly one of the most important regarding the globalization process. According to Gonçalves (1984), the multinational company should be seen as the outcome, of a historical process characterized by the concentration and centralization of capital, inherent to the current stage of the capitalist dynamics, and, as a consequence, the globalization of economic relationships. Firms that saturate the domestic demand and assume monopolistic or oligopolistic dimensions channel their activities aiming the exploration of new markets (Krugman 1979). Consequently, firms are losing their national identity to become non-flag multinational corporations.

The Multinational Enterprises (MNE) filed of study is associated with discussions regarding industrial organization aspects, firms directive strategies influenced by psychological elements, the macroeconomic environment of domestic economies and the systemic conditions of the world economy; this plural object permits a vast number of interpretations, often conflicting among them. However, one idea is well accepted by all the parties: the dissemination of firm activities throughout the globe striving for cheaper resources, new consumers markets and the discovery of new technologies intensify the level of competition to the agents involved, imposing a new and faster pace dynamics. According to Chesnais (1996), pany productive internationalization is a consequence of its degree of international involvement and occurs by several means. This process might be materialized by intensiveness of trade on goods and services; by commercial insertion; by foreign direct investment (FDI); through association with foreign companies and by the capital flow. All of those methods are based on capital accumulation and appreciation beyond national borders of the domestic company.

The acceleration of competition magnifies the mass of uncertainty experienced by firms during the decision to become a multinational corporation. When companies dominate the internal market knowledge and the domestic market, then postulate to expand their business, they recognize the new competitive circumstances. Now, generally, their competitors are sumptuous corporations, rulers of their respective home economy. The expected technological battle forces the ability to allocate efficiently resources to visualize profitable opportunities; firms must play strategically, and this is our main focus.

This work has the aim to extend an existent literature using connections between statements of different theories to set a simple model that intends to speculate firms' behavior upon competition in the decision-making process on whether to become an MNE. The idea of the model is to capture various features of different theoretical streams of internationalization so that it can be viewed as an eclectic approach - inspired by the will of Dunning since his first work at 1978. Nevertheless, the paper aimed only one type of international involvement: Foreign Direct Investment (FDI), for the

sake of simplicity the model will not contemplate the other two types of international involvement: exports and licensing.

The exclusive FDI approach makes possible to focus on its more extensive specificities. Dunning (1988) affirmed that FDI involves transfers of other resources beyond capital, like technology, management organization, and marketing skills, and its expected return on these, broader than only the capital profits, is what prompts enterprises to become MNEs. Thus, capital is simply a conduit for the transfer of other resources rather than the sole reason for direct investment. In the case of direct investment, resources are transferred internally within the firm rather than externally between two parties: the legal control is still retained over their usage. Therefore, the expected return mentioned by Dunning is not simply a function of profit and the tangible operation, but more a holistic and complete acknowledgment of the benefits of being international, going extensively beyond the pecuniary sphere. This shall be considered in our model as an Expected Benefit Return (EBR).

Hopefully, the model framework will allow clear comprehension of the incentives (or disincentives) for a firm to expand overseas regardless (because) the tenacious competition. With a game theory approach, this paper studies the interaction of the object firm with competitors upon the final goal to absorb more profits, acquire more knowledge and, consequently, to enhance the brand image worldwide; in other words, the decision whether to continue dominating the limited domestic market without any significant assumption of risk or to explore an all embracing global market with higher and riskier competition.

Our main find states that the Stackelberg model is a Nash Equilibrium since we suppose an upper limit for the autonomous price of the good produced. So the optimal behavior by the national firm is to wait for the entrance of the international oligopoly in the market. After this, the national firm can acquire advantages from its experimental knowledge and from the activity observation of its competitors. The imitation, reverse engineering, and the promotion of alignable differences proportionate organizational and productivity skills that overcome the first-move advantages.

2 Literature Review

In order to showcase the correct theoretical platform used for the game-theory application, the section aims to point-out to the relevant literature review assessed in the research. When studying the companies' processes of internalization, some theorists focused on the economic features of the process; this paper will rely especially in the contributions of John Dunning and Alan Rugman to format its hypothesis. As a theoretical counterpart, other studies gave priority to psychological variables related to the process, the celebrated Uppsala Model is going to provide us insights that will help us shape the behavior of the agents involved in the game theoretical frame.

Initially, we shall focus on the Dunning Paradigm: the respective model is constructed upon the nuclear understanding that the productive internationalization of firms is explained by the influence of a series of comparative advantages that assembled generates a holistic panel represented by the sub-paradigm called OLI (Ownership, Localization and Internalization). The ownership advantage (O) is related to a possession of tangible or intangible income-generating asset such as: technologic differential, brand notoriety, etc. These characteristics allow the company to distinct itself from the mass of internal competitors and act as a propellant of the internationalization

process.

The ownership advantage permits the company to target the exploration of the localization advantages (L) of the recipient country. The presence of desirable raw material, important consumer market, and appropriate infrastructure will designate the magnitude of the localization advantages of a specific recipient country. Finally, the internalization advantage (I) is the product of a dialogue that intends to compare the benefits of avoiding costs when assuming the external operation in contrast with the risk of technology leak on a cheaper licensing scheme.

Very important for our premises baseline is remark that according to Dunning (1977): "In principle, there is no reason to suppose a national multiplant firm would behave very differently if its plants were located in a different country", this has a direct impact on our assumptions on firm behavior when operating abroad. Dunning (2001) also stated that contemporary market dynamics led to a new motive for foreign production: an opportunity to enhance ownership specific advantages. This understanding will be encompassed in the further presented model as knowledge gains by producing in foreign markets.

Also vital for our game-theory structure of premises, the Rugman (1980) model is the starting point for the construction of a general theory focusing in the principle of internalization (similar concept to the (I) advantages on Dunning's Paradigm) as the main explanatory element for the existence of MNEs and FDIs. Rugman argues that firms become multinational to acquire knowledge about foreign markets. The author asserts that MNEs are by nature efficiency seekers, a concept that again contemplates a richer series of variables in comparison to the sole search for profit maximization.

