



PONTIFICIA UNIVERSIDAD CATOLICA DE CHILE  
ESCUELA DE INGENIERIA

# **ENTRY-TIMING ADVANTAGES IN RENEWABLE NATURAL RESOURCES INDUSTRIES**

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Thesis submitted to the Office of Research and Graduate Studies in partial fulfillment of the requirements for the Degree of Master of Science in Engineering

Advisor:

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Santiago de Chile, October, 2017

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To my parents and my beloved  
Mater, for their unconditional love  
and support. Mphcev

## **ACKNOWLEDGMENTS**

In first place, I would like to thank my family, specially to my parents who have always supported me in every challenge and have encouraged me in pursuing my dreams, and the most important: they love me no matter what.

In second place, I would like to thank my supervisor Alejandro, for his immense support his disposition to help and to guide me in this process, without him I would not have get to this point. He has become in an example of how to be a good engineer and a good person.

At last I want to thank to God and my beloved Mater, for being with me the entire journey of my life, holding my hand in the toughest moments and being loyal to the covenant we have made. Also I would like to thank to Mario Hiriart for his intercession and example of life.

## GENERAL INDEX

DEDICATION .....	i
ACKNOWLEDGMENTS .....	ii
LIST OF FIGURES .....	iv
LIST OF TABLES .....	v
ABSTRACT .....	vi
RESUMEN.....	viii
1: INTRODUCTION .....	1
1.1: Background .....	1
1.2: Objectives.....	7
1.3: Hypotheses .....	7
1.4: Thesis Outline .....	8
2: ENTRY-TIMING ADVANTAGES IN RENEWABLE NATURAL RESOURCES INDUSTRIES .....	9
GENERAL CONCLUSIONS AND FURTHER RESEARCH .....	51
REFERENCES.....	54

## LIST OF FIGURES

Figure 2-1: Conceptual Model .....	19
Figure 2-2: Model Decision Tree Red and White Grape Producers Minority Game .....	30
Figure 2-3: Price and Production Dynamics .....	31
Figure 2-4: Cumulative Profit Comparison Crowd vs Anti-Crowd Groups .....	34
Figure 2-5: Cumulative Anti-crowd- Crowd Profit Difference in the Presence of Learning Economies .....	36
Figure 2-6: Firm Performance in the Presence of Technology Innovation .....	38
Figure 2-7: The Crossed Impact of Price Sensitivity, Setup Time and Total Number of Competitors on Anti-crowd Performance .....	41

## **LIST OF TABLES**

Table 2-1: Model Initialization Parameters.....	28
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## **ABSTRACT**

Order of entry advantage has been a popular topic of study in the managerial area of research. Since the seminal paper of Lieberman and Montgomery (1988) the researchers have focused on understanding how the firms can gain a competitive advantage by entering early or late. The literature has explained these through isolating mechanisms which work as entry barriers for new entrants. Also, there has been an intense empirical work to prove that order of entry constitutes a competitive advantage and specially pioneers acquire these. However, results have been contradictory and that is why lately has been included contingencies to understand how and in which conditions this order of entry advantage occurs. In the present work, we focus on an under-studied industry in the strategy management field: renewable natural resource industry whose nature is more similar to commodities than differentiated product.

We construct a simulation model to study the existence of order of entry advantage in this industry. We consider two markets that competitors can serve and change from one to another after a set up time. Due to its commodity nature, we do not talk about early movers or late entrants but of anticrowd (the minority) and crowd competitors. These competitors differ in their heuristic to make market changing decisions making anticrowd behave in an anticyclical fashion and crowd behave in a procyclical fashion in relation to current product prices. We consider different scenarios: without isolating mechanisms and then considering learning effects and technological breakthrough.

We conclude that an order of entry advantage can be acquired in the context of natural resources industry by following an anticrowd strategy. However, the existence of this advantage depends on some contingencies as: environmental dynamism, competitive conditions and production restrictions. When increasing environmental dynamism and competitive conditions the anticrowd advantage increases and when increasing production restriction, it decreases. Also, when considering some supply side isolating

mechanisms as learning effects and technological breakthrough the advantage decreases but still exists. In particular, the first mechanism favors stronger to crowd competitors than anticrowd, and the latter mechanism has a neutral effect. This work, opens a wide field of research in strategy management: order of entry in natural resources industry.

