ERASMUS UNIVERSITY ROTTERDAM

ERASMUS SCHOOL OF ECONOMICS

MSc. Marketing

Quality and Price Competition in a Duopoly setting with an upcoming entry: The Incumbent's case

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Abstract:

The quality competition involving a market entry has not received the appropriate amount of attention from the academic research community. This contradicts with the fact that incumbents seem to own the power to navigate the market, in terms of demand, to any direction they find more profitable. The present work analyzes the potential equilibriums derived in a duopoly, when an entrenched company competes with an entrant in both price and quality. It explains how quality decisions made by the incumbent determine the optimal price choices driven by profit maximization. My model delivers encouraging results for the incumbent, who seems to enjoy higher profits than what the entrant receives, almost in any scenario under duopolistic conditions. However, a series of alternative phenomena, such as different market industries combined with different targeted segments, different pricing and quality policies etc., is able to "disturb" the incumbent's dominance. Real market examples and a survey of 95 people deliver results not aligned with the theoretical findings. While the majority of the survey participants either stick to their initial optimal price and quality levels or move to a strategic choice opposite of what they expect from their future competitor, the theoretical evidence yields higher profits when the incumbent sets price and quality positively related to the entrant's strategic decisions. This fact proves that a great gap between theory and empirics can occur and demands closer attention.

Keywords: Quality Competition; Price Competition; Nash Equilibrium; Incumbent; Entrant; Simultaneous and Sequential Choice.

Rotterdam, 09/02/2019

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I.Introduction

"Competition is merely the absence of oppression."

(Frederic Bastiat, 1850)[1]

These words express clearly the importance of competition in the business world for over a century now. Both the business and the academic society have put a lot of thought on the matter as an attempt to either trace it and explain it or even strategically deal with it. The competition among firms of the same industry has caused much trouble in the business planning and the strategic decision making of the companies involved. Globalization has intensified the competition, expanding its influence from a local to an international level and allowing the different multinational brands to stand out and take the leading role in the markets that they are active. This is the main reason why various colossal global brands take advantage of this phenomenon by entering many local markets and shaking the balance of the local market share division for their own benefit. This situation is substantially common in retailing and has currently gathered the research spotlight more than ever (Kumar and Paul, 2018), mostly after the massive expansion of e-commerce the past decade (Brynjolfsson et al., 2013). As Chimhundu et al. (2015) highlighted, the strategies of both retailer and manufacturer can be considered as the outcome of "active, undirected and confrontational competition".

What becomes clear from the lines above is that strategy makers should pay close attention to the upcoming competitive response from their rivals' side to prevent mistaken decisions and misguided policies (Aboulnars et al., 2008). Leeflang et al (2017) refer to the importance of the competitive reaction when a new entry in the market takes place. In the present study, game theoretic approaches are used to analyze the effect on the incumbent's behavior and policy-making caused by an entrant in the same industry.

Every firm differentiates its products from its rivals' in order to maximize its revenues and attract as many customers as possible. The differentiation process consists of two channels: the product differentiation, which discerns each firm from its competitors based on the goods and services it offers, and the price discrimination, which sets price as the element of differentiation among similar goods or services. Moorthy (1988) clearly supports that firms face the challenge of choosing that product quality and price which will distinguish them from others to maximize profits, even though they are aware that their rivals will act

[1] Originally retrieved from the book "Economic Harmonies" by Frederic Bastiat, 1850.

accordingly, and this phenomenon occurs regardless the theoretical framework used per case examined.

The aforementioned facts give a substantial reason why this is a crucial topic to investigate further. I have framed my focus on the incumbent's response facing a market entry with the intention to test the validity, or better stated, the compatibility of the theoretical results with real-life cases. The existing study is conducted following the setting neatly presented by Moorthy (1988). Its contribution lies on the extension of the model used by the author in order to capture both the simultaneous and the sequential choice game between an incumbent and an entrant. In this case, the two-stage quality choice model happens simultaneously, however the entrant has already observed the past choices and performance of the competitor-to-be. Furthermore, in the background and keeping the entrant in the dark, the incumbent gathers information about the upcoming activity of the entrant and their[2] strategic choices. This concealed activity gives the entrenched firm the chance to reevaluate their options and possibly change strategy to prepare better for the future market battle, while the entrant considers the incumbent's initial optimal position still valid and upon competition. Demonstrating different scenarios to cover as many strategic-decision combinations as possible, brings this study closer to how the market operates, how firms interact under different competition conditions and what consumers finally have available in terms of product quality and price (welfare outcome).

There is a plethora of market incidents, where the fierce competition led to market exits or on the contrary, empowered particular sectors and let further market entries flourish. A case that exemplifies the first market condition is the loud and surprising exit of Kodak from the digital camera market, besides its innovative path through all the years of its market activity. The latter market condition gets exemplified by the numerous online webshops, such as Amazon, which exploits the large capacity abilities of the digital environment to survive the strong competition due to the big number of such platforms available.

My interest is concentrated in the reaction of incumbents facing alternative circumstances given from their competitor's side. Undoubtedly, they gather a lot of power in their hands to navigate most of the times the market operations to directions that can work in their favor.

[2] To avoid any misconception, I would like to be politically correct when referring to entrant and incumbent. This is why, throughout my analysis, I use plural forms in grammatical terms to generalize my writing with respect to gender application.

Geroski (1995) declares that entrants struggle to survive with solid evidence describing the situation and the survival rates in the US. The author's comment continues claiming the necessity of a decade to pass for a successful entry to get entrenched in the market and reach the size of an average incumbent. They seem leaders in an entrant's eyes, sometimes only because of the fact that they are already active in a market for a longer period than any potential entrant, not to mention their power to allow or deter a potential market entry. However, Tellis and Golder (1996) rescue us from rushed conclusions that a pioneer is always a first successful leader in the industry. By running a historical analysis, they point out that early leaders enter the market about thirteen years after the market pioneer on average. Thus, calling a pioneer first in the market due to the entry-timing ranking is not necessarily translated to long-term successful leadership in the particular sector. Kerin, Varadarajan and Peterson (1992) affirm the above statement with a conceptual and empirical investigation, finding that not only the order of entry does not secure competitive advantages but surprisingly, there are cases where the characteristics of the later entrant get combined with the ones owned by the incumbent to boost the profits of both sides.[3] Moreover, the authors mention that this market role distribution comes after the definition of solid strategic decisions firms have to make regarding price, quality or other product attributes, marketing expenses and production costs. Firms should pay close attention to the existing market conditions and be agile towards changes in their environment if they wish to achieve the maximum performance and fight competition in terms of profitability and market share.[4]

Findings like the aforementioned make the subject beg for further research and elaboration and this is mainly what stimulated the present study. In the majority of literature that has happened to catch my attention, I have noticed that there is either a theoretical analysis or an empirical investigation as a theory extension to validate any theoretical ground base. This distinction does not find me in agreement, since I believe that complete analyses touch both research methods in order to deliver a full and clear picture of the subject under discussion. Thus, the present work follows a layout that allows me to exhibit in Section II part of the available academic research relative to the topic, to analyze the theoretical setting and model employed to reach theoretical results in Section III, to present the empirical results in Section

[3] To be more specific, the authors state that in case of a pioneering incumbent with strong R&D skills and a later entrant with marketing oriented advantage, a potential reverse order entering the market would minimize the profits of both firms.

[4] This statement is further discussed by Hrebiniak and Joyce (1985).

IV, to discuss the generated outcome in Section V and to conclude in Section VI. Finally, the appendix shows all the important derivations and equation solving that are important for the analysis but not presented in Section III, as well as the structure of the survey described in section IV.

II.Literature Review

A vast amount of knowledge coming from the academic society covers separately or a partially combined the simultaneous and sequential games in a duopoly, under price and/or quality competition, with minimum or maximum differentiation. Though some studies are embellished with real-market-cases exemplification, many others have remained under the "safety" of the theoretical modeling serving academic purposes. This research means to concorde all these separate pieces of the puzzle and take a step further by shedding some light onto alternative competition approaches and potential strategic recommendations.

Prices play possibly the most substantial role when it comes to competition matters and the strategy making of a firm, no matter how big or small its size might be. It defines not only the market positioning of the brand compared to its rivals but also the brand positioning and associations that consumers tend to create in their minds in order to organize the available solutions towards their needs' satisfaction. Gerstner (1985), with an extensive literature analysis, reveals that many factors but product quality can lead to higher prices, such as advertising and brand popularity. Although a large number of consumers seek for information before jump into conclusions about product quality, when financial commitment is required, it is a common phenomenon for consumers to perceive price level as the main quality indicator. According to Boyle and Lathrop (2009), consumers have assimilated a positive relationship between product price and quality over years, which cannot be sufficiently supported by empirical findings. The authors highlight the trend that leads to different scales of price-quality relationship with respect to product kind; prices of non-durable products appear to be more intensively correlated with quality than prices of durable products, a phenomenon that surprises the authors considering the vast availability of digital information.

The truth is that maximum differentiation can incur many extensions towards multiple directions. Some distinct figures from the academic world of economics have focused on the theoretical and mathematical clarification of the topic, setting a solid foundation stone for further analysis to happen with ease. Relevant academic studies exemplifying this point are

the ones by Dixit (1986), Quirmbach (1988) and Bramness (1979), while others criticize classical models like Cournot quantity competition (see Simon, Puig and Aschoff, 1973)) or the Hotelling model for locational competition (see d'Aspremont et al. (1979), further elaborated below), shaking the ground base of what is taken for granted until recently.

Although my work is considered theoretical to a great extent, there is no close relation with the discussion of all the theoretical background developed during the past century in the field. Besides, this part is covered by many papers very neatly, such as Shapiro (1989) and Moorthy(1993). It acknowledges, though, the importance of the work already executed from many economists and especially, the extension of quality competition proceeded by Moorthy (1988), which operates as the starting point of this analysis. More particularly, the main idea for this study is triggered by the work of Moorthy (1988), which analyzes the quality and price competition following a duopoly setting. It aims to contribute to the available voluminous literature by switching the business focus from the entrant towards the established firm and its optimal output reactions or strategic opportunities, considering the circumstances taking place each time.

There is no doubt that market balance and role division is quite unstable. The market territory that a firm owns in the present might get either shrinked or enriched by changes in the market's chess board. Entries and exits are constantly present in our era full of digital and high-tech solutions, which are the key of every game changer. As Bresnahan (1989) points out, technology is a crucial factor, which can influence both demand and supply elasticities and eventually, determine the market power concentration.[5]

Dominici (2011) has very accurately described that game theory is originally a military strategic product. However, its further application in the business world was pretty fast spread. Nash (1950) gave shape to the noncooperative idea of game theory with the "Nash Equilibrium", which illustrates how rational and intelligent the predicted way that firms will choose to compete with their rivals is. Part of any firm's strategy appears the prediction of the strategy adopted by its competitors and the tool for such a cause is the best-response function relative to the others' policies, identified by the Nash Equilibrium (Moorthy, 1993). As mentioned by Moorthy (1985), this interaction of firms through the strategies they choose to implement is known as competition interdependence, from the sense that any strategic choice

[5] Bresnahan et al. (1987) for a better understanding of the distinction of the factors that determine the market concentration in the short run and long run.

is the result of a series of events taken place in the past by the firm per se or its competitors and it is going to cause a further impact to its environment.

To clarify it further, the Nash Equilibrium does not necessarily mean that firms choose the best response possible, as if they were monopolists, but they make a decision as the best reaction to that of their competitors, without having the incentive to deviate afterwards (Holt, 2007). For imperfect Nash Equilibria to hold, Fudenberg and Tirole (1983) assert that firms should commit on their production choices eternally. Otherwise, any production variation other than planned sets the Nash Equilibrium concept as unsuitable. In their study, they employ the "perfect equilibrium" as defined by Selten (1965), which allows the stipulation of the best response of each firm after the completion of every round of potential events and decisions. The authors have treated their resulted equilibria accordingly, as a way to deal with changes in their aggregated results over time. Based on what the authors note in their analysis, the setting employed in my study happens to be suitable for the application of Nash Equilibrium, since the two players of the game take as given that the optimal choice of their rival is the obvious one as specified from the solution game. Before overpassing their research full with useful historical background information, Fudenberg and Tirole (1987) make some remarks also on the Stackelberg leader and follower, referring as "Stackelberg equilibria" to the solutions generated by the backwards induction of the full-information sequential-choice game, albeit no substantial difference from the Nash equilibrium properties has been defined.