One important concept is defensive FDI, according to Rugman (1985) defensive FDI is often undertaken by MNEs in an oligopolistic industry. It arises from the concern to protect their market shares on a worldwide basis as well as on a domestic one. Knickerbocker (1973) postulates that once one MNE set up a subsidiary in a specific foreign market, its rivals respond by opening their own affiliates in that respective market; we will try to examine that via a game theory approach. Finally, to complete our triad, the Uppsala Model - formalized at Johanson and Vahlne (1977)- is the main actor of the behavioral (psychological) approach of internationalization. Here, the nuclear agent is the manager of the firm with his respective autonomy in the corporation, endorsed by his own perception, risk aversion and international culture familiarity. Therefore, given the circumstances, the decision-makers in our model are rational. This gives us compatibility with game theory basic assumptions, our firm (symbolized by the decision-maker) is a rational agent, and so its competitors.

In the model, the company's saturation of the domestic consumer market inevitably leads to the penetration into foreign markets. Nevertheless, the international operation is surrounded by a mass of uncertainty; reflect of cultural, legal, social and business dissimilarities between destination and origin countries. In this context, filled with uncertainty and information asymmetry, knowledge is defined as the key variable for achieving success in the international market. Firms will pursue knowledge accumulation and control at all time, impeding knowledge leakage and oblivion. In the model, knowledge is an outcome that can be divided into two elements: objective knowledge and experimental knowledge. Objective knowledge is transmittable; it can be learned from books. Experimental knowledge is a result of the effective realization of a matter, it can be only learned by experience. This knowledge discrimination will determine our simple knowledge function in the model presented next section.

3 The model

The present model aims to represent the firm's behavior in global markets regarding competition and the attribution given to knowledge retention as well as the search for new consumer markets, aiming to enlarge the mass of profit and its stock of knowledge. We call this richer ambition that aggregates a pecuniary return plus an intangible gain as Expected Benefit Return. The model also intends to analyze the relationship between the key variable - experimental knowledge - and the market share of the participants, as well as the trends when ranging other parameters in the equilibrium state.

We suppose the firm is an efficiency seeker, beyond the profit search, it wants to fix presence in strategic locations where it can benefit in a series of aspects like ultimate product knowledge, access to political hub, closer relationship with global suppliers, and contact with strategic human, capital, and natural resources. Another assumption is that the cost structure is equal for all participants, however this result is achieved by different manners, which specificities (internal knowledge) need to be protected internally. The decision process is centered on a manager agent, previously and exhaustively trained to take this important job-position. Consequently, we can argue that this manager has the authority and ability to take the best possible decision relative to the set of information that is available at a specific point in time. Therefore, we consider that the decision-maker acts rationally, enabling the use of a game theoretical approach. Ultimately, represented by its manager, the firm is also considered a rational agent.

In this model, the main player is a national firm that dominates the domestic market by being more productive than its internal competitors. Productivity here is a consequence of ownership advantages and our national firm is a monopoly in its country of origin. Thereby, the national firm has the financial resources to invest in a production plant abroad and to incorporate the necessary knowledge to do so. The knowledge is the main element for the decision investment to enter the international market. Firms will choose to operate via FDI because they fear dramatically knowledge dispersion (Rugman 1986). Exports and licensing are not part of the decision-making process defined in this model, therefore our model is a specific FDI-scope theoretical model.

After controlling the internal market, the national firm enters into a state in which it faces the possibility of becoming a multinational enterprise (MNE). Even though the national firm is driven by economic results, now the company faces a new source of uncertainty. The national firm, in a global perspective, faces the competition of an international oligopoly that has global competitors with the same productivity level. This new context changes the national firm possibility to exercise monopoly power. Now, the national firm faces an oligopoly structure that limits its monopoly profits.

We suppose that the national firm and the international oligopoly do not have the same set of information (knowledge). In this model, the opportunity on becoming an MNE derives from the fact that we consider the targeted market a foreign emergent economy, with a significant consumers market but a deficient supply in the national firm's activity. The psychic distance regarding all the possible incoming firms is normalized to one; $PsyD = 1$. The national firm is able to identify this opportunity and to start a viability study, pondering the gains and the uncertainties on entering this specific targeted market. The context of the study is aligned with Georgantzis et al. (2012) paper that affirms that companies are imperfectly informed about the state of demand, especially consumers' preferences in the market they are oriented to enter. Most likely, the international

oligopoly will also visualize this market opportunity and its members will also start a study of the same nature.

All the participants are aware of the competitors' capabilities to identify and study the market opportunity. Nevertheless, they are unaware of the competitors' decision whether to enter the market or not. Hence, in our game structure, we will also imply that the international oligopoly will identify the market opportunity and will start a viability study.

The key assumption here is that even though firms can't anticipate each other's intention when the international operation is effectively put in practice, the information will become common knowledge when the entrance is made - this is evident because of the contemporary amplitude of the media's activity. Important to state that since our main agent of study is the national firm, we adopt its perspective on the forthcoming model.

In our model, the national firm is considering to enter in this specific targeted market, then it reaches a decision without the knowledge of this global competitors. If it decides to enter the market, there will be two possible case scenarios: first, the international oligopoly might also consider entering the market and then they will compete in a Cournot oligopoly structure; the second possibility is the international oligopoly not entering the market, therefore the national firm will assume monopolistic power in its new location. The inverse is also true, the national firm might choose not to enter the target, being accompanied by a positive choice of the international oligopoly or not.

It is of vital importance the definition on the temporal extension between the nods of the game. By simply understanding the sequential movement from the national firm after the international oligopoly decision, one might consider the national firm is a late mover, not a follower. This would have a direct impact on the pecuniary effect and the knowledge transfer effect, since the international oligopoly would have a longer period to mature the market and impose entering barriers to the national firm - the knowledge effect would no longer offset the pecuniary effect, the final result of our model would no longer be valid. This is a hypothesis excluded in our model since we shall consider the length of each period being insufficient time for the international oligopoly to set impassable entering barriers to the market.