Keywords: Entry Timing, Decision-Making, Mathematical Simulation, Natural Resources Industries.

## **RESUMEN**

Dentro de la literatura de estrategia, el estudio de ventajas competitivas de orden de entrada se ha vuelto muy popular. Con el artículo seminal de Lieberman y Montgomery (1988) los investigadores se han enfocado en cómo las firmas generan ventajas competitivas por entrar primero o después a una industria. La literatura ha explicado estas ventajas a través de mecanismos de aislamiento competitivo que funcionan como barreras de entrada para los nuevos competidores. Ha habido un fuerte estudio empírico, que ha hecho énfasis en las ventajas que obtienen los pioneros de la industria. Sin embargo, otros estudios han obtenido resultados contradictorios. En este contexto se incluye el concepto de contingencias, que se refiera a las condiciones que afectan la existencia o efectividad de la ventaja de orden de entrada, más allá del orden de entrada en si mismo. En este trabajo nos enfocamos en una industria poco abordada en el área de estrategia: industrias de recursos naturales renovables, la cual es más similar a los commodities que a los productos diferenciados.

Construimos un modelo de simulación para estudiar la existencia de ventajas competitivas de orden de entrada en esta industria. Consideramos dos mercados en que los competidores pueden actuar y cambiarse entre ellos después de pasar un período de cambio. Debido a la naturaleza “commodity” de la industria, no se habla de pioneros o entrantes tardíos sino de los competidores anticrowd (que son la minoría) y crowd. Estos agentes difieren en la heurística con la que toman sus decisiones de cambio entre mercados, estas hacen que los anticrowd se comporten de manera anticíclica y los crowd cíclicamente en relación a los actuales precios de los productos. Se consideran diferentes escenarios de simulación: sin mecanismos de aislamiento competitivo, con curvas de aprendizaje, con innovaciones tecnológicos de proceso.

Concluimos que pueden conseguirse ventajas competitivas de orden de entrada al seguir una estrategia anticíclica en el contexto de industrias de recursos naturales renovables. Sin embargo, la existencia está sujeta a ciertas condiciones: dinamismo del entorno, condiciones competitivas y restricciones de producción. Al incrementar el dinamismo del entorno y las condiciones competitivas, la ventaja competitiva para los anticíclicos aumenta. Mientras que al incrementar las restricciones de producción la ventaja para los anticíclicos disminuye. Por otro lado, al incluir mecanismos de aislamiento competitivo de productor como: curvas de aprendizaje e innovaciones tecnológicas de proceso, la ventaja de ser anticíclico disminuye pero sigue existiendo, en particular la curva de aprendizaje favorece más a los cíclicos y las innovaciones tecnológicas favorecen a ambos por igual. Este trabajo abre un amplio campo de investigación dentro de la estrategia: orden de entrada en industrias de recursos naturales.

Palabras clave: Momento de entrada, Toma de Decisiones, Simulación Matemática, Industrias de Recursos Naturales

## 1. INTRODUCTION

### 1.1. Background

Strategy is an area of study transversal to all industries. Order of entry is a strategy topic that focuses on studying the impact that this order has on the firm's performance: profitability, market share, etc. It has been highly studied in the last three decades. It all started with the seminal paper of Lieberman and Montgomery (1988) where they propose a list of advantages and disadvantages of being the first mover in an industry, whose definition is not clear but it is mainly the first firm or group of firms that enter an industry.

They propose that those advantages rely on isolating mechanisms (Rumelt, 1987; Suárez and Lanzolla, 2007). These mechanisms can be listed in three groups: Technological leadership: mainly learning curve, R&D and patents. Preemption of assets: refers to input factors, locations and plant and equipment. Buyer switching costs refers to the buyer choice under uncertainty. Also, they mention some disadvantages of being first-mover: free-rider effect, market uncertainty, shifts in technology or consumer needs. They propose that order of entry advantage can be measured by considering the profit of the firm, the market share or the probability of survival. The latter are proxies of economic profit but with some problems.

As mentioned above, order of entry has been a popular topic of study (Suarez & Lanzolla, 2007), there are two approaches to study it: theoretical and empirical. The empirical has been much more used (Zachary, Gianiodis, Payne, & Markman, 2015), this may occur because there are some databases with industry information and the only difficulty is to create a good enough econometric model to test and prove certain hypothesis and to theorize with their findings.