As already mentioned, product differentiation appears as one of the most common tools companies have available to deal with industry competition. The two main subcategories of product differentiation are the horizontal and the vertical differentiation. The first case covers all the changes in a single product attribute, although this differentiation does not help consumers distinguish which good to choose based on the quality level (it depends on tastes). In the latter case, however, consumers prefer clearly one product over the rest available, after being able to identify which one is superior in quality. Belleflamme and Peitz (2010) give an almost intuitive definition of this discrete choice model distinction: "If for equal prices consumers do not agree on which product is the preferred one, products are horizontally differentiated; if on the contrary, for equal prices, all consumers prefer one over the other product, products are vertically differentiated." This definition assumes a duopoly framework and does not take into account any technology or cost factors. It is worth noting that in

reality, the distinction between horizontal and vertical differentiation is much complicated, because, as the two authors mention, goods and services consist of more than one characteristics and combine both types of differentiation. On one hand, this induces consumers to want more of each characteristic (vertical differentiation), but on the other hand, they may differ in how they perceive the different attributes (horizontal differentiation).

In accordance with Hotelling (1929), the differentiation issue is related to the store location chosen by each firm. But this literal interpretation of the location can be extended to capture the distance of differentiated goods considering the different attributes and quality levels they might own. In my case, quality is the mirror image of location, in a sense that firms choose the quality level of their products in order to reach maximum profits in a way similar to location choice game. Instead of determining store location on the given unit interval towards profit maximization, firms pursue maximum profits in the particular segment their quality level serves, either by choosing quality simultaneously with their competitors or by making their quality decisions observing the ones of their competitors in a sequential choice framework (Prescott and Visscher, 1977). Salop (1979) and Lancaster (1979) consider competition only from its localized dimension, taking the Hotelling path. In particular, under the model proposed by Hotelling (1929), firms are located at the extremes of the quality interval in the case of maximum differentiation, so as to reach the maximum market share in a given segment, to enjoy higher market power and profits, and to relax price competition. On the other hand, there is a contradictory power which drives firms closer to each other in terms of their quality choices under minimum product differentiation. This is the only way to maximize their market share and eventually, their profits, since they are forced to set prices equal to the marginal cost (Belleflamme and Peitz, 2010). d'Aspremont et al. (1979) demonstrated that the "Principal of Minimum Differentiation" is not valid when firms act as aggressive price setters intending to "steal" their competitors' market share, a fact that intensifies the power of maximum differentiation and the importance of quality in the choice game within competitors.

The purpose of this analysis is not the further examination of every scenario involving the firms' price and location choice to reach profit maximization, but the investigation of the quality and price dilemmas an incumbent faces upon a potential entry in the industry. This entry can be defined either as a completely new firm in the market or as an industry expansion of an existing brand, in an attempt to cover a new-for-the-company segment or to

introduce and serve a newly established segment. Real example directly derived from the market is the totally newly-introduced concept of Amazon Go stores, the no-cashier grocery solution of Amazon.com, with its high checkout-free technology that makes it one of its kind among the rest supermarket chains. In addition, another type of entry may occur, that of targeting a new segment; in the airline market, easyJet started recently serving the French people from Bordeaux with new destinations, including Tel Aviv and Luxemburg, intensifying the competition among the airlines serving these destinations before 2018, such as Air France.

Leaving temporarily the market cases behind, there are substantial differences as far as the model assumptions are concerned, notwithstanding the fact that the structure of my analysis follows Moorthy's framework. To be more specific, one difference is that in the model employed here, the two firms are not identical, since they cannot share the same profit function due to the entry costs burdening the entrant. In addition, Moorthy(1988) assumes that consumers are homogenous under equal prices, while Hotelling's approach for consumer heterogeneity seems more appropriate to capture the different quality preferences in the market.

Furthermore, the incumbent is already established in the market, a fact that reduces significantly the costs related to production know-how, capacity, and advertising purposes. Even though my setting employs for both players the same per-unit production cost, gradually increasing with the escalation in quality levels, this fact does not mean that the two firms are considered identical. Last but not least, Moorthy (1988) sets his framework considering one part of the market unserved by the two firms, allowing for a substitute solution. On the contrary, my approach captures the scenario, in which the market is completely covered by the two firms involved in the game. The analysis following below will distinguish further any minor or major difference with Moorthy's setting and it will validate its contribution to the literature available for the discussed topic.

III.Theoretical Analysis

Assumptions

As the first part of this theoretical analysis, I will demonstrate all the required assumptions made as to how the market operates.

Assuming a duopoly with one incumbent and one entrant, the spotlight of this study is concentrated on the reaction of the incumbent relative to quality choice, considering the entrant's choice, taking as a fact that the entry will happen. It is clear that in case the two firms offer same products, consumers will make a choice depending only on price. In general, firms avoid to compete in prices not only due to lower profits but also because price competition decreases margins relatively more than cannibalization, another challenge that big companies with wide product portfolio face (Moorthy,1988).

The framework employed involves the price competition, meaning that, in order to reach the perfect Nash Equilibrium[6], firms make the quality choice and then, they determine the price level. The solution of this choice concept demands two-stages backwards induction, under which the firms first set prices for given quality levels in stage two and then, determine the level of quality to compete in stage one. This setting can be characterized as consumer-centric, since it appears that firms make their strategic choices mostly driven by demand and utility forces.

Moreover, the market is considered to be separated in two segments; the one is represented by consumers that show preference towards the lower-quality product, while the other includes consumers who prefer the higher-quality product. At this point, it should be highlighted that this study considers that the two firms serve the whole market, aligned with Hotelling's assumption and contradictory to Moorthy (1988), whose equilibria involves the inclusion of the "passive substitute"[7], apart from the two products offered by the two competitors.

[6] According to Tirole (1989), a perfect Nash Equilibrium takes place only when a player of the game has no incentive to deviate from their actions, taking the actions of their opponents given and they do not wish their alternation. Also, it is worth noting that a static game occurs when actions happen simultaneously, while a dynamic game happens when a player observes their rivals' actions before distinguish theirs (Chapter 11).

[7] Moorthy (1988) allows the existence of the passive substitute, which is preferred by consumers when none of the two firms satisfy their preferences with the products provided in the market. In this way, the author to investigate the firms' strategic moves when they face the danger of zero demand. However, this aspect is out of scope for the present analysis and thus, it is assumed that the whole market is served by the two competitors under discussion.

Lastly, many analyses assume that when price equalization is binding, every consumer type has a distinct ideal product attribute. This follows again the Hotelling (1929) framework, while Moorthy (1988) goes against this school and adopts the assumption that all consumers share the same ideal product under price equalization.

The Model

This study considers a duopoly consisting of one incumbent labeled (in) and one entrant labeled (e). The two firms decide first the quality level (s) and then, they compete by setting the price (P) that optimally paves the way towards profit (Π) maximization. The analysis includes both simultaneous and sequential choice model and each case is consisted of two quality scenarios: 1) $s_{in} < s_e$, and 2) $s_{in} > s_e$. The reason why I do not analyze the case where $s_{in} = s_{in}$ is because this is the most simple case out of the three scenarios, approached better by the Hotelling model properties and the ones of minimum differentiation, quite studied by the literature available. My reasoning here has to do with the fact that the equality of quality levels between firms cancels off any effect coming from maximum differentiation and quality competition, the main concept this study investigates. Moreover, under this case, the distinction between the incumbent and the entrant gets eliminated and the setting formulated represents the choice game in a typical duopoly.

The ultimate purpose is to identify the optimal strategy the incumbent should adopt given the new entry in the market. Of course, the sequential game allows the entrant to observe the quality choice of the incumbent, but not the opposite. My interest is targeted at investigating only the scenarios when firms cover both consumer types by offering different levels of quality every time. This means that they cannot share the same quality during the choice game. Especially in the sequential quality choice, a quality decision operates as a commitment and it is difficult for a firm to deviate in every period. Consequently, quality works as a defense policy from the incumbent's side towards an upcoming entry and price is the only unfixed tool that can be adjusted during the game. However, in the sequential game, I find it interesting to specifically elaborate on the options the incumbent has after reconsidering their initial ones in an upcoming market entry.

Following Moorthy (1988)'s setting, duopolists compete in one product, even though their portfolio can cover a wide variety of products and services with multiple attributes. To express mathematically this particular product and attribute diversity, I employ the product

interval [*0,* ∞) to match Moorthy's assumption. Basically, this interval shows that even though firms may offer a wide range of products, this setting allows the competition between the two rivals related to only one attribute, which here is represented by quality. Consumers are distributed uniformly on $[\underline{\theta}, \overline{\theta}]$, based on their willingness-to-pay, and they are of mass $M=\overline{\theta} - \underline{\theta}$. As I mentioned above, there are two types of consumers seeking products of either low or high quality. This distinction determines the level of willingness-to-pay (WTP) of each individual, in such way that people of the high-quality type are willing to pay more for a quality increment of a product than the low-quality type. Suppose that a number $s_i \in [\underline{s}, \overline{s}]$ stands for the quality level and $\theta \in [\underline{\theta}, \overline{\theta}]$ denotes the different WTP for quality s_i, where $\theta \sim u[\underline{\theta}, \overline{\theta}]$. The first expression shows that for instance, the incumbent chooses quality s_{in}, which is low if it is closer to the lower bound or high if it approaches the upper bound. The respective outcome goes for the entrant. The later expression is important to clarify some properties but also the logic behind the heterogeneity of consumer choice. Although all consumers prefer higher than lower quality, they value it substantially differently and this heterogeneous valuation of quality expressed by θ shows that consumers with larger θ value any quality improvement more intensively. Thus, the utility function that captures the characteristics of the population under discussion has the property: $\frac{\partial^2 u(\theta, s, p)}{\partial s \partial \theta} > 0$.[8]

Consumers are uniformly distributed along the interval [*a, b*], where $0 < a < b$. This interval represents their quality preference and defines their purchase type. In this case, the marginal cost to produce product quality s is $c \cdot s^2$, no matter the quantity supplied. The quadratic form, as in Moorthy's model, serves the cause of increasing-in-quality marginal cost with a higher pace than consumers' WTP, in order to avoid offering a quality s_i of infinite level to any consumer of type *t*. As a result, s_0 *(b)* is the ultimate limit of quality consumers can enjoy. Considering that for any price P_i the total surplus, which determines whether a purchase happens or not, is $(t \cdot s - c \cdot s^2)$, the outflow of the property above is that for all the consumer types *t*, there is a quality level $s_0(t)$ such that $t \cdot s_0(t) - [s_0(t)]^2 = 0$, meaning that neither the incumbent nor the entrant would find profitable to produce $s > s_0(t)$ for consumer *t*.

[8] The baseline of the model and the properties analysed in this section are a combination of Moorthy (1988)'s setting and Belleflamme and Peitz (2010)'s analysis for the quantity competition under vertical differentiation in Chapter 5.

About the cost parameter, I have taken into account the per-unit production cost to construct the profit function expressing both players' status. However, the format I employed does not show the effect of fixed or other kinds of costs that probably occur. The main reason is because the effect of such cost does not influence the strategic decision making that the two firms perform and thus, the necessity of their presence was not intense to consider it as a crucial omission.

Finally, this framework does not support the fierce price competition delivered by minimum differentiation, since in that case, firms would have priced at the marginal cost level without having any incentive to deviate from that equilibrium level. Apart from that, consumers would maximize their utility by purchasing from the firm offering the highest quality, since the prices available would be the same. This brief analysis gives a clear picture of the setting and consequently, no further elaboration of this scenario is provided.

The main proposition expected from this research predicts that the two firms will find more profitable to choose product differentiation through quality, despite the burden of higher costs. In this way, both players will have the opportunity to relax price competition between them, which is often translated as a big distraction from a firm's strategic goals, and to achieve higher profitability. Nevertheless, this might not be always the case due to many factors involved in the process, e.g. the number of firms active in the market, the kind of products launched, the target group of the specific market segment etc. After the analysis following, the reader should be one step closer to safe conclusions regarding all the aforementioned or implied parameters of the framework.