The important phase comes after the second nod when the media disclose (not disclose) the operation (or its absence) in global news and then it becomes a common knowledge. Here the decisions are already public, therefore we consider that the firms can review its previous decision based on the competitor's action. Consequently, the national firm will decide or not to revise its previous decision if it was not to enter the market.

For the sake of simplicity, we consider the international oligopoly as a collusive unit. This is definitely a heroic assumption, but provokes a duopoly structure in our model that simplifies the analytic result without a great impact in our main object: to adopt the national firm perspective and understand its behavior. Hence, if the national firm decides not to follow the international oligopoly, then the latter will behave as a monopoly. Nevertheless, if the national firm decides to enter the market following the international oligopoly, then it will constitute a competition like within the Stackelberg model. The whole picture is clarified in the extensive form of the game.

The main contribution of this paper is to join the concept of the knowledge function developed by Uppsala into three different market structures and to analyze the decision of the national firm relative to entering in the global market through the optics of game theory. Since the knowledge

function is the core of our work, it deserves a more detailed explanation.

3.1 The Knowledge function

The knowledge acquisition derived from the target market engagement depends basically on two terms, which nomenclature was adopted from the Uppsala model: a constant K_o, called objective knowledge and the experimental knowledge, represented by $K_e(q)$, which is a function of quantity.

The objective knowledge (K_o) is a constant in our model because it can be transmittable, our managers are rational and the firms have the resources to operate in a foreign market. This series of assumptions enlighten a mechanism in which the manager of the firm will set a scheme providing the access to all transmittable information available at a point of time; there is not a significant financial constraint in that operation. The objective knowledge refers to the knowledge of the target market, therefore is a knowledge acquired in the viability study and part of the internationalization process. It's straightforward to notice that, if a firm intends to operate abroad and, consequently, has the financial resources to hire knowledge, $K_o > 0$.

The experimental knowledge, represented by $K_e(q) = \ln q^{\phi}$, is a result of the effective realization of a matter. According to Pedersen and Petersen (2002) the requisite knowledge about the local business environment is inherently experimental and specific to the individual foreign market. Therefore, the respective knowledge can be only attained by experience; it is the learning-by-doing nature of knowledge. Following K_o's nature, $K_e > 0$ or otherwise by default it wouldn't be attractive to undertake global activities, at least considering the acquisition of knowledge.

We consider quantity as a good proxy of the variable that determines the magnitude of the firms' absorption on experimental knowledge, bigger the operation's scale, higher is K_e. Katila and Ahuja (2002) reports a nonlinear relationship between experience and innovation (a consequence of knowledge absorption); in which innovation presents diminishing returns from experience. This fact supports us to incorporate the experimental knowledge in a nonlinear way into the model.

Nonetheless, in the solution of the model with the Stackelberg structure, we decide to incorporate a linear form in the knowledge function of the national firm. Besides the analytical convenience, the literature supports the linear form of the experimental knowledge function for the national firm when it follows the international oligopoly, (Argote et al. 2000; Bandura 1977; Argote and Miron-Spektor 2011; Levitt and March 1988; Zhang and Markman 1998). This is a direct consequence of knowledge spillover between firms operating in the same market. When inexperienced, firms shall imitate decision or practices adopted by competitors that generated successful outcomes (Lu 2002). So, the national firm when entering the market before the international oligopoly, it can benefit from the observation of the experience faced by the other firms.

Here, in accordance with the Zhang and Markman (1998), the underlying idea is that: when able to imitate, compare operations, learn from its competitors and expand through better alignable differences, the follower will enjoy better experimental knowledge accumulation in respect to the scale operation. Hence, the knowledge function for the national firm differs from the knowledge function for the international oligopoly in the Stackelberg structure:

Knowledge function for all firms in the Monopoly and Cournot structure, and for the international oligopoly in the Stackelberg structure:

$$K = K_o + K_e(q) \tag{1}$$
$$K_e(q) = \ln q^{\phi}. \tag{2}$$

Knowledge function for the national firm in the Stackelberg structure:

$$K_{NF^S} = K_o + \phi \cdot q \tag{3}$$

Since we have three structure markets, we have three possible strategies for each of two agents: the national firm and the international oligopoly.

3.2 Equilibrium for the Monopoly case.

As before mentioned, in the first stage of the game sequence the national firm and the international oligopoly will choose simultaneously and without compliance whether or not to enter the respective specific market. Based on this framework we will have two possibilities in monopolistic behaviors: a) the national firm decides to enter this specific market while the international oligopoly prefers not to, and b) the national firm decides not to undertake the investment while the international oligopoly via collusive behavior operates as a monopolistic firm. Here, we employ a linear demand function. In any case, via symmetry of the cost structure, the following operation solves both the Expected Benefit Return (EBR) maximization problem:

$$EBR(q_i) = q_i \cdot (a - b \cdot q_i) - c \cdot q_i + K_o + \ln q_i^{\phi}$$

For $i = \{\text{national firm } (NF), \text{ international oligopoly } (IO)\}$. This enables the optimal quantity for the agent to enter alone in the market and, therefore, achieves the monopoly profit[1]

$$q_{i^M} = \frac{(a-c) + \sqrt{(a-c)^2 + 8b\phi}}{4b} \tag{4}$$

This result states that the agent that choose to enter the market alone will enjoy a monopolist position.

3.3 Equilibrium for the Cournot competition case.

Another conjecture is both firms deciding simultaneously to engage in the foreign operation, the outcome of that is a standard Cournot competition outlook in the newly established market.

$$EBR(q_i) = q_i \cdot [a - b \cdot (q_i + q_{-i})] - c \cdot q_i + K_o + \ln q_i^{\phi} \tag{5}$$

[1]To ensure a positive quantity, we use only one root of the solution and set $a > c$. One also can suppose that the firm will ever choose the bigger quantity of production because of proportionate more experimental knowledge to the same level of EBR.