On the other hand, the theoretical approach has been less used, they try to discover logical reasons to argue the order of entry advantages and often cite empirical studies to reinforce them.

Suárez and Lanzolla (2007) make a literature review and note that the theory has focused more in micro aspects: firm capabilities than in macro aspects. In their attempt to contribute in this aspect, by doing some research they propose that the pace of market evolution and the pace of technology evolution affect the effectiveness of isolating mechanisms leading to first mover advantages. These isolating mechanisms strengthen when pace of market evolution and pace of technology evolution are both smooth. The isolating mechanisms get weak when both pace of market evolution and technology evolution are abrupt. When both paces are different in intensity the effect on isolating mechanism is not clear.

As mentioned above this approach has been strongly used by researchers. They work mainly with longitudinal data, and the most used techniques are: regression models and survival/event study (Zachary et al., 2015) . With the findings of their models they strengthen some theories or try to build them from their work.

On one hand, there was enough empirical evidence to believe that to entry first was a key of success, in fact Lieberman and Montgomery (1988) strengthen their theory with the following findings: Robinson and Fornell (1985) suggest that entry timing is a major determinant of market share- a measure of the advantage, proxy of profit- in a cross-section study of consumer goods, then Robinson (1988) in a cross-section study of industrial goods indicates that first-movers tend to have larger market share, even Urban et al (1986) propose an inverse relation between order of entry and market share.

On the other hand, Suárez and Lanzolla (2007) say that there are some empirical studies that “show little or no evidence of a relationship between order of entry and a firm’s market share, higher return on investment or failure risk”.

The reason of these contradictory findings is that there are some mistakes in most of the studies that support first-mover advantage (Golder & Tellis, 1993; Lieberman & Montgomery, 1988; Suarez & Lanzolla, 2007). The problems about most of the studies claiming a first-mover advantage come from three sources. First that they mainly use PIMS and ASSESSOR data, these databases do not consider the firms that did not survive, therefore there is a sampling bias, so the advantages of first-movers would be

overrated (Golder & Tellis, 1993; Lieberman & Montgomery, 1988; Suarez & Lanzolla, 2007). Second, the way that they classified firms as first-movers, early or late entrant lacks validity and reliability, their information came from informants who may not know well the firm and their responses were not corroborated.(Golder & Tellis, 1993). Third, the concept of first-mover is different in the database that the one used by the researchers, so the conclusion they get are weak (Golder and Tellis, 1993).

Golder and Tellis (1993) realize the limitations of the existent data and make a historical analysis, by getting information from a large number of periodicals and books. In addition, it comes from the time that the industry emerged, so information is more trustable. The information gathered was corroborated by a strict procedure. They also included in their analysis the firms that did not survive. By taking these precautions, they eliminated the early mentioned issues. Their study considered 50 product categories, they collected 17 key features from every category. They create three samples, two of them in which was more favorable to find Anti-crowd advantages, because they contained well known first-movers: Xerox, Polaroid, etc.

They found surprising results, opposing to previous studies: the failure rate of first-movers was 47%, very high so the survival bias would be huge. In terms of average market share, the first-movers got 10% very low in comparison to the results of other studies using PIMS and ASSESOR data that indicated 30%. About average market leadership, the results are that in 11% of the categories while in other studies it was 50%.

With these findings, the existence of first-mover advantages was not clear. Zachary et al (2015) develop a very complete literature review, by selecting the more relevant articles about order of entry of the best journals of management and marketing. They realize that the research has focused mainly in empirical studies, and analyze the articles about order of entry antecedents, order of entry consequences. They notice that there are contradictory findings and they propose the reason are contingencies, these contingencies affect entry antecedents, entry consequences. They propose that entry

timing is one of various contingencies that affect entry decisions, not the most important. Their conceptual model proposes that entry choices depend on five contingencies: When to enter, how to enter, what type of entry, where to enter and who are the players. This way, they broaden the concept passing from entry timing to entry choices.