Simultaneous Game:

This section depicts the game when incumbent (*in*) and entrant (*e*) choose simultaneously the quality level $s_i \in [\underline{s}, \bar{s}]$ without holding any information on each other's choice. Next, they set the prices. To reach the subgame perfect Nash Equilibrium describing the optimal choices from both sides, I follow backwards induction; I present first the price setting in stage two considering the quality level as given and then, I examine the quality choice in stage one.

The market is divided in two distinct segments; $M_{low} = [a, \hat{t}]$ which includes the lower-type consumers that prefer products of lower quality, and $M_{high} = [\hat{t}, b]$ consisting of the higher-type of consumers that are willing to buy only for the high-quality products. The

two markets are separated by the indifferent consumer $\hat{t}$, where $\hat{t} = \frac{Pe - Pin}{s_e - s_{in}}$, who reaches the same level of utility regardless the quality received. From the above, we conclude that consumers of type $t < \hat{t}$ belong to M_{low}, while consumers ot type $t > \hat{t}$ belong to the segment M_{high}. Beginning with the scenario $0 < s_{in} < s_e$, the market segment M_{low} gets served by the incumbent and the market segment M_{high} by the entrant. The setting described so far allows the total division of the market, meaning that all consumers buy from one of the two firms necessarily.

Demand Functions:

- $Q_{in}\ (P_{in},\ P_e) = \frac{Pe - Pin}{s_e - s_{in}} - a$
- $Q_e\ (P_{in},\ P_e) = b\ - \frac{Pe - Pin}{s_e - s_{in}}$

Profit Functions:

- $\Pi_{in}\ (P_{in},\ P_e,\ s_{in},\ s_e) = (Pin - cs_{in}^2)(\ \frac{Pe - Pin}{s_e - s_{in}} - a)$ (1)
- $\Pi_e\ (P_{in},\ P_e,\ s_{in},\ s_e) = (Pe - cs_e^2)(\ b - \frac{Pe - Pin}{s_e - s_{in}}\ )$ (2)

The corresponding First Order Conditions (FOC)[9] of the profit functions with respect to prices deliver the price reaction function[10] of each firm given the price choice of its rival to achieve profit maximization and they are the following:

$$\frac{\partial \Pi in}{\partial Pin} = \frac{Pe - Pin}{s_e - s_{in}} - a + \frac{cs_{in}^2 - Pin}{s_e - s_{in}} = 0$$

$$\frac{\partial \Pi e}{\partial Pe} = b - \frac{Pe - Pin}{s_e - s_{in}} + \frac{cs_e^2 - Pe}{s_e - s_{in}} = 0$$

Price Reaction Functions:

- $P_{in}\ (P_e) = ½\ [\ P_e + cs_{in}^2 - a\ (s_e - s_{in})]$ (3)
- $P_e\ (P_{in}) = ½\ [\ P_{in} + cs_e^2 + b\ (s_e - s_{in})]$ (4)

[9] All the necessary mathematical operations and computations have been performed using the software "Mathematica". Some of the most important results are extensively presented in the Appendix.

[10] According to Dixit (1986), the term "reaction function" is not the most appropriate one to describe the interaction state towards the equilibrium, when firms make strategic decisions simultaneously. Even though he acknowledges its established and wide acceptance, he suggests the phrase "equilibrium locus" as more precise.

By substituting P_{in} with equation (3) in equation (4), we receive the equilibrium price of the entrant as a function of the two firm's quality levels. The same step provides us with the equilibrium price of the incumbent [11].

Equilibrium Prices [12]:

- $P_{in}^{*}(s_{in}, s_e) = \frac{1}{3}[cs_e^2 + 2cs_{in}^2 + (b - 2a)(s_e - s_{in})]$
- $P_e^{*}(s_{in}, s_e) = \frac{1}{3}[2cs_e^2 + cs_{in}^2 + (2b - a)(s_e - s_{in})]$

The reduced form of the profit functions after the substitution of the equilibrium prices in (1) and (2):

$\Pi_{in}(s_{in}, s_e) = 1/9\,(s_e - s_{in})(cs_e + cs_{in} + b - 2a)^2$ (5)

$\Pi_e(s_{in}, s_e) = 1/9\,(s_e - s_{in})(2b - a - cs_e - cs_{in})^2$ (6)

The FOCs of equations (5) and (6) with respect to quality s_i result respectively in the reaction function of incumbent towards entrant's quality: $s_{in}(s_e) = s_e/3 + (2a - b)/3c$ (7) and the reaction function of the entrant: $s_e(s_{in}) = (2b - a - cs_{in})/c$ (8), if $s_e > (2b - a)/2c$ or $s_e(s_{in}) = (2b - a + cs_{in})/3c$ (9), if $s_e < (2b - a)/2c$.

- When $s_e > (2b - a)/2c$ holds, then equation (8) is taken into account and the equilibria yielded are the following:

  - $s_{in1}^{*} = (a + b)/4c$ (10), generated when I substitute (8) in (7).
  - $s_{e1}^{*} = (7b - 5a)/4c$ (11), employing a further substitution of (10) in (8).

  Based on the equilibrium qualities (10) and (11), the final version of equilibrium profits and prices goes as follows:

  - $\Pi_{in1}^{*} = 3(b - a)^3/2c$
  - $\Pi_{e1}^{*} = 0$

  Since the Nash Equilibrium is reached when there is no motivation for choice deviations, this is why I cannot accept this solution set as sustainable. The entrant is

[11] The substitution of (3) in (4) can happen in reverse, since the simultaneous decision-making denudes both firms of the market role tag they own. Therefore, any substitution sequence leads to the same ultimate result, which is here the pair of the two equilibrium prices.

[12] All the values that represent the Equilibrium status of a firm are denoted by an asterisk. In some cases, such as the price equations yielded by equations (3) and (4), which are expressed with respect to s_{in} and s_e, the asterisk indicates that some factors have been already taken into account and their effect has been transmitted to other parameters.

clearly damaged by reaching zero profits and if this is the case then, clearly their motive to enter the market is going to get diminished. Even though any entry is handled as an investment accompanied with the required risk and zero or even negative profits are part of the plan in the beginning, this setting rejects any no-positive profit outcome to be the equilibrium level of this subgame.

- Following the same procedure under the condition $s_e < (2b-a)/2c$, the equilibrium game is formulated like this:
  - $s_{in2}^* = (5a - b)/8c$ (12) [13]
  - $s_{e2}^* = (5b - a)/8c$ (13).

  The substitution of (12) and (13) in profit equations (5) and (6) delivers the reduced equilibrium version of the two player's profits:
  - $\Pi_{in2}^* = 3(b-a)^3/16c$ and
  - $\Pi_{e2}^* = 3(b-a)^3/16c$ (14).

  This pair of optimal quality levels yields also the price equilibria:
  - $P_{in}^* = (49a^2 - 58ab + 25b^2)/64c$ and
  - $P_e^* = (25a^2 - 58ab + 49b^2)/64c$.

The second set of results require a closer look. Although it is easy to notice that $P_{in}^* < P_e^*$, still the firms enjoy the same amount of profits as shown above $(\Pi_{in2}^* = \Pi_{e2}^*)$. The fact that the entrant charges more than the incumbent can be justified by the higher quality that they produce, which rises the production costs and consequently, it demands for a higher price charged as compensation. Despite the higher price of the entrant, the incumbent manages to earn the same as their rival. A possible explanation is the incumbent's established market experience and potential dominance related to their longer market activity compared to the entrant. Besides, in most cases this is the biggest risk/issue burdening any new market entry, which has to fight the high brand awareness and loyalty incumbents enjoy in the targeted segments and/or benefits from economies of scale (Wernerfelt, 1984).[14] It is certain

[13] I assume here that $5\alpha - b > 0$, otherwise $s_{in1}^* < 0$, which is violation of the primary assumption that quality takes values larger than zero. In case that $5\alpha < b$, the results of the simultaneous game are not considered as equilibrium because in every quality scenario, at least one firm has incentive to deviate to achieve a better combination of quality and profits.

[14] As Pehrsson (2009) highlights, brand loyalty works not only as a sales booster (Aaker, 1996) but also as an entry deterrent available to incumbents in order to keep their market dominance established by loyal customers.

that this outcome is generated by many factors other than marketing oriented, such as the timing of entry and the industry and segment of interest, but this discussion is not part of the purpose of this analysis and thus, I will not elaborate further.

If I repeat the foregoing procedure when $s_{in} > s_e$ with all the steps demonstrated so far then the results showing the equilibrium status of both firms are the following:

- If $s_e < (2b - a)/c$ and $s_{in} > (b - 2a)/c$, then:
  - $s_{in1}^* = (7b - 5a)/4c$ and $s_{e1}^* = (a + b)/4c$
  - $\Pi_{in1}^* = 0$
  - $\Pi_{e1}^* = (a - b)^2(a - 2b)/c < 0$, because $(a - 2b) < 0$ as primarily assumed.

  As it can be implied, this quality position is not sustainable for the two players at the same time. Therefore, it gets rejected and the price computation or any other further elaboration is not needed anymore.

- If $s_{in} > (b - 2a)/c$ and $s_e > (a - 2b)/c$ [15], then:
  - $s_{in2}^* = (5b - a)/8c$
  - $s_{e2}^* = (5a - b)/8c$, which is positive only if $5a > b$. In other words, for this solution to be an equilibrium position, the restriction $b \in (2a, 5a)$ should hold throughout the game.
  - $\Pi_{in2}^* = \Pi_{e2}^* = 3(b - a)^3/16c > 0 \quad (14)$, since $b > 2a > a$. Thus, this solution is accepted as sustainable, giving no reason to the players to deviate.
  - $P_{in}^* = (25a^2 - 58ab + 49b^2) / 64c$ and
  - $P_e^* = (49a^2 - 58ab + 25b^2) / 64c$.

  This is the same level of prices as when $s_{in} < s_e$, though here the subscripts are reversed. This fact is normal because in this setting with the quadratic version of the quality, the firm offering the higher quality charges also higher.

The final conclusion under the assumption $s_{in} > s_e$ is that the incumbent reaches the same level of profits as the entrant under the simultaneous-choice game, in spite of the fact that the

[15] This inequality already holds and might even be unnecessary to mention, since (a - 2b) < 0 and any quality level is positive by default.

incumbent charges a higher price than the new competitor does. This situation is the product of higher production costs due to higher product quality offered. However, this outcome should make the established firm reconsider its strategy when an entry is waiting at the corner, in order to make its dominance more permanent and continue being first in consumers' minds.

Comparative Statics - Simultaneous Choice

The comparative statics is the method that allows the analysis of the changes in equilibrium values of the endogenous variables of interest due to changes in exogenous variables. Basically, what we receive as outcome is the change of the equilibrium solution due to a change in one of the parameters involved. In our case, the goal is to reveal the interaction between the prices and qualities of the two rivals. For this purpose, I develop all the necessary derivations using the set of equations under the condition $s_{in} < s_e$, having first certified that when $s_{in} > s_e$ holds, the findings yielded are identical.

I begin with the identification of the relationship between the two prices, employing the reaction functions (3) and (4). Taking the partial derivative of P_i^* with respect to P_j [16], it yields a constant positive number free from any factor including the variable of interest (P_j). This means that the reaction function of price for each firm depending on the rival's price choice is strictly upward sloping and an increase (decrease) of the latter variable induces an increase (decrease) in the price response of the competitor. All changes described take the ceteris paribus principle as given. At this point, I shall clarify that the reason I proceed with the computations using the reaction functions is because I need to employ a function that captures properly the price interaction between the firms. However, the price expressions developed in subsequent stages are not appropriate to provide this illustrated interaction. This reciprocal actions gets vanished due to the concordance of the price effect with quality's and other factors' effects, e.g. see the functions $P_{in}^*(s_{in}, s_e)$ and $P_e^*(s_{in}, s_e)$.

Now, if I differentiate $P_{in}(s_e)$ with respect to s_e, the result is clearly positive based on the primary assumptions of my setting. However, this is not the case when I differentiate

[16] The reader should keep in mind that the analysis yielded by comparative statics refers to the optimal price determined by a player. Since this mathematical technique involves the derivation of one player's price with respect to the other player's price, I execute the derivation of the reaction function $P_i(P_j)$ with respect to P_j, represented by functions (3) and (4).