For symmetry, one shall find the optimal production for the Cournot structure,

$$q_{iC} = \frac{(a-c) + \sqrt{(a-c)^2 + 12b\phi}}{6b}. \tag{6}$$

So, each agent will choose the same quantity when facing a Cournot oligopoly.

3.4 The Stackelberg Equilibrium.

Now, the national firm that originally decided to maintain itself in the domestic market composes the third situation in our model. In a simultaneous fashion, the international oligopoly enters the discussed specific foreign market. After analyzing the international oligopoly's outcome in its new adventure through the media's reports, the national firm might review its own previous decision and undertake the investment; even though at this point it is not facing an untouched territory anymore. Here, the key point is the assumption that the national firm will have access to the international oligopoly knowledge by inverse engineer, knowledge spillover, and employee's flow; enhancing its alignable differences in the same product category. Therefore, the functional form of the national firm's knowledge function will change becoming linear - a direct result of the upgrade on the accumulation of experimental knowledge in respect to the scale.

Mathematically this can be achieved in a sequential choice game, in which the leader (international oligopoly) have the ability to forecast the follower reaction function, i. e., the leader can input the follower's best reaction function in its objective function.

The problem faced by the national firm is:

$$EBR(q_{NFS}) = q_{NFS} \cdot [a - b \cdot (q_{NFS} + q_{IOS})] - c \cdot q_{NFS} + K_o + \phi \cdot q_{NFS}. \tag{7}$$

The best reaction function for the follower (national firm) is:

$$q_{NFS} = \frac{(a-c+\phi)}{2b} - \frac{q_{IOS}}{2}. \tag{8}$$

The problem faced by the international oligopoly is:

$$EBR(q_{IOS}) = q_{IOS} \cdot [a - b \cdot (q_{IOS} + q_{NFS})] - c \cdot q_{IOS} + K_o + \ln q_{IOS}^{\phi}. \tag{9}$$

Adding the best response funcion for the national firm results into the optimal production for the leader:

$$q_{IOS} = \frac{(a-c-\phi)}{4b} + \frac{1}{2b}\sqrt{\left(\frac{(a-c-\phi)}{2}\right)^2 + 4b\phi} \tag{10}$$

This enables us to achieve the optimal production chosen by the follower (national firm in the Stackelberg structure):

$$q_{NF^S} = \frac{3(a-c)+5\phi}{8b} - \frac{1}{4b}\sqrt{\left(\frac{(a-c-\phi)}{2}\right)^2 + 4b\phi}. \tag{11}$$

In this context, the follower operates under a favorable circumstance compared to the leader. This can be interpreted as: even though the initial confidence (risk assumption) on entering the market is compensated by an advantage on the later competition, the possibility of the follower adapting its operation through the absorption of the leader's knowledge will overcome the pecuniary effect.

4 The Game Approach

The preceding description of the business interaction constitutes a dynamic game of imperfect and complete information. Dynamic in the sense that it permits sequential choices - a chain of events, that carries knowledge about previous plays made by the opposite agent. In a dynamic game scheme, credibility is the element that governs players reaction.

This game will feature complete information because the viability study undertaken by the firms will precisely forecast the range of conjectures, each state of competition will be beforehand acknowledged, i.e., the payoffs will be common knowledge. This implies directly into a state of symmetry of information, which will be stressed with more details in the upcoming extensions. However, given the nature of our first stage - in which we stated simultaneity of decision, we must consider an imperfect information environment. In this work simultaneity don't express an act in the exact same fraction of time, beyond that it attempts to express a state in which the agents decide without the knowledge of the rival's decision when facing the same question. In the extensive form of the game this will be represented by an information set at the second decision nod.

4.1 Extensive form of the game

This game approach incorporate a set of players, $P = \{NF, IO\}$, a set of strategies, $S = \{S_{NF}, S_{IO}\}$, with, $S_{NF} = \{(no, no''); (no, yes''); (yes, no''); (yes, yes'')\}$ and $S_{IO} = \{(no', no')\}$, and a set of payoffs,

$$U = (EBR_{NF^C}, EBR_{IO^C}), (EBR_{NF^M}, 0), (0, 0), (EBR_{NF^S}, EBR_{IO^S}), (0, EBR_{IO^M})$$

4.2 The Nash Equilibria

By the right application of the mechanism to find the possible Nash equilibria (N.E.), it is straightforward to identify the N.E. in this game: $N.E. = \{(no, yes''), yes'\}$.

The Nash Equilibria of the game is enlightening. The national firm will primarily decide not to assume the risks of engaging in the specific foreign market. This is due to the fact that the national firm is able to antecipate its advantage on scrutinizing the international oligopoly's performance and operation on the specific market, and consequently absorb the benefits that accrue

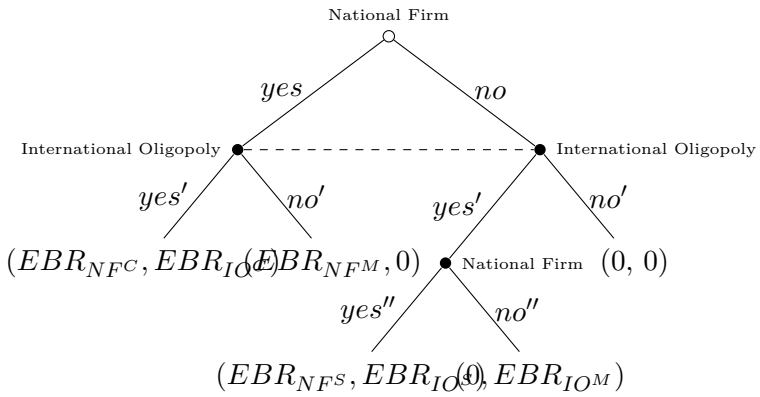

Figure 1: Extensive-form game.

from imitation, alignable differences or replication of knowledge operation. In this specific case, the knowledge factor offsets the pecuniary gains of the first-mover described by Kerin, Varadarajan, and Peterson (1992) and Lilien and Yoon (1990). Therefore, even though the national firm has the initial intention to enter the specific market, it prefers to avoid the initial risks of pioneering and adaption - relegating this to the international oligopoly. After analyzing the outcome and the procedure adopted by the international oligopoly the national firm will finally enter the market to enjoy knowledge transfer and profit enlargement.