As mentioned at the beginning, strategy is transversal to all industries, there has been much theoretical development specially in differentiated product. However, certain industries like natural resources one, remains underexplored in spite on their economic relevance (George, Schillebeeckx, & Liak, 2015) . In fact, these industries represent “around one third of global exports (World Trade Organization, UNCTAD, 2013) and national economic activity in most emerging economies.

In the context of renewable natural resources, the products behave as commodities, as the industry exists for a long time ago (thousands of years in the case of agriculture) there are not new industries, this way entry timing is related to the decision of producing one product another. For example, when a fruit farmer has to decide whether he plants apple trees or pear trees. In this context, the idea of first-movers does not make sense. Therefore, in this research the approach to study order of entry advantages is different and one key tool is simulation.

Simulation methodology is getting more significant in the last years in developing theory on strategy (Davis, Eisenhardt, & Bingham, 2007). This methodology allows to develop simple theory which is incomplete (Davis et al., 2007; Harrison et al., 2007),- which suggests to use it in the order of entry topic where the theory to develop- so it can be very useful in management and strategy fields, in addition it helps “especially in contexts where systems typically involve interactions with nonlinear feedback or when linear models have limited value” (García-Sánchez et al 2014). It has many purposes: “It

can be useful in developing theory and in guiding empirical work. It can provide insight into the operation of complex systems and can explore their behaviors. It also can examine the consequences of theoretical arguments and assumptions, generate alternative explanations and hypotheses, and test the validity of explanations” (Harrison et al., 2007).

However, management academics have not taken advantage of this methodology, as an example between 1994 and 2003, the rate of papers using simulation methodology in the main management journals varied from 0.3% to 3.7% (Harrison et al., 2007). The main advantages of this methodology are that it requires a precise definition of the theoretical logic of the phenomenon (Davis et al., 2007) which establishes a solid ground to develop theory and it offers a laboratory to carry out any possible experiment, so it provides the researchers possibilities they cannot get in real life.

On the other hand, there are concerns that have led to the misuse of this methodology, they are: the validity of the model, it is possible that the model is not a good representation of reality so the conclusions obtained are meaningless, it is limited to the parameter-space defined, this means that the conclusions obtained are valid only with the parameters considered, not in every situation so it is risky to generalize from the simulation results (Davis et al., 2007).

In this context, considering the previous literature about order of entry and simulation methodology, a mathematical simulation model is developed in order to analyze the existence of order of entry advantage in renewable natural resources industries where there almost do not exist isolating mechanisms. This industry is different from differentiated product, these exist from centuries ago and they do not follow the business cycle but follow the commodity price cycle and super cycles. The model considers two different markets A and B that the competitors can choose to serve and change from one to another after a set up time characteristic of the industry which is a technological or biological constraint, for example: the time that a tree needs to grow. These markets

follow the same linear demand with the same negative slope. The competitors are classified in two groups:” anticrowd” which are a minority and “crowd” whose only difference is the heuristic they follow in their changing decision. Meanwhile crowd producers take into account current prices for changing from market, anticrowd take into account current prices but also the competitors which are changing from market and therefore they anticipate future prices and with that set of information they decide whether to change or not. By following these heuristics, anticrowd producers behave countercyclically and crowd behave procyclical in relation to the current product prices. These heuristics remain constant during the simulation span which means that competitors do not change from group, this is based on repetitive strategic momentum.

In order to include a more realistic model, other features are included, these are: learning effects and technological breakthroughs. These mechanisms affect the supply by reducing cost while staying in a market and not changing and dropping the cost when adopting new technology respectively.

### **1.1. Objectives**

The main objective of this work is to study the existence of order of entry advantages in the natural resource industry. To do that the specific objectives are the following:

- i. To study the existence of order of entry advantages by following an anticyclical strategy in natural resource industry
- ii. To study how certain contingencies affect the advantage obtained by following an anticyclical strategy
- iii. To build a simulation model that allows to infer theory and to address the first two objectives

### **1.2. Hypotheses**

The main hypotheses of the research are:

- i. Following an anticyclical strategy gains a competitive advantage in commodities industries with no isolating mechanisms
- ii. The order of entry advantage obtained by following an anticyclical strategy depends on contingencies: setup time, total number of competitors and sensitivity to change.
- iii. Anticyclical strategy gains an advantage even in the presence of learning effect and technological breakthroughs.