$P_e(s_{in})$ with respect to s_{in}. As shown explicitly in Part I of the Appendix, this derivative is positive only if $s_{in} > (b-2a) / 2c$. Otherwise, an increase (decrease) in s_{in} leads to a decrease (increase) in P_e, keeping the rest of the parameters involved constant. Finally, the differentiation of s_i with respect to s_j yields a positive constant number,[17] giving a strict positive sign to the interaction between the two quality levels. As a consequence, a decrease (increase) in s_i induces a decrease (increase) also in s_j and vice versa, ceteris paribus.

The results I have reached in this section seem credible and are aligned with the fact that in product differentiation settings with price competition, prices are strategic complements and reaction functions are upward sloping (Belleflamme and Peitz, 2015).[18] Jørgensen, Sigue and Zaccour (2001) mention that price leadership is always in favor of the first mover regardless the demand function employed. If the reaction functions are decreasing or constant, then the game incurs the properties of strategic substitution, rewarding only the price leader, who acts also first. In the present setting, when the decisions are made simultaneously, the best price response for both firms are increasing. This means that there is strategic complementarity and if the equilibrium levels are valid in the case of choice sequence as well, then the entrant would be in favor as the second mover.

Sequential Game:

Continuing with the same duopoly setting, now I focus my examination on the optimal response of the incumbent, depending on the alternatives available to the entrant, assuming that the incumbent is aware of the new entry. Demonstrating the quality choice sequence in this section, first I operate backwards induction to determine the subgame perfect equilibrium, endogenizing the quality choice of the entrant, which was taken as given in the simultaneous choice game. Thus, I start with the optimal solution for the entrant, which is identical to the Nash Equilibrium of the simultaneous choice game. The reason why the entrant shares the same Nash Equilibrium solutions in both games is because they are considered as the second mover in sequence, observing the incumbent's initial quality status before determining theirs. However, it is the incumbent who has the privilege of holding

[17] For the differentiation of s_e with respect to s_{in}, I take into account only the reaction function (8) because the equation (9) delivers zero profits to the entrant and thus, I consider it rejected.

[18] As a brief note, when prices are strategic complements, the increase of a firm's price evokes the increase of its rival's price (see Belleflamme and Peitz (2015), page 391).

information about the rival's future decision with the intention to prepare properly for the upcoming competition by reconsidering their options and possibly deviate from their present strategy.

Instead of demonstrating possible scenarios taking into account the potential initial quality choices triggered by the incumbent as the game's first mover, I use the Nash Equilibrium outcome from the simultaneous choice game to determine the incumbent's original decisions, which are the ones the entrant observes before defining their own. Starting the analysis by displaying all the possible optimal choices the entering firm can reach and continuing with the reaction functions from the leader and first mover of the game will be the layout of this section. The quantities once again are considered exogenous, so the model does not include them in the equilibrium definition.

Imitating the structure of the simultaneous choice game, firstly I analyze the case in which the incumbent offers lower quality to the market ($s_{in} < s_e$). The entrant's intention is to benefit as much as possible from the perks of product differentiation by choosing a quality level for the new product positioned in the opposite-from-the-incumbent side of the quality interval. As already displayed in the previous section, the entrant's profit function that gives such an outcome is the following: $\Pi_e = (P_e - c \cdot s_e^2)(b - \frac{P_e - P_{in}}{s_e - s_{in}})$ (2).[19] The entrant employs the rival's price as exogenous. By taking the FOC with respect to P_e, the differentiation of the profit function gives the price reaction function of the entrant $P_e(P_{in}) = [c \cdot s_e^2 + P_{in} + b(s_e - s_{in})]/2$. This is the price that the incumbent takes into consideration for the solution of this Subgame Nash Equilibrium. Since the incumbent is aware of the price and quality decisions of the future competitor, in the profit function these specific variables are expressed as functions with respect to the initial incumbent's choices given by the Nash Equilibrium of the simultaneous game; namely $P_e(P_{in})$ and $s_e(s_{in})$. Thus, $\Pi_{in} = (P_{in} - c \cdot s_{in}^2)(\frac{P_e(P_{in}) - P_{in}}{s_e(s_{in}) - s_{in}} - a)$ (1') is the profit function of the incumbent that captures the choices determined by the entrant.

By deriving equation (2) with respect to P_e and s_e, the outcome is the reaction function of the entrant given the incumbent's decisions; $P_e(P_{in})$ and $s_e(s_{in})$ respectively. These two equations, when substituted in the profit function of the incumbent, generate the optimal

[19] For the ordering of the equations in this section I borrow the counting order from the simultaneous-game section, only for the functions that these two parts share.

choice of the existing leader after exploiting the advantage of being aware a new entry will occur in the market. The FOC of equation (1') with respect to P_{in} generates a profit function that seems bigger in value than the simultaneous-game outcome (5):

$\Pi_{in}(s_{in}, s_e) = (s_e - s_{in})(cs_e + cs_{in} + b - 2a)^2/8$ (2'), coming from the price reaction function $P_{in}(s_{in}, s_e) = [(b-2a)(s_e - s_{in}) + cs_e^2 + cs_{in}^2]/2$ (3').

- Substituting equation (3') and (8) into (2') delivers:

  $\Pi_{in}(s_{in}) = (b - 2a - 2cs_{in})(3b - 3a)^2/8c$ (4').

  Differentiating (4') in terms of s_{in} gives us $\Pi_{in1}^* = -9(b-a)^2/4 < 0$. This holds when $s_e > (2b-a)/2c$.

- If, instead of (8), I substitute (9) for $s_e < (2b-a)/2c$, the incumbent's profits are:

  $\Pi_{in}(s_{in}) = (b - 2a - 2cs_{in})(5b - 7a + 4cs_{in})^2/216c$ (5').

  The FOC gives two potential optimal qualities for the incumbent:

  - $s_{inA}^* = (7a - 5b)/4c$ (6'), which yields the optimal profit:
  - $\Pi_{inA}^* = 0$, and
  - $s_{inB}^* = (a + 5b)/4c$ (7'), which yields the optimal profit:
  - $\Pi_{inB}^* = (b-a)^3/4c$ (8').

Obviously, the incumbent's benefit lays beneath equation (8') and thus, s_{inB}^* is considers as the equilibrium quality level that gives no incentive to the incumbent to deviate. The optimal price generated by (7') is $P_{inB}^* = c[-2ab(6 + c^2) + a^2(8 + c^2) + b^2(4 + 5c^2)]/16$ (9').

To reveal the entrant's optimal choices, it would be misleading to use the equations demonstrated in this section instead of the ones presented in the simultaneous game, since the entrant is not aware of the strategic deviations performed by the incumbent upon the entrant's arrival in the market. Thus, the entrant's equilibrium levels are the following:

- $\Pi_e^* = 3(b-a)^3 / 16c$
- $P_e^* = (25a^2 - 58ab + 49b^2) / 64c$
- $s_e^* = (5b - a) / 8c$

Now, evaluating the case when $s_{in} > s_e$, the equilibrium scenery is slightly different from what described explicitly above. The concluding outcome is that the profits of the incumbent

are larger than the ones reached by the entrant, which is the equilibrium level of both firms when they compete in quality simultaneously.

Comparative Statics - Sequential Choice

Following the same logic as in the comparative statics analysis for the simultaneous-choice game, I perform the differentiation of both firms' prices with respect to their rival's price and quality level, as well as the derivation of one's quality level with respect to the other's. The analysis above employs the assumption where $s_{in} < s_e$.

To begin with, differentiating P_e with respect to s_{in} and also, to P_{in} delivers a positive derivative, which means that the reaction function is in both cases upward sloping and a change either in quality or in price of the incumbent leads to a change of the same nature and direction in the entrant's price choice. The same interaction occurs between the two firms' quality level, under which a decrease(increase) in the incumbent's quality induces a decrease (increase) in the entrant's quality decision, ceteris paribus.

Accordingly, the differentiation of P_{in} with respect to s_e is positive, meaning that if no other changes occur, an increase (decrease) in quality of the entrant causes an increase (decrease) in the incumbent's price. Here, I cannot differentiate P_{in} in terms of P_e because in this game, the strategic choices made by the incumbent are different from the ones that the entrant takes as given to determine theirs. As a consequence, in the end, the incumbent exerts no influence in the decision making of the entrant, as the latter falsely believes, and incurs no influence by the entrant while determining the new equilibria. This fact holds also in case of the quality determined by the incumbent.[20]

Finally, I have created complementary equations to examine the potential relationship between the two quality levels. The FOC of equation (2') with respect to s_{in} delivers two results: firstly, the reaction function $s_{in}(s_e) = (2a - b - cs_e)/c$, which is negative and therefore, it gets rejected, and secondly, the reaction function $s_{in}(s_e) = (2a - b + cs_e)/c$, which is positive only if $s_e > (b - 2a)/c$. This quality reaction function solidifies the positive influence of s_e on s_{in} ,which means that s_{in} follows the direction of a potential change in s_e, ceteris paribus. Apparently, the comparative statics analysis for the entrant in the sequential

[20] Since it is difficult to visualize this independency of qualities and prices between the two firms, I will try to help the reader understand my point by diving into details about the reaction functions in the sequential game. To determine the incumbent's profit function (1'), I take into account $P_e(P_{in})$ and $s_e(s_{in})$ from the simultaneous game. The substitution happens before the mandatory differentiations, providing no reaction function of nature $P_{in}(P_e)$ and $s_{in}(s_e)$ describing the incumbent's behavior.

game, differentiating P_e with respect to P_{in}, matches with the analysis in the simultaneous game, as the entrant does not deviate from that equilibrium position. In case of $s_{in} > s_e$, the outcome of comparative statics is identical with what analyzed above.

Theoretical Results - Propositions

Result 1:

In both simultaneous and sequential choice, we notice that the profits of the incumbent are higher compared to what the entrant receives, no matter the level of quality the two players choose. Under choice sequence, the incumbent's superiority is quite obvious (see equations (14) and (8') when $s_{in} > (b - 2a)/2$).[21] Under choice simultaneity, when $s_{in} > s_e$, I have shown profit equality between the two firms, excluding costs other than production costs connected with the qualitative upgrade of the product though. As a consequence, when all kinds of costs are taken into consideration to complete the entrant's profit function, the profits of the firm entering face directly a substantial decline. To this set of extra costs belong all the expenses related to advertising and brand communication, which facilitate the familiarization of consumers with the entrant's product/service. This is not the case for the incumbent, who has been serving the market for longer time and has already passed the extra advertising costs that stimulate awareness. I find these additional expenses quite relevant with the cost inequality between the two duopolists.

There is academic evidence that connects brand awareness and consequently, brand equity with a great amount of cost/investment and the market competition. Motameni and Shahrokhi (1998) assert that when brand equity has been achieved in a "mature" market, it can operate as market entry deterrent, discouraging new entrants to enter the market and thus, protecting the well-established brand from extra competition. It also allows the incumbent to charge a price premium keeping the quality level stable. In addition, the authors mention that the expenditure to build brand awareness and reach eventually brand equity is that high that potential entrants cannot support it. Referring to the Coca Cola - Pepsi eternal price competition, they argue that only well-known brands with a substantial budget dedicated to advertising could threaten this market as a possible entry. Hence, the higher profitability that

[21] For better understanding of this particular threshold of sin, see the graphs following below, in result 5.

characterizes the incumbent can be the result of well-founded and lasting brand loyalty. Consumers receive a good quality over time and their lasting satisfaction turns into brand loyalty towards the incumbent, inducing brand-equity boost (Aaker, 1996). Under these circumstances, consumers show no incentive to deviate from a safe and already-tested product choice by trusting a newly launched product, introduced by the entrant.

Result 2:

From the comparative statics describing the simultaneous game, after differentiating the firm's price with respect to its competitor's price, we can safely conclude that there is a positive relationship between the two firms' pricing. If the one changes its price level, the optimal reaction of the other firm is to proceed similarly, changing its price level towards the same direction. This kind of best response holds whether the incumbent produces a lower quality level than the entrant or vice versa.

A possible explanation that can justify this behavior is the ultimate benefit from the maximum differentiation the two players try to achieve. Firms behave as described above because both have an advantage or motivation to charge simultaneously higher prices; the one providing the lower-quality product increases the market power, while the other, which provides the higher-quality product, charges a higher premium, keeping demand stable (Belleflamme and Peitz, 2015; Tirole, 1989). Nevertheless, this result should be treated with caution when the number of firms participating in the market rises; duopolistic and oligopolistic models do not necessarily lead to the same findings (Economides, 1989).