This is corresponding to Lee et al. (2000) that states "Moreover, in some instances, a fast second move can produce results superior to those of the first mover" and, also, "While the first mover literature argues in favor of moving first, a number of scholars have promoted early imitation as a profitable alternative to moving first". Therefore, the literature supports the stated result in specific circumstances: to be the second mover can be an optimal strategy (Baldwin and Childs 1969; Katz and Shapiro 1987; Teece 1986).

5 Results from the calibration of the Nash Equilibria.

The subsequent stage after reaching the Nash Equilibria of the game is to depict the trend between the key variable (experimental knowledge) and the quantity pro- duced by the national firm and the international oligopoly, in respect to variations on the other parameter of the equation. To do so, one shall calibrate the Nash Equilibria for each player. This mechanism will allow the analysis of the relations between the parameters, the consistency of the trends and, ultimately, the economic interpretation of the outcome.

According to Cooley (1997) "a model is calibrated when parameters are quantified from casual empiricism or unrelated econometric studies or are chosen to guarantee that the model mimics some particular feature from the historical data". As a result of the inexistent data, in this study, the parameters shall be chosen in order to establish relationships and analyze trends. Nonetheless, the future extensions of this work will more thoroughly describe the intention to generate an empirical framework to validate or not the model. Therefore, the results of the calibration must be compared to empirical results in order to attest the outcome with higher assertiveness.

One important step is the understanding of the impact of experimental knowl- edge on the

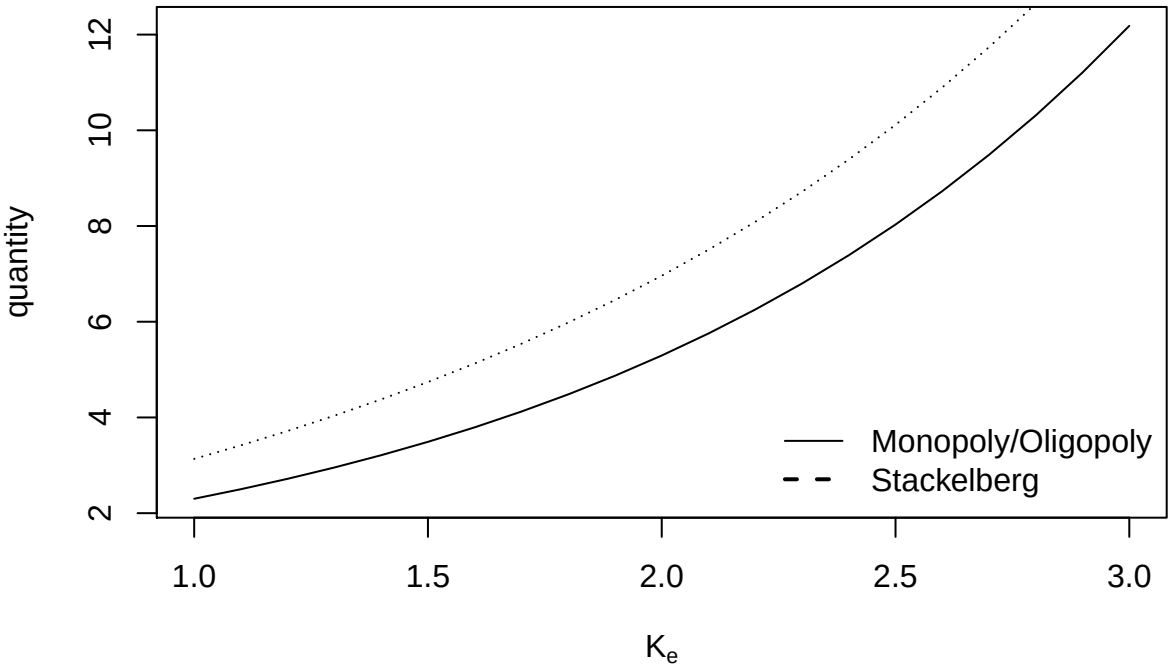

Figure 2: Relation between Experimental Knowledge and the quantity produced. Source: Generated by the authors

entire market. According to our calibration, augmenting the stock of experimental knowledge will result in higher total quantity produced for all the market structures studied. The relationship is slightly convex; therefore increasing the stock of experimental knowledge has a decisive influence on output quantity, as shown in Figure 2. Note that, for the Stackelberg structure the curvature is slightly steeper because of the linear form of the experimental knowledge function for the national firm. This can be reached by different interpretations: a) higher experimental knowledge will enhance productivity of the competitors, making the operation more efficient, lowering marginal cost and increasing production; or b) lower marginal costs will diminish the barrier to entry, possibly increasing the number of players and, therefore, increasing the total quantity produced. The default values of the parameters are $a = 10, b = 0.8, c = 1, \phi = 1.2$.

After the definition of the impact of experimental knowledge on the whole market, one should analyze the changes in the quantity produced and the expected benefits return given changes in each parameter. With this analysis, we can see how the payoffs behave since we make some variations in the parameters.