### **1.3. Thesis Outline**

This document is organized as follows: the Abstract, then the Resumen, then chapter 1 is the introduction where the context is given for a proper understanding of the research, its objectives and the hypotheses. Chapter 2 corresponds to the article sent to the journal. Finally are presented the main conclusions, limitations and future development of the research, to end with the references.

## **2. ENTRY-TIMING ADVANTAGES IN RENEWABLE NATURAL RESOURCES INDUSTRIES**

### **ABSTRACT**

This paper expands the entry-timing literature to natural resources industries. The endogenous cyclical nature of these industries allows firms to strategically switch between serving different markets, obtaining entry-timing advantages beyond those provided by traditional competitive isolating mechanisms. In the specific context of an atomized renewable natural resources industry, we model the entry timing of two cohorts of competitors using two different decision-making heuristics: a crowd and an anti-crowd group. The crowd group determines entry timing based on current market prices. The anti-crowd group uses both current prices and information related to competitors' investment decisions to make a decision. Through a mathematical simulation, we determine the conditions under which following the anti-crowd heuristic leads to entry-timing competitive advantages.

Keywords: Entry Timing, Decision-Making, Mathematical Simulation, Natural Resources Industries.

Scholars in the strategic management field have long been concerned with the question of whether firms can create competitive advantages by strategically timing their entry into new markets (Lieberman and Montgomery 2013; Makadok 1998; Zachary et al. 2014). A significant body of research argues that order of entry competitive advantage emerges from competitive isolating mechanisms, which are contingent on contextual conditions (Lieberman and Montgomery 1988; Mueller 1997; Suárez and Lanzolla 2007; Zachary et al. 2014). Recent studies in the field have attempted to build an integrative view of entry-timing advantages (Fosfuri, Lanzolla, and Suárez 2013; Zachary et al. 2014) or considered new contingent factors (Markides and Sosa 2013; Markman and Waldron 2014).

We take a contingency view and examine the conditions under which timing of entry matters in renewable natural resources industries (hereafter referred to as natural resources for ease of exposition). Natural resources represent 25% of global exports (World Trade Organization 2015), and national economic activity in most emerging economies and several developed countries depends heavily on natural resources industries. In spite of this, these industries have received limited attention to date and consequently represent a rich area for enquiry (George, Schillebeeckx, and Liak 2015).

The theoretical need for a conceptual approach to studying entry timing in natural resources is justified by a number of factors that limit the applicability of traditional mechanisms. First, natural resources industries do not emerge from a radical product innovation; therefore, establishing an isolating mechanism based on this type of

technological leadership is not a viable strategy. Second, these industries face a highly competitive commodity market in which the product is decoupled from the producer when consumers purchase it. Commodities like grapes, cattle or soybeans are totally or partially fungible, meaning that the market will trade them and will be priced the same, regardless of the producer, as long as they meet a specified minimum standard known as basis grade. Thus, the possibility of establishing demand-side isolating mechanisms is minimal.

In natural resources industries, firms usually own a primary asset (i.e. land) that can be deployed to produce different commodity products. In this context, entry timing takes the form of a decision about when to invest in a certain market and divest from another. The prices of these alternative commodities are negatively correlated, since the decision to produce one implies a reduction in the supply of the other. The decision to switch products has a significant lag time, resulting in zero revenue until full production is reached. A producer of red wine grapes, for example, has to decide whether to continue producing this type of grape or switch to white wine grapes. By managing the oscillation of relative prices, firms can reap benefits from strategic entry-timing, extending their competitive advantage beyond that provided by traditional supply-side isolating mechanisms.

To explore these potential entry-timing advantages, we develop a mathematical simulation model that mimics the behavior of natural resources industries, in which firms' decision-making based on different heuristics is the main mechanism affecting the evolution of the industry. We identify two groups of competitors that use contrasting

strategies: crowd and anti-crowd (Cavagna 1998; Challet and Zhang 1998; Lo, Hui, and Johnson 2000). The majority group (“the crowd”) makes market entry decisions by analyzing current average prices, while the minority group (“the anti-crowd”) analyzes current prices but also forecasts future price levels by taking into account the number of competitors that are currently moving from one market to the other. We sustain the existence of repetitive strategic momentum so decision-making remains stable in the same heuristic pattern (Amburgey and Miner