Additionally, as explained already in the comparative statics of simultaneous choice, the phenomenon of strategic complementarity is present in this setting. This forces the two players to follow each other's changes in strategic variables, such as price and quality, as optimal competitive strategy.

Result 3:

Continuing with the findings from the comparative statics in the simultaneous game, the model delivers the same pattern of solution for the quality choices as the price-oriented result discussed above. When a firm witnesses an increase in quality level implemented by its rival, then its best response is to increase its quality level too. This holds regardless the position of each firm in the quality scale. This tendency is probably caused by the fact that even though

the firms benefit from maximum differentiation by keeping the adequate distance in quality, they still compete with each other. From this point of view, they still have to keep up with their competitor's progress, maintaining the optimal qualitative difference $(s_i^* - s_j^*)$. [22] In real market conditions, two firms that are active in the same industry might offer differentiated products and still compete closely with each other. Therefore, they should keep up with their rival's qualitative upgrades if they want to avoid a forced market exit. Acemoglu and Cao (2014), under the umbrella of productivity and innovation, underscore the inclination of the entrant towards higher quality produced by adopting radical innovations. Their intimate goal is to improve their products in such scale that can allow them to "creatively destroy" the incumbent and take the lead of the market. On the other hand, the incumbent normally implements incremental technological changes, quality-oriented among others, that any entering firm has no access to, in lower cost of innovation in contrast to the entrant. This mutual innovative behavior can exemplify the interdependency of the two players following each other's competitive moves.

Result 4:

In simultaneous game, when $s_{in} > (b - 2a)/2c$ and $s_{in} < s_e$, then an increase in s_{in} induces a decrease in P_e, ceteris paribus. In other words, when the incumbent offers a lower-quality product and decides to increase their quality level, then the best reaction from the entrant's side is the price reduction. A possible justification for such a strategic decision is that a quality upgrade from the incumbent's side will cause a price increase for the incumbent's product. As a fundamental principle of economics, demand falls when prices rise, meaning that consumers belonging to the incumbent's segment (M_{low}) will reconsider the market choices available and if they are not loyal enough, they will switch to the entrant's product. If the entrant provides higher quality at reduced price, then consumers will alternate their preferences towards the entrant's product with ease. This exactly is the entrant's intention proceeding to a price decrease when facing the incumbent's quality increase. In reality, this scenario is feasible in case of the economy-of-scale effect and/or the cost leadership from the entrant's side.

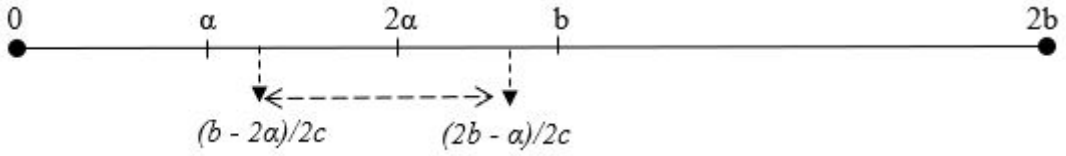
[22] Considering the quality equilibria (12) and (13), *Se2 - Sin2=(6b-6a)/(8c)>0.*

Result 5:

The last noteworthy finding yielded in the *simultaneous game* is related to the quality interval that delivers the optimal quality levels when the players are in the equilibrium status.

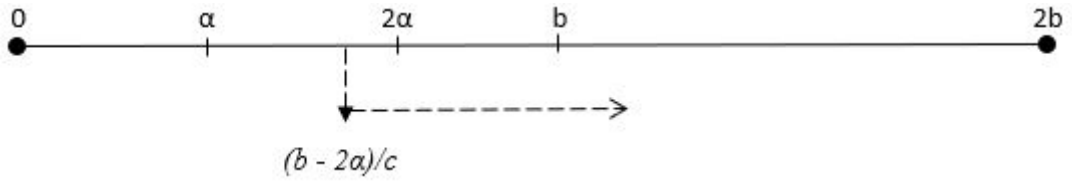
i) If $s_{in} < s_e$, then we get optimal prices and maximized profits when $s_e < (2b - a)/(2c)$ and $s_{in} > (b - 2a)/(2c)$. Between this interval, the two firms receive the maximum possible profit level, considering the cost restriction mentioned above. Under this scenario, the incumbent serves the low-quality market, while the entrant serves the high-quality market. Graph 1 illustrates the specific quality range:

Graph 1. Optimal Quality - Simultaneous game ($s_{in} < s_e$)



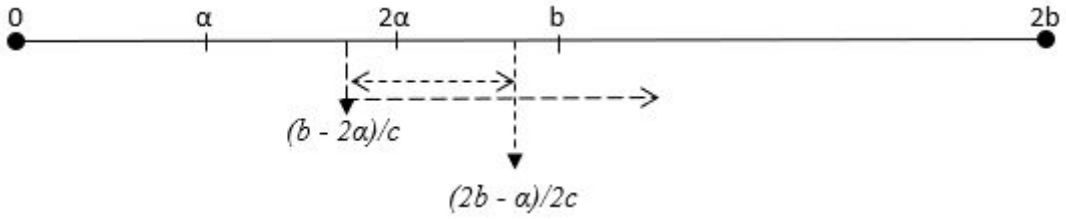
ii) If $s_{in} > s_e$, then the only condition needed for optimal prices and profit maximization is $s_{in} > (b - 2a)/c$. When this is the case, the incumbent serves the high-quality market, while the entrant serves the low-quality market. Excluding the non-production costs, the two firms earn the same amount of profits. The intuition behind is that the high-quality firm, the incumbent, charges a higher price but serves a lower number of consumers. On the contrary, the low-quality firm, the entrant, serves the bigger mass of consumers but charges a lower level of price. This situation yields the profit equality under scope. The graphical representation follows in Graph 2:

Graph 2. Optimal Quality - Simultaneous game ($s_{in} > s_e$)



In the *sequential game*, regardless the scenario employed ($s_{in} < s_e$ or $s_{in} > s_e$), we reach both firms' equilibria in the interval under the following conditions: $s_{in} > (b-2a)/c$ and $s_e \in ((b-2a)/c,\ (2b-a)/2c)$. The common area is positioned again between $(b-2a)/c$ and $(2b-a)/2c$, as in Graph 1. The incumbent owns more information about the entrant and he/she has the opportunity to deviate from their initial quality position without the entrant being aware of such a deviation. This result leaves the entrant in the profit level equal to what he/she earns during the simultaneous game. However, the incumbent has the chance to change quality offered and thus, price charged towards higher level of profits. This is the first-mover advantage and it favors the incumbent. See Graph 3 for the particular quality-interval illustration:

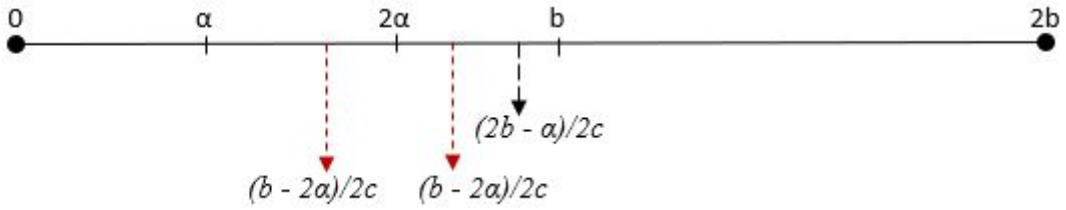
Graph 3. Optimal Quality - Sequential game



Under any circumstance, $b \in (2a, 5a)$[23] throughout the whole game setting. From the conditions above, a last restriction comes to the surface. In order to secure the positive sign of the quality values, respecting the difference of the quality levels chosen by the two players, $0 < a < c < b$ must hold throughout the game solving. In this way, no inequality yielded from the equilibrium solutions contradicts with the relationship $s_{in} < s_e$ or $s_{in} > s_e$. Below, Graph 4 illustrates the impact of cost change on the optimal quality level of the two firms:

Graph 4. Quality Scale Interval: cost

[23] This restriction appears mandatory for the between-firms quality levels not only to remain positive but also to preserve their appropriate distance in terms of scale in order the low-quality firm to continue serving the market segment M_{low} and the high-quality firm the market segment M_{high}.



The purpose of the red dotted arrows is to depict the uncertainty behind the level of production cost related to the quality level (c). This framework does not specify the potential values of c. If $a << c$, the value $(b-2a)/c$ should be placed between $2a$ and $(2b-a)/(2c)$. Consequently, the position of $(2b-a)/(2c)$ per se cannot be precisely determined as well. However, it is true that it should not exceed b, no matter the precise cost level. All the graphs above present all the quality-oriented equilibriums yielded in previous steps. Their purpose is to help the reader visualize the benchmark levels of quality that each firm should choose to maximize their profits. The graphs determine only the range of quality that delivers profit maximization but not the exact level due to the undefined cost term.[24]

IV. Empirical Study

In this section, my purpose is to exhibit and interpret the results gathered by conducting a small empirical research in order to check the validity, or better stated, the ease of market application of the theoretical findings generated throughout the study. This empirical investigation has been conducted using a questionnaire as the main tool, which includes main concluding lines from the different scenarios and the comparative statics analyzed previously. To structure this part, I followed the concept of the study of Ding (2007), which is not directly relative to competition matters but it still has to do with the logic of game theory.

To go more into details, the questionnaire format follows the between-subject structure and the questions have been divided into two different sections; the one captures the choices to be made by the participants when acting as the incumbent and the other one captures the choices to be made when the participants act as the entrant. The first scenario includes five questions; three of them covered the different nature of influence prices and quality levels can have between the two players and the intention is to test whether the results indicated by the comparative statics analysis are aligned with the "common logic", the instincts and the

[24] The graphs 1 to 4 aim to show how the optimal quality range is spread across the quality scale. The intention is not to illustrate which firm earns the most, as this aspect can be extracted by the equilibrium provided in previous sections.

decision-making of people of different age, status and background. The other two questions cover equally the simultaneous and the sequential choice game. They show the difference in the agent's response when the incumbent is aware of the new entry and the strategic options they will have to compete in the future. The second block of questions asks from the participant to make decisions from the entrant's position. It identifies the participant's decision-making pattern, but again the questions are more comparative-statics oriented. This second block consists of only three questions, since the entrant's strategy in both simultaneous and sequential choice game is identical.

To proceed with such an empirical investigation, I used as an industrial example the automobile sector, constructing tailor-made questions to extract conclusions that can be generally applied in various industries, at least to some extent. The automobile manufacturers offer highly differentiated products in terms of quality, while the quality level defines the price level more or less. Berry, Levinsohn and Pakes (1995) argue that the automotive industry often gets under the academic microscope due to its significant contribution to the economic growth of a country and its oligopolistic nature that simplifies the researchers' job to come up with theoretical conclusions, able to support the market battlefield. Taking this a step beyond, the rapid technological evolution has conquered clearly this sector, among others, creating a new market segment ready to be explored. Not many automobile companies have entered the submarket of battery-electric vehicles (BEV) and self-driving cars, setting a suitable scenery to depict properly the application of the present theoretical framework in the real world than other industries.

The participants of the survey were in total ninety five and the questionnaire was designed in such way that allow the randomization of the two question blocks. More specifically, the logic behind this between-subject design is to avoid biased results in the case of presenting both scenarios to every participant (within-subject design). Since there is no right and wrong answer, there was no need to drop any of the responses received, as long as all questions were answered. This means that although 110 responses were obtained originally, fifteen of them had to be excluded from the analysis, since their status remained pending throughout the data analysis. In the table below, demographic information of the respondents is displayed. The percentages in the parentheses represents the category appeared more frequently in total.

Table 1. Participants' General Information[25]

Demographics	(%)	Total (absolute)	Females	Males
		95	56	39
	%		58.9	41.1
Age				
<21	4.2	4	3	1
21-30	74.7	71	45	26
31-40	14.7	14	6	8
41-50	4.2	4	1	3
>50	2.1	2	1	1
Status				
working	38.9	37	18	19
work & study	25.3	24	15	9
studying	33.7	32	21	11
other	2.1	2	2	0
Education				
high school	2.1	2	2	0
HBO	5.3	5	2	3
BSc.	30.5	29	14	15
MSc.	62.1	59	38	21

[25] The reason why I present the demographic information in detail is to secure the validity of the empirical results employing the particular sample. This is achieved by showing that although the population of the female respondents is not equal to the population of the male respondents, the two gender groups are relatively equally-distributed across the several categories. For instance, the majority of both females and males own a master's degree, even though the absolute number of respondents is unequal between the two groups.