5.1 Behaviour of Expected Benefit Return and the quantity produced given changes in the parameters.

5.1.1 Results from hanging parameter a, other held constant.

In this subsection, we compare the effect of changes in each parameter on the Expected Benefit Return. We plot it for each market structure to see how the EBR behaves since the parameter hanging from some range defined arbitrarily. We can see in Figure 3 that hanging the parameter a from 1 to 15 by 1. This parameter expresses the price independently of the quantity - we

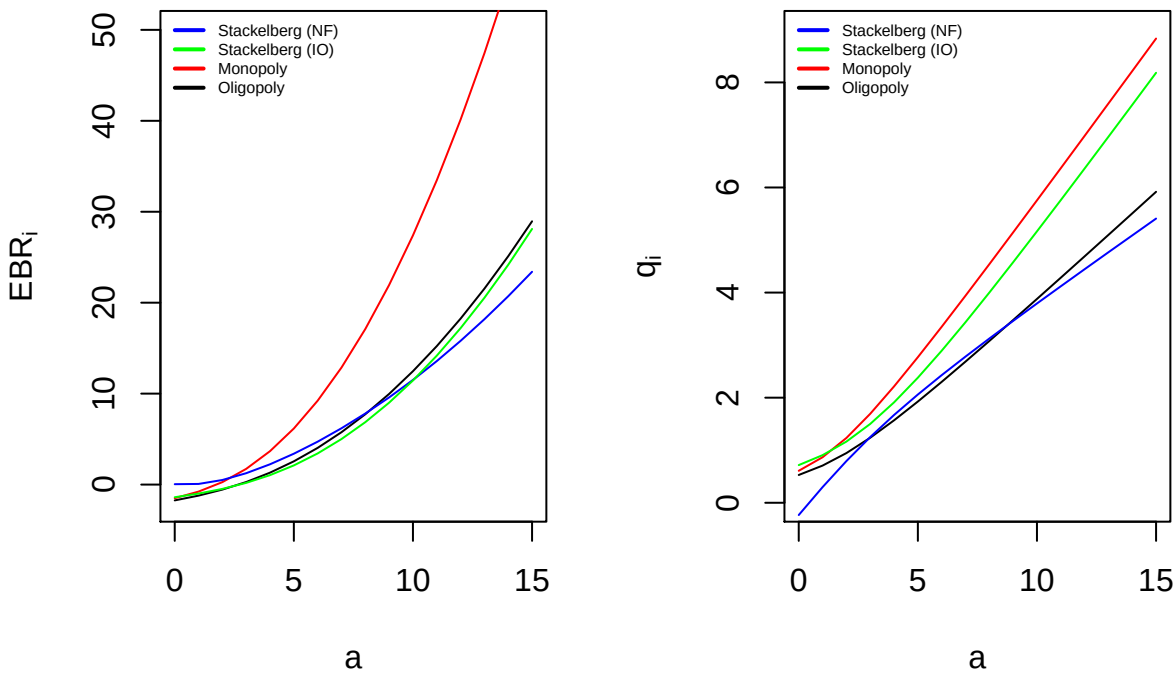

Figure 3: Behavior of the Expected Benefit return (EBR) and quantity produced from changes in the parameter a.

call it autonomous price. One can interpret the parameter a as one that carries the inherent value of a product, independently of the quantity produced. According to our calibration for all market structures, the Expected Benefit Return shows a positive relationship with the parameter a. Well, with increasing inherent value of a product and higher stock of experimental knowledge the advantage of the firm will be magnified, augmenting its EBR. This is due to the fact that a) reverse engineering (imitation) becomes even more vital to competition, and b) the follower has a bigger scope to implement *alignable differences* based on Zhang and Markman (1998).

With a Low level of the *autonomous price* the EBR at the Stackelberg structure is higher than the others market structures. when getting closer to the *autonomous price* of value 3, being a monopolist is better for the national firm. Sice the Nash Equilibria shows that both firms enter the market, one must analyze the results from the oligopoly output. One can visualize that nearby an autonomous price of seven, being the follower is worst than enter at the same time that the *international oligopoly*. One could conclude that the equilibrium is sensible on the level of the autonomous price. This implies on a outcome opposite to our theoretical result. It states that the Stackelberg Equilibrium is a Nash Equilibrium independently of the level that the parameter a could assume. To ensure that the Stackelberg Equilibrium is a Nash Equilibrium, one must make the assumption of an upper limit for the *autonomous price*. Implicitly, above this upper limit, the autonomous price is so high that suppress any gain from the experimental knowledge.

Regarding the relationship between the autonomous price and the quantity produced, we can see a straightforward positive sign. This means that a higher autonomous price will generate higher incentives, and a better prospect for the agents to produce more and, hence, gain more market share. The slope of the knowledge curve presents a slight variation according to the market structure that the agents are inserted. Increasing a makes the relation more concave for the national firm while becoming more convex for the other agents. This is clearly another fact endorsing the conclusion

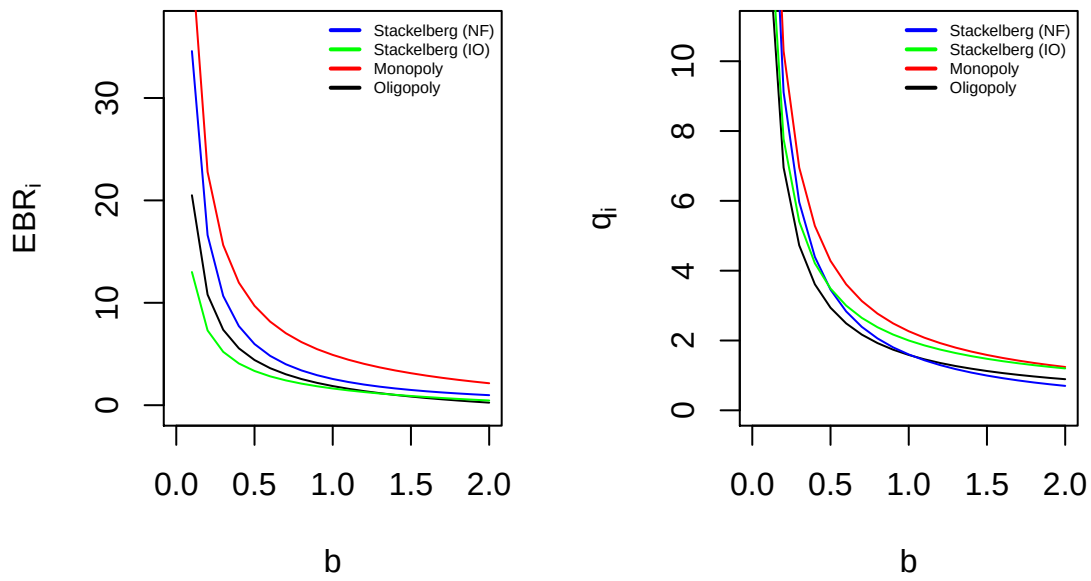

Figure 4: Behavior of the Expected Benefit return (EBR) and quantity produced from changes in the parameter b.

that the autonomous price may suppress the benefits from the experimental knowledge if its at a sufficiently high level.

5.1.2 Results from hanging parameter b, other held constant.

In the price equation, b is the variable that captures the quantity effect in the final price - here we shall name it the *collectability index*. This because it conveys the idea of the product that can be accumulated by the agent, normally in reflect with its price. We know from the basic theory of demand that higher is b, less elastic is the demand function. So, the increase of b reduces the quantity produced and the Expected Benefit Return at the equilibrium. We can see from the Figure 4 that bigger the market power is, the worst it is for the agent an increase in the parameter b. This occurs because the monopolist (or the one that owns higher market power) will trade products at the level where the demand curve is more elastic. Here, part of the consumer surplus can be extracted. Therefore, when b show values above 1, the demand become even more inelastic, causing a clear reduction in the quantity produced and the EBR. When the demand curve becomes more elastic (b near to 0), the level of the quantity produced and the EBR increase at the equilibrium.

Regarding the difference of impact from the parameter b on the Stackelberg structure (our outcome of interest), the result means that a more collectible product (low b) will promote a greater production from the follower, relative to the leader, increasing its market share with a more extensive stock of experimental knowledge. A higher b also reduce the experimental knowledge, this explains the more pronounced effect of the increase of the collectability index in the EBR than the quantity produced. For the follower (national firm), its EBR is bigger than the EBR for the leader or for the case of Oligopoly outcome, confirming that the Nash Equilibrium remains independently of the level of the collectability index.

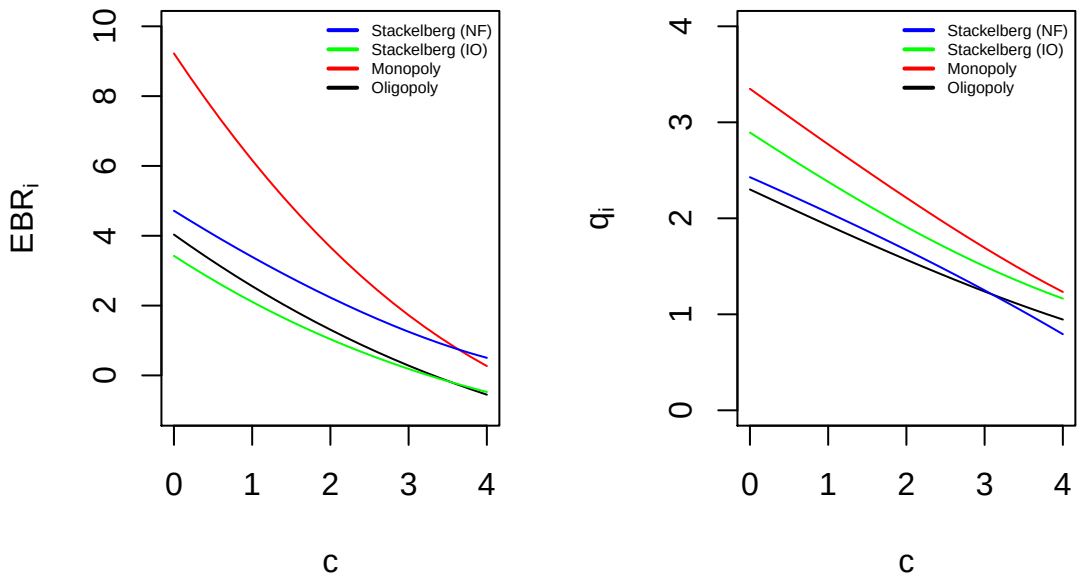

Figure 5: Behavior of the Expected Benefit return (EBR) and quantity produced from changes in the parameter c.

5.1.3 Results from hanging parameter c, other held constant.

The Figure 5 clearly shows the negative relation that marginal cost has with the final quantity produced at the equilibrium. It states that the higher is the marginal cost (remember that our cost structure is linear) lower will be the quantity produced and the EBR at the equilibrium. When the parameter c increases, the Expected Benefit Return remains higher for the national firm when facing a Stackelberg Structure. This is another evidence for the stability of the Nash Equilibria regarding changes in the marginal cost. The slope of the quantity produced and (so) the slope of the experimental knowledge is stable even with the variation on the marginal cost level.

By focusing on the Stackelberg model, it's easy to show that national's firm stock of knowledge has a positive relationship with that the quantity produced - see equation (3). The Figure 5 also shows that for a higher marginal cost, becoming a follower is better than being a monopolist. This expresses the potential advantage of acquiring knowledge from the leader by the fact that at a certain level of marginal costs, the national firm will earn even more profits that a monopolist one. This is other evidence that carries us to believe that the Stackelberg model is in fact the Nash equilibrium.