Risk				
aversion	35.8	34	19	15
neutrality	20	19	14	5
love	44.2	42	23	19

As demonstrated in Table 1, the vast majority of the respondents are highly educated[26] and considerably young. This can be counted as a very positive aspect for the findings of this survey, since they are the future executives and entrepreneurs that will set the market rules really soon. Another point that needs to be highlighted is that many of the respondents have already been working, or even working while studying by 26%, which means that they have been exposed to the market and its competitive nature, a phenomenon that adds extra validity points to the responses collected. Albeit their market experience, the majority of participants declare that its risk aversion or neutrality is relatively high, a fact that hinders risky strategic moves when uncertainty is loudly present.

Question Block 1: The incumbent's side

Continuing from the main observation extracted from above, when people do not own sufficient information to secure the outcome of a competition game, then they tend to stick to the choices already made up to that point. This is confirmed by the first set of questions exhibited in Part III of the Appendix (Q1.1-Q1.5). When participants knew about the future plan of their competitor, they were changing their strategic choices to defend their market presence and territory by choosing to serve in advance the segment the entrant will target later. This first-mover advantage was chosen by the 66% of the respondents, as one can see in Table 2 exhibited below. This percentage consists of people at the most young age intervals, who are currently studying. The group of people that work already chose to keep the strategic variables stable regardless of the potential entry product choice. This group represents the 33% of the responses about the incumbent's choices, is highly educated, covers the age extremes and is either risk neutral or, and mostly, risk tolerant.

On the other hand, the simultaneous choice finds almost equally participants choosing either to preserve their initial strategic moves towards an upcoming entry (50% of

[26] It was not asked from the participants to specify their educational background in terms of specialization. It is considered throughout the survey that any highly educated person is capable to collect and analyze the necessary or given information to give sound and reasonable answers regardless their field of expertise.

respondents) or to increase the quality and price level, as an attempt to achieve profit maximization while decelerating the entrant's potential success (46% of respondents). The most serious factors that determine this choice are the risk aversion, the education received and the current working status of the participant. The first scenario is mainly embraced by young risk averters, from all the educational categories, who either study or work. The latter choice attracts highly educated risk neutrals or risk seekers that have already some work experience.

From the comparative-statics analysis that concerns the incumbent, there were three survey questions generated. In the case where the incumbent serves the low-quality market M_{low}, 20% of the participants responded that an increase in P_e stimulates an increase in P_{in}, when no other changes occur. The rest 80% decided to sustain their initial quality and price levels, albeit the entrant's actions. The key determinant is once again the risk engagement of the respondents, correlated with the age and working status. In particular, extreme ages with basic education and some work experience claim that are risk lovers and confident that as incumbents, they would continue leading the market without any changes in their strategic choices. However, the minority that chooses to follow the entrant's strategic changes can be described as middle aged, well educated and equally spread in the risk engagement interval.[27]

On the contrary, when the incumbent serves M_{high}, then 57% of respondents would decrease P_{in} facing an increase in P_e, the rest 30% would increase P_{in} and the remaining 13% would leave P_{in} stable, ceteris paribus. For this situation there is no clear pattern detected; the share of risk lovers is equal to the share of risk averters, as well as their education and age range. The only noteworthy observation is that all the respondents belonging to the 57% rate are currently working.

Finally, when people were asked about their reaction when the entrant serving M_{low} would decrease their quality, 68% of them would leave s_{in} untouched. The demographic profile of this percentage is relatively young, with work experience and equally represented by risk lovers and averters. From the rest, 23% would increase s_{in}, while only 9% would follow the entrant's move by reducing s_{in}, ceteris paribus.

[27] Here, the equal distribution in the risk scale means that this group of people consists of ⅓ of risk averters, ⅓ risk neutrals and ⅓ risk lovers.

Concluding with the incumbent's case, the particular results are quite inconsistent with the theoretical findings of comparative statics that expect identical adjustment of strategic choices between the two firms. What participants loudly stated is that they would remain in their initial strategic-choice position when a strategic change would occur from the entrant's side, instead of imitating their rival's move towards the same change direction (both agents increase or decrease their strategic variables). A possible explanation behind this phenomenon is the big number of risk lovers participated in the survey, since they dare to intensify the degree of maximum differentiation in the market by not reacting to a change in the entrant's prices or quality or even proceeding to opposite changes to what the competitor chooses, no matter the market segment covered by the incumbent.

Question Block 2: The entrant's side

Now, moving to the question block describing the entrant's position, the participant's job was slightly less demanding, since the setting allows the entrant to decide strategy based on what they observe already in the market. This condition reduces any uncertainty involved in the market rules. The three questions exhibited in Part III of the Appendix (Q2.1-Q2.3), facilitate the better understanding of choices related to the way people perceive and react to different market scenarios. The first question intends to show whether a potential entrant would prefer minimum product differentiation upon entry, launching a product of same quality and price as the incumbent's. The alternative cse is the maximum differentiation, in which the entrant deviates from the incumbent's product position by offering lower (higher) quality and lower (higher) price than the incumbent. The vast majority of 69% asserts that maximum differentiation leads to higher profits for the entering firm, 47% of which supports the launching of a higher-quality product compared to the incumbent's product. The last choice expresses young/middle-aged people, who either study or work, have reached high levels of education and show a substantial tolerance in risk.

Sequentially, people were asked to solve dilemmas retrieved from the comparative statics analyzed in Section IV. Supposing that the incumbent serves M_{high} and decides to increase P_{in}, 63% of the respondents would keep their initial price stable, while 24% of the respondents would also increase P_e, ceteris paribus. The first ratio consists of the youngest age categories by 88%, the majority is females and 24% are currently studying. The latter

group is also represented by young ages but the majority is working and loves risk (58%). Almost the same scenery occurs when the incumbent serves M_{low} and decides to increase P_{in}. In that case, 45% of the participants would not change P_e at all, 37% would increase it and the remaining 18% would decrease it, ceteris paribus. Here, I present all the groups because they show dramatic demographic differences. For instance, the majority is represented by females, currently working, who mainly distinguish themselves as risk averters. On the contrary, only people that are risk neutral or seekers would choose to decrease P_e. Finally, the participants belonging to the 37% are from 21 to 30 years old by 95%, highly educated, equally working or studying. Table 2 [28] summarizes the most common responses by question analyzed above.

Table 2. Empirical Results

Agent (Question)	Type of game	Top answer	Number of respondents (%)
Incumbent (Q1.1)	Sequential	First-mover advantage	60%
Incumbent (Q1.2)	Simultaneous	No change in P_{in}, s_{in} / ↑P_{in}, ↑s_{in} upon entry	50%-50%
Incumbent (Q1.3)	Comparative Statics $s_{in} < s_e$	P_{in} remains stable when ↑P_e	80%
Incumbent (Q1.4)	Comparative Statics $s_{in} > s_e$	↓P_{in} when ↑P_e	57%
Incumbent (Q1.5)	Comparative Statics $s_{in} > s_e$	s_{in} remains stable when ↑s_e	68%
Entrant (Q2.1)	Simultaneous	Entrant serves M_{high} / $s_e = s_{in}$, $P_e = P_{in}$	47%-31%
Entrant (Q2.2)	Comparative Statics $s_{in} > s_e$	P_e remains stable when ↑P_{in}	63%

[28] For a more extensive presentation of the empirical findings, including demographic information of the sample per answer submitted, see Table A.1 in the Appendix.

Entrant (Q2.3)	Comparative Statics $s_{in} < s_e$	P_e remains stable when $\uparrow P_{in}$ / $\uparrow P_e$ when $\uparrow P_{in}$	45%-37%`

What comes out from the aforementioned findings is that people tend to stick to their own strategic choices despite the changes happening in their environment. This is probably the safest option when lack of competition information creates a veil of uncertainty in the market, regardless of strategic variable's level and market leadership. Later, I will elaborate more on this aspect and how these competing moves have actually a theoretical background. The second most common reaction follows what the theoretical model predicts as optimal choice in quality competition, which is the absolute adoption of the competitor's strategic decisions (positive relationship of the strategic variables between the two competitors). In total, this survey shows that the firm interaction defined by the comparative statics analysis is the boldest possible alternative, because only risk lovers tend to embrace such strategic responses.

In spite of the the gap between the conventional wisdom derived by the empirics and the theoretical findings, the empirical results described above can be still supported by the theory. In cases where the first-mover's advantage is depicted in the questionnaire, then the respondents have sensed this potential benefit of the incumbent, choosing to take action accordingly by 66% on average. When no deviation from the initial price or quality level is selected as the optimal reaction, then the agent (either the incumbent or the entrant) acting accordingly makes use of the scale effect. The scale effect is connected with the production cost and it gets activated when firms have different production costs from each other, leading to different price levels. In line with Raith (2003), the scale effect reduces the benefit from a price decrease, when this is implemented by the firm with the higher production cost. To adjust everything in my case of examination, the firm that offers higher product quality, has a bigger cost burden than the firm which serves the low-quality market. If the latter reduces the quality level it offers, with the intention to charge a lower price and increase its market share, then its rival will not gain much if it adopts this quality decrease. This case is covered by the empirical study with question Q1.5, and indirectly by questions Q1.3, Q2.2 and Q2.3 (considering that any price change occurs as a part of adjustment in the production cost).

When it comes to the negative relationship between the price levels of the competing companies, as delivered by the questionnaire results, there is again a theoretical background which can validate that this is a strategic behavior. This phenomenon is the brand stealing effect. According to Raith (2003) again, when a cost leader faces an increase in the competitor's price level, then the cost leader can steal some of the competitor's market share by lowering the price charged. This behavior causes a negative relationship between the price charged by the competing firms. In the survey, although question Q1.3 delivers a negative price relationship, this price deviation comes from the firm serving the high-quality market tier instead of the cost leader. This case can also appear as evidence of the brand stealing effect because the high-quality firm will now offer a better value-for-money deal, considering that its competitor offers still low quality but only at a higher price. In this way, the high-quality firm will most possibly attract consumers that prefer to receive better quality for a small increase in their WTP.

As a result and in line with Kurokawa and Matsubayashi (2018), a high-quality product does not give necessarily a comparative advantage in the firm that serves the high-quality market over its low-quality market competitor. If the latter decides to make strategic changes towards marketing repositioning, the chances to receive higher profits than the high-positioned firm are many, contradicting to the main principles yielded by the vertical differentiation. This can be prevented by the high-quality firm by making risky strategic choices, according to what has already been described earlier, especially when this firm is the incumbent owning information about the entrant's moves in advance.

V. Discussion

The purpose of this section is to elaborate further on some key-findings from the analysis and connect them with the business reality, as a way to justify some theoretical phenomena, giving to them an empirical dimension. Moreover, some potential limitations are discussed.

In an attempt to interpret the contradiction between the theoretical and the empirical findings of this work, I suppose that people familiar with the mathematically structured logic, i.e. they own an academic background, are in a position to accept the validity of the theoretical indications about the optimal choices available in this game. However, they have the tendency of rejecting them when they are requested to practise real-market reactions (Selten, 1978). This phenomenon might also be connected to the pattern I observed,

according to which the majority of risk lovers belong to the working group and consequently, to older-age categories, expressing more an opinion retrieved by their market experience than by their academic background. Consequently, they behave conservatively rather than boldy, taking strategic decisions that aim to secure the market share/position that, supposingly, they already have rather than expand it.

Depending on the industry, most of the times it is more sensible for an entering company to incline towards the maximum-possible level of quality and the large premium that accompanies it. In short term period, lower quality is translated into lower production costs, lower prices charges and larger quantities demanded. But if the entrant handles this new product as an investment for the future, high quality is preferable in a long-term scale due to the reputation effect as explained by Shapiro (1983). In my setting, one can find the equilibria yielded when the entrant pursues both high and low quality level. In this way, I identify the incumbent's optimal reaction under any quality scenario of maximum differentiation and simultaneously, the reader has access to the complete picture of the game for a better understanding. Therefore, one should not perceive the demonstration of less realistic cases a limitation of this study.

My setting does not consider the innovation adoption. There are real-market cases, such as Tesla, Inc., whose entry introduces new segments to their activity market, covering a whole new concept of needs with their highly innovative and pioneering products. The innovation parameter can operate similarly to the quality effect from the sense that they both are points of difference among competitors, affecting the size of the production cost and they lead to positive social welfare (given that the quality provided is also high).[29] Since my research lacks this approach, the extension of the topic towards the innovation path is suggested for future studies in order to clarify properly the influence of this factor on the equilibria yielded for both players.

[29] To avoid transmitting false messages, I want to clarify that quality choice determines the marginal cost per unit produced and it can either increase it or decrease it regarding the quality level adopted. However, the adoption of new technologies can have only a positive sign in the profit function, because they contribute to the reduction of the production cost and the productivity upgrade of a firm. Schumpeter (1943) highlights the risk accompanying any innovating activity and states that the bigger and more distinguished a company (preferably a monopolist) the easier it is to innovate, undertaking any insecurity coming with it. The analysis on the subject by Tirole (1989) in Chapter 10 implies that normally an entrant cannot support such a risk burden when compared to an incumbent. Of course, there are always exception to the rule, but this matter is not discussed further in this study.

It would be an omission at this point not to scrutinize briefly the influence of the equilibria exerted over the total welfare through socially optimal and efficient solutions. The social benefit is served prima facie by the biggest possible number of firms offering products of the highest possible quality. But this is not always the case, especially when the production costs, and consequently the price, rises upon an increase in quality level. As a matter of fact, this phenomenon impinges substantially upon consumers served by the low-quality firm due to their low WTP, because firms are obliged to increase prices in order to counterbalance the rising production cost and maintain the level of profits declared. This setting considers a duopoly, which allows greater variety offered than a monopoly in terms of consumer welfare. As Lancaster (1990) asserts, the product variety increases in market competitiveness, delivering better variety conditions, and thus welfare, under monopoly threatened by an upcoming entrant than under protected monopoly. Furthermore, the product differentiation escalates under price competition than quantity competition, serving better the consumer's benefit (Motta, 1993). This happens due to fiercer competition anticipated at the end of the game. However, a clear conclusion about the conditions that deliver the maximum welfare or the optimal number of varieties cannot be reached in this setting.

Although product differentiation decelerates price competition, models of imperfect competition where firms choose product characteristics do not necessarily generate predictions concerning prices and product choices. Firms may have an incentive to offer better substitutes to generate more demand, which may lead to instability in competition (Belleflamme and Peitz, 2015). Further research is more than welcome to shed more light on such dilemmas and to prove to what extent marketing strategies are a better tool against competition from the incumbent's side.

Lastly, the industry examples discussed previously are not part of a duopoly, a fact that impedes any direct comparison of a theoretical business model with the real-market arena towards potential strategic conclusions applicable in practice.

VI. Conclusion

The intention of this particular study is to stimulate discussion and arouse the reader's interest in quality-competition matters, which belong to the classics of industrial organization but yet are involved in applications from many other economic divisions, such as marketing, international economics and so on.

The theoretical analysis provided has been initiated and structured upon Moorthy(1988)'s foundation and setting, in an attempt to unfold another aspect generated from the author's analysis. According to the theoretical findings, the incumbent seems to be in a safer place upon any upcoming entry, although this balance can easily be shaken and collapse unless the incumbent is alert and ready to take risks and stay always updated to what customers need. My survey was conducted to test the extent to which the theoretical model is easily applied in real-market terms. The fact that the theory is not fully supported by the empirical results of this survey shows the necessity for further and extensive research on the topic. Besides, nowadays, market competition is on the first page of the agenda of every high-level manager and executive, with established and new players changing the scenery of market leadership more than ever.

This work can be perceived as a small drop in the ocean of market competition. Further research is extremely necessary to cover gaps this survey only managed to point out. A larger empirical investigation, with a sample capturing better the population, can possibly enlighten us further about the controversial results practice and theory deliver and about the specific factors that keep these two pillars either connected or distant. Several of my findings need the presence of specific assumptions to give them validity. Questions, such as what happens when the two players do not cover the whole market or when capacity or other kind of costs burden the two firms, are few of many directions this subject can be stressed to. Another research extension that would be interesting to examine refers to the change in the optimal reaction of the incumbent when launching a new product, acting as the entrant of their own market, with the threat of cannibalization awaiting around the corner. Since this survey has touched the competitive conditions in the automobile industry, it has been noticed that cannibalization has already invaded the Tesla's realm[30] , a tangible example that confirms the claiming need for extended investigation.

Despite its short extent, this work has managed to provide edifying suggestions for managerial activities and strategic purposes. It is a solid starting point, since the framework employed, as simple as it may be, yields results that do not contradict the path been paved by

[30] In his article on Forbes.com, Collins(2018) reports the difficult position of the automotive miracle named Tesla, which launched Model 3 as a "premium sedan segment entrant" and saw the sales of its Model S gradually declining.

the existing academic literature over time. However, it only scratches the surface of the topic and further effort in studying it in depth is highly recommended.

References

Aaker, D. A. (1996). Measuring brand equity across products and markets. *California management review*, *38*(3), 102.

Aboulnasr, K., Narasimhan, O., Blair, E. and Chandy, R. (2008). Competitive response to radical product innovations. *Journal of Marketing*, *72*(3), pp.94-110.

Acemoglu, D., & Cao, D. (2015). Innovation by entrants and incumbents. *Journal of Economic Theory*, *157*, 255-294.

d'Aspremont, C., Gabszewicz, J. J., & Thisse, J. F. (1979). On Hotelling's "Stability in competition". *Econometrica: Journal of the Econometric Society*, 1145-1150.

Bastiat, Frederic. (1850). *Economic Harmonies*. 1979. Irvington-on-Hudson, N.Y.: Foundation for Economic Education.

Belleflamme, P., & Peitz, M. (2015). *Industrial organization: markets and strategies*. N.Y.: Cambridge University Press, pp.112-125.

Berry, S., Levinsohn, J., & Pakes, A. (1995). Automobile prices in market equilibrium. *Econometrica: Journal of the Econometric Society*, 841-890.

Boyle, P., & Lathrop, E. (2009). Are consumers' perceptions of price-quality relationships well calibrated?. *International Journal Of Consumer Studies*, *33*(1), 58-63.

Bramness, G. (1979). *the general conjectural Model of oligopoly-Some Classical Points Revisited* (No. 142). University of Warwick, Department of Economics.

Bresnahan, T. F., Reiss, P. C., Willig, R., & Stigler, G. J. (1987). Do entry conditions vary across markets?. *Brookings Papers on Economic Activity*, *1987*(3), 833-881.

Bresnahan, T. F. (1989). Empirical studies of industries with market power. *Handbook of industrial organization*, *2*, 1011-1057.

Brynjolfsson, E., Hu, Y.J. and Rahman, M.S. (2013). Competing in the age of omnichannel retailing. *MIT Sloan Management Review*, *54*(4), p.23.

Chimhundu, R., McNeill, L.S. and Hamlin, R.P. (2015). Manufacturer and retailer brands: Is strategic coexistence the norm?. *Australasian Marketing Journal (AMJ)*, *23*(1), pp.49-60.

Collins, J. (2018). The Model S Finally Has Competition-From The Model 3-And That's Not Good for Tesla. Retrieved from https://www.forbes.com/sites/jimcollins/2018/07/03/the-model-s-finally-has-competition-from-the-model-3-and-thats-not-good-for-tesla/#22876b8e59c6

Ding, M. (2007). A theory of intraperson games. *Journal of Marketing*, *71*(2), 1-11.

Dixit, A. (1986). Comparative statics for oligopoly. *International Economic Review*, 107-122.

Dominici, G. (2011). Game theory as a marketing tool: uses and limitations. *Elixir Marketing Management 36*, 3524-3528.

Economides, N. (1989). Symmetric equilibrium existence and optimality in differentiated product markets. *Journal of Economic Theory*, *47*(1), 178-194.

Fudenberg, D., & Tirole, J. (1983). Learning-by-doing and market performance. *The Bell Journal of Economics*, 522-530.

Fudenberg, D., & Tirole, J. (1987). Noncooperative game theory for industrial organization: an introduction and overview.

Geroski, P. A. (1995). What do we know about entry?. *International Journal of Industrial Organization*, *13*(4), 421-440.

Gerstner, E. (1985). Do higher prices signal higher quality?. *Journal of marketing research*, 209-215.

Holt, C. A. (2007). *Markets, games, & strategic behavior* (pp.76). Boston, MA: Pearson Addison Wesley.

Hotelling, H. (1929). Stability in competition, *The Economic Journal*, 41-57.

Hrebiniak, L. G., & Joyce, W. F. (1985). Organizational adaptation: Strategic choice and environmental determinism. *Administrative science quarterly*, 336-349.

Jørgensen, S., Sigue, S. P., & Zaccour, G. (2001). Stackelberg leadership in a marketing channel. *International Game Theory Review*, *3*(01), 13-26.

Kerin, R. A., Varadarajan, P. R., & Peterson, R. A. (1992). First-mover advantage: A synthesis, conceptual framework, and research propositions. *The Journal of Marketing*, 33-52.

Kumar, A., & Paul, J. (2018). Mass prestige value and competition between American versus Asian laptop brands in an emerging market—Theory and evidence. *International Business Review*.

Kurokawa, S., & Matsubayashi, N. (2018). Price and quality competition with quality positions. *Journal of Economics & Management Strategy*, *27*(1), 71-81.

Lancaster, K. (1979). Variety, equity and efficiency (Columbia University Press, New York).

Lancaster, K. (1990). The Economics of Product Variety: A Survey. *Marketing Science, 9*(3), 189-206.

Leeflang, P. S. H., Wieringa, J. E., Bijmolt, T. H. A. and Pauwels, K. (eds) (2017) Advanced methods for modeling markets. Cham, Switzerland: Springer (International series in quantitative marketing).

Moorthy, K. S. (1985). Using game theory to model competition. *Journal of Marketing Research*, 262-282.

Moorthy, K. S. (1988). Product and price competition in a duopoly. *Marketing science*, *7*(2), 141-168.

Moorthy, K. S. (1993). "Competitive Marketing Strategies: Game-Theory Models". In J. Eliashberg and G. L. Lilien (eds.), *Operations Research and Management Science*, Vol. 5, Amsterdam: North-Holland, pp.143-190.

Motameni, R., & Shahrokhi, M. (1998). Brand equity valuation: a global perspective. *Journal of product & brand management*, *7*(4), 275-290.

Motta, M. (1993). Endogenous Quality Choice: Price vs. Quantity Competition. *The Journal of Industrial Economics, 41*(2), 113-131.

Nash, J.F. (1950). The bargaining problem. *Econometrica 28*, 155-162.

Pehrsson, A. (2009). Barriers to entry and market strategy: a literature review and a proposed model. *European Business Review*, *21*(1), 64-77.

Prescott, E. C., & Visscher, M. (1977). Sequential location among firms with foresight. *The Bell Journal of Economics*, 378-393.

Quirmbach, H. (1988). Comparative Statics for Oligopoly: Demand Shift Effects. *International Economic Review, 29*(3), 451-459.

Raith, M. (2003). Competition, risk, and managerial incentives. *American Economic Review*, *93*(4), 1425-1436.

Salop, S. C. (1979). Monopolistic competition with outside goods. *The Bell Journal of Economics*, 141-156.

Schumpeter, J. A. (1943). *Capitalism, Socialism and Democracy*. London: Unwin University Books.

Selten, R. (1965), "Spieltheoretische Behandlung eines Oligopolmodells mit Nachfragetragheit," *Zeitschrift fur die gesamte Staatswissenschaft 12*, 301-324.

Selten, R. (1978). The chain store paradox. *Theory and decision*, *9*(2), 127-159.

Shapiro, C. (1983). Premiums for High Quality Products as Returns to Reputations. *The Quarterly Journal of Economics, 98*(4), 659-679.

Shapiro, C. (1989). The theory of business strategy. *The Rand journal of economics*, *20*(1), 125-137.

Simon, J. L., Puig, C. M., & Aschoff, J. (1973). A duopoly simulation and richer theory: an end to Cournot. *The Review of Economic Studies, 40*(3), 353-366.

Tellis, G., & Golder, P. (1996). First to market, first to fail? Real causes of enduring market leadership.

Tirole, J. (1989). *The theory of industrial organization*. Cambridge, MA: MIT Press.

Wernerfelt, B., (1984). A resource - based view of the firm. *Strategic Management Journal*, *5*(2), 171-180.

Appendix

Part I. Simultaneous Choice - Comparative Statics

The sequence of all the mathematical steps followed has been described as neatly and clear as possible. In this section, I have included the differentiations performed to reach the desired results belonged to the comparative statics part. What has been explained below holds for both $s_{in} > s_e$ and $s_{in} < s_e$, but the equations computed for the latter case are used to proceed through this demonstration.

Firstly, I started with the differentiation of P_{in} with respect to P_e employing equation (3):

$\frac{\partial P_{in}}{\partial P_e} = 1/2$.

Repeating the same procedure but with reversed subscripts, using equation (4):

$\frac{\partial P_e}{\partial P_{in}} = 1/2$.

Thus, both prices are interdependent on each other, the way Moorthy (1985) defines it, and their relationship is strictly positive.

Before deriving (3) and (4) with respect to s_e and s_{in} respectively, I substitute the equilibrium price of the rival and the equilibrium quality level of the player per se in (3) and (4). In this way, I manage to express P_{in} only in term of s_e and P_e as a function of s_{in}. From this process I receive:

$P_{in}(s_e) = 1/12[c^2(b-5a)^2 + 4cs_e^2 + 4(b-2a)(s_e + (bc-5ac)/8)]$ and

$P_e(s_{in}) = 1/3[1/4(a-5b)^2c^2 + cs_{in}^2 + 1/8(2a-b)(ac - 5\ b\ c\ +\ 8\ i)]$.

$\frac{\partial P_{in}}{\partial s_e} = 1/3\ (b - 2a\ +\ 2\ c\ s_e) > 0$

$\frac{\partial P_e}{\partial s_{in}} = 1/3\ (2\ a\ -\ b\ +\ 2\ c\ s_{in}) > 0$ only if $s_{in} > (2a - b)/2c$, keeping in mind that $b > 2a$.

For the differentiation of s_i with respect to s_j, I use only the reaction functions that generate positive profit, which are equations (12) and (13), valid under the restriction $s_e < (2b - a)/2c$.

$\frac{\partial s_{in}}{\partial s_e} = \frac{\partial s_e}{\partial s_{in}} = 1/3 > 0$, which reveals a positive relationship between the competing firms' qualities.

Part II. Sequential Choice

From (1') we have $\Pi_{in} = (P_{in} - c \cdot s_{in}^2)(\frac{P_e(P_{in}) - P_{in}}{s_e(s_{in}) - s_{in}} - a)$. Plugging equation (3) in (1') delivers:

$\Pi_{in} = [(P_{in} - c \cdot s_{in}^2)(cs_e^2 - P_{in} + (b - 2a)(s_e - s_{in}))]/[2(s_e - s_{in})]$, which differentiated by P_{in} generates:

$\frac{\partial \Pi_{in}}{\partial P_{in}} = [cs_e^2 - P_{in} + (b - 2a)(s_e - s_{in}) - (P_{in} - c \cdot s_{in}^2)]/[2(s_e - s_{in})] = 0 \Rightarrow$

$P_{in}(s_{in}, s_e) = 1/2\ [cs_e^2 + cs_{in}^2 + (b - 2a)(s_e - s_{in})]$. Taking this into account, we get:

$\Pi_{in}(s_{in}, s_e) = 1/8\ (s_e - s_{in})(b - 2a + cs_e + cs_{in})^2$.

To express Π_{in} as a function of s_{in}, I plug in the quality reaction function (9) computed in the simultaneous game and the following series of calculations is the outcome:

$\Pi_{in}^*(s_{in}) = 1/8[-s_{in} + (2b - a + cs_{in})/(3c)][b - 2a + c((2b - a + cs_{in})/3c) + cs_{in}]^2 \Rightarrow$

$\Pi_{in}^*(s_{in}) = (2b - a - 2cs_{in})(5b - 7a + 4cs_{in})^2/(216c)$

$\frac{\partial \Pi_{in}}{\partial s_{in}} = (a\ -\ 2\ b\ +\ 2\ cs_{in})(5b - 7a + 4cs_{in})/27\ +\ (5b - 7a + 4cs_{in})^2/108 = 0 \Rightarrow$

$1/36\ (7\ a^2\ +\ 2\ a\ b\ -\ 5b^2\ +\ 16\ (b - 2a)cs_{in} + 16c^2 s_{in}^2 = 0 \Rightarrow$

$s_{inA}^* = (7\ a\ -\ 5\ b)/(4\ c)$ or $s_{inB}^* = (a +\ b)/(4\ c)$.

As explained in Section III, only the s_{inA}^* is accepted because it returns positive profits.

The incumbent's equilibrium price is calculated as the combination of three different equations: $P_{in}(s_{in}, s_e) = 1/2\ [cs_e^2 + cs_{in}^2 + (b - 2a)(s_e - s_{in})]$, $s_{inA}^* = (7\ a\ -\ 5\ b)/(4\ c)$ and $s_e^* = (5b\ - a)\ /\ 8c.$

This combination returns the following mathematical steps towards the desired equilibrium price :

$P_{in}^* = 1/2\ [c(5b - a)^2/(64c^2) + c(7a - 5b)^2/(16c^2) + (b - 2a)(15b - 15a)/(8c)] \Rightarrow$

$P_{in}^{*} = c\,[b^2(4 + 5c^2) - 2ab(6 + c^2) + a^2(8 + c^2)]/16$.

Part III. Empirical Study (Questionnaire)

Q1.1 Supposing that you are the general manager of a leading automobile company worldwide and *you are aware* of an upcoming electric-vehicle *entry* from a powerful Silicon-Valley entrant offering a car of a **higher quality and higher price** than the company you manage does. What is your reaction?

o You stick to your initial price and quality decisions, continuing serving your old customers not interested in the new product (maximum differentiation perks). (1)

o You act before the entry occurs by increasing your product's quality level and price, targeting the entrant's desired segment first (first-mover advantage). (2)

o You act before the entry occurs by lowering your product's quality level and price, to intensify the difference between the entrant's product and yours (intensified maximum differentiation). (3)

Q1.2 Supposing the company you manage is the incumbent and you expect a new market entry in the near future. However, there is *no information* available about the entrant's strategic decision (a.k.a. product quality and price level). In order to maximize your profits by guessing your competitor's move, would you prefer to

o lower your initial quality and price choices (if they are relatively high) to meet those of the entrant? (1)

o increase your initial quality and price choices (if they are relatively low) to meet those of the entrant? (2)

o keep the same quality and price levels regardless the entrant's strategic decisions? (3)

Q1.3 Given that your competitor produces a **higher-quality** car and charges a **higher price** than you do, how would you react in a potential **increase in his/her price** charged?

o You would increase your price. (1)

o You would leave your price stable. (2)

o You would decrease your price. (3)

Q1.4 Suppose that your competitor produces a **lower-quality** car and charges a **lower price** compared to you. An **increase in his/her price** level will cause:

o You would increase your price. (1)

o You would leave your price stable. (2)

o You would decrease your price. (3)

Q1.5 Finally, suppose you offer a car of **superior quality** compared to your competitor. If your competitor decides to **decrease his/her car quality**, what would you do?

o You would decrease your quality too. (1)

o You would leave your quality level stable. (2)

o You would increase your quality. (3)

End of Block: In the shoes of the incumbent

Start of Block: In the shoes of the entrant

Q2.1 Imagine you own a young but already well-known automobile company, which wishes to enter a new market segment. The market is served by only one car manufacturer until now (incumbent). Which of the following strategies do you think is more profitable for your company?

o Launch a car of similar quality and price to the models already produced by your competitor. (1)

o Launch a car of higher quality and price than the models offered by your competitor. (2)

o Launch a car of lower quality and price than the models offered by your competitor. (3)

Q2.2

Given that your competitor produces a **higher-quality** car and charges a **higher price** than you do, how would you react in a potential **increase in his/her price** charged?

o You would increase your price. (1)

o You would leave your price stable. (2)

o You would decrease your price. (3)

Q2.3 Suppose that your competitor produces a **lower-quality** car and charges a **lower price** compared to you. An **increase in his/her price** level will cause

o an increase in your price too. (1)

o a decrease in your price. (2)

o no change in your price. (3)

End of Block: In the shoes of the entrant

Start of Block: Additional Background Information

Q3.1 Please indicate your gender:

o Male (1)

o Female (2)

Q3.2 Please indicate your age:

o <21 (1)

o 21-30 (2)

o 31-40 (3)

o 41-50 (4)

o >50 (5)

Q3.3 Please specify your current status:

oWorking (1)

o Working and studying (2)

o Studying (3)

o Other (4)

Q3.4 Choose the maximum level of education you have reached:

o High school (1)

o College of applied science (HBO) (2)

o University (Bachelor's level) (3)

o University (Master's level) (4)

o Other (5)

Q3.5 Please indicate how much of a risk lover you consider yourself. Note that a risk lover prefers high returns of investments with unknown risks.

0 10 20 30 40 50 60 70 80 90 100

End of Block: Additional Background Information

Table A1. Empirical Results - Overview[31]

Block	Questions	Options	Total (%)	Gender	Risk	Status	Age	Education
1) Incumbent	Sequential Choice	Max Differentiation	30	-	averters (52%)	students (54%)	18-30	-

[31] Some notes for the better understanding of the table: Firstly, the empty cells mean that there was no dominance of a specific value worth mentioning, but this is not necessarily translated into equal distribution. Additionally, "Education" depicts the categories that are either by-far dominant or exclusively stated. The same applies for "Status".

		1st Mover Advantage	66	-	neutral/ lovers (92%)	work	extremes	BSc/MSc
		Intensified Max Differentiation	4	males	lovers (50%)	-	-	-
	Simultaneous Choice	Decrease P_{in}, s_{in} upon entry	4	-	averters -lovers (50% - 50%)	-	-	-
		Increase P_{in}, s_{in} upon entry	46	males	averters (67%)	-	18-40	All levels
		Keep P_{in}, s_{in} same upon entry	50	-	-	work/ work &study	-	BSc/MSc
	Comparative Statics ($s_{in}<s_e$)	↑P_e increases P_{in}	20	-	equally spread	equally spread	equally spread	equally spread
		↑P_e does not change P_{in}	80	-	lovers (40%)	work/ work &study	21-30/ >50	BSc (64%)
		↑P_e decreases P_{in}	0	-	-	-	-	-
	Comparative Statics ($s_{in}>s_e$)	↑P_e increases P_{in}	30	-	averters -lovers (50%- 50%)	work/ study	21-50	BSc/MSc
		↑P_e does not change P_{in}	13	-	lovers	equally spread	equally spread	BSc/MSc
		↑P_e decreases P_{in}	57	-	averters -lovers (50%- 50%)	work	21-50	BSc/MSc

		↑s_e decreases s_{in}	9	males	equally spread	equally spread	equally spread	equally spread
		↑s_e does not change s_{in}	68			work	21-40	
		↑s_e increases s_{in}	23	males	lovers (60%)	work/ work &study	equally spread	BSc/MSc
2) Entrant	M_{low} or M_{high} to max Π_e	$s_e = s_{in}$, $P_e = P_{in}$	31	females	lovers (50%)	study	21-30	BSc/MSc
		$s_e > s_{in}$, $P_e > P_{in}$	47	-	lovers (50%)	work/ study	18-50	BSc/MSc
		$s_e < s_{in}$, $P_e < P_{in}$	22	females	averters (64%)	work &study	21-32	HBO/BSc/ MSc
	Comparative Statics ($s_{in}>s_e$)	↑P_{in} increases P_e	24	-	lovers (58%)	work	21-40	HBO/BSc/ MSc
		↑P_{in} does not change P_e	63	females	equally spread	study/ work &study	21-30	MSc
		↑P_{in} decreases P_e	13	-	lovers (57%)	work	-	-
	Comparative Statics ($s_{in}<s_e$)	↑P_{in} increases P_e	37	females	equally spread	study/ work	21-30	BSc/MSc
		↑P_{in} decreases P_e	18	females	neutral/ lovers (100%)	equally spread	-	HBO/BSc/ MSc
		↑P_{in} does not change P_e	45	females	-	work	21-50	HBO/BSc/ MSc