5.1.4 Results from hanging parameter ϕ, other held constant.

The parameter ϕ is the most important in our analysis. It resumes the intensity in which the quantity produced generates the experimental knowledge. We call it *learning efficiency* because it represents the capacity of the firm to improve your system of production and attain more productivity when it is absorbing knowledge from its activity. One can see in Figure 6 that exists a positive relationship between *learning efficiency* and quantity produced for all the agents except for the leader in the Stackelberg equilibrium. With respect to the Expected Benefit Return, the behavior is exactly the same. Figure 6 also shows that the national firm owns a steeper relation. This is due to the linear knowledge function that it faces, highlighting the fact that the national

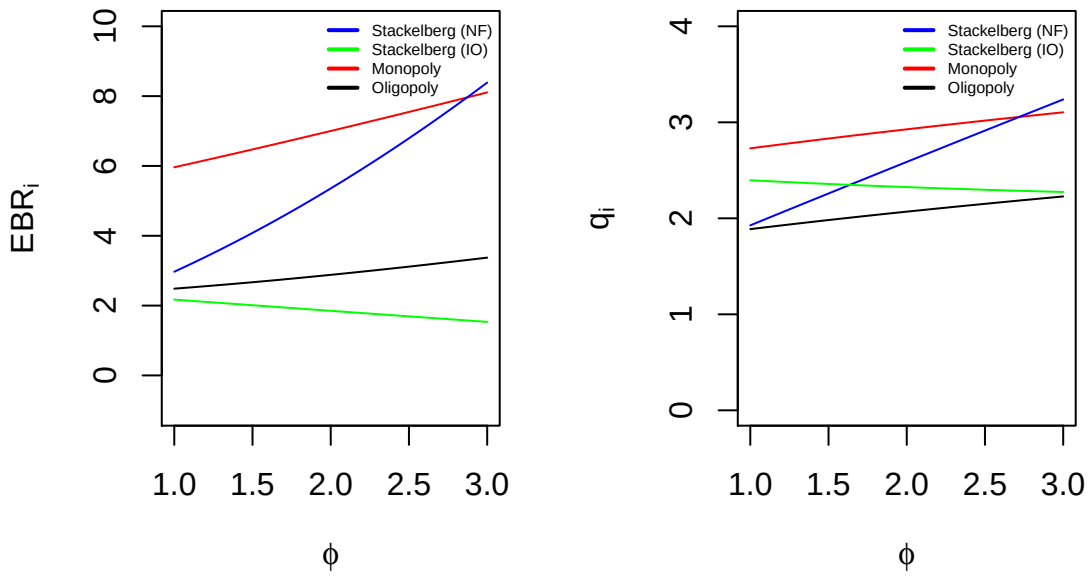

Figure 6: Behavior of the Expected Benefit return (EBR) and quantity produced from changes in the parameter ϕ.

firm has a competitive advantage from its better capacity to transform the quantity produced in experimental knowledge (the linear form of its knowledge function attest this). The opposite negative relation found for the international oligopoly comes from the fact that the better shape of the experimental knowledge function for the national firm leads to an advantage, incresing its market share and, consequently, diminishing the market share (and so the quantity produced) of the international oligopoly.

Primarily, one can verify that for both the quantity produced and the Expected Benefit Return, the national firm has a steeper shape among all the other market structures, even compared to the monopolist case when the *learning efficiency* is near to 3. This is other one fact that support the stability of the Nash Equilibria in the Stackelberg outcome.

6 Conclusion

The intention of this work was to extend the existing literature by introducing a new approach to a long-lasting discussion. The model aggregates characteristics of complementary theories that construct the platform that permits the game theory application. The Ownership-Location-Internalization (O.L.I.) paradigm of John Dunning provided the information to understand the mean (ownership advantages) used by companies to differentiate and become corporations with financial resources to undertake global productive investment, the internationalization advantage guides us through the F.D.I. decisions. Rugman's supports and amplifies the internationalization principle, articulating a general theory based as well on the scope of the firm that modulated our company behavior. The Uppsala model offered the rationality via the managerial features that match the game theory basic assumption. Finally, the game theoretical approach allows us to understand the rational interaction of firms in this globalized environment, in which the knowledge that creates an inherent differential, must be protected when entering foreign markets without the cultural, business and legal expertise.

The mathematical operation outcome clarifies that the knowledge has a positive relationship with the optimal quantity, which reflects the domain of the firm in respect to a sector. Therefore, the Rugman's efficiency seekers companies will mobilize efforts not only to assure more profits but as well to protect and acquire knowledge fostering their dominant position. The Nash equilibrium found in our extensive arrangement endorsed again that we shall move progressively to a more globalized economy. Even facing a more tenacious competition, the great corporations will decide to operate in foreign markets.

The key finding of the paper is the attribution of the knowledge competition in the complete context. In the main agent's perspective - the national firm - knowledge transfer that accrues from the international oligopoly and the possibility to promote alignable differences offset the pecuniary loss of not being a pioneer in the market. Therefore, following immediately the entry of the pioneer is preferable than assuming the risks of being the first entering the market in our specific context. Here, the pecuniary gains disclosed by others researchers will overcome by the knowledge adaption.

According to our calibration results, the follower will always be assuming more market share with increasing experimental knowledge, and as a consequence, will earn more profits enhancing its Expected Benefit Return. The only exception happens when the autonomous price is so high, that the tactics to overcome first-mover advantages will be hampered and obtain more experimental knowledge is not sufficient to acquire the advantages of imitation and reverse engineering. So with an upper limit restriction for the autonomous price, the Nash Equilibria is depicted when the agents face a Stackelberg market structure, where being the follower is better than being the leader.

Obviously, the presented model depicts only a very specific context of interaction in an enormous series of possible competitive scenarios. Nonetheless, it provides an intuition of the behavior of firms regarding global scale competition; the equilibrium advocates that as firms detect new international market opportunities, they will launch international enterprises - even though the international operation's results might be smaller than the ones in the domestic environment. Clearly, some assumptions are oversimplified and hump the explanatory force of the model, but our results give us new insights about the choices involved in the internalization process faced by the firms that still maintain relevance in the economic literature. Finally, this paper offers a game theoretical approach that enforces the theoretical conclusions on the possibility of a Stackelberg Equilibria situation where is better being a follower.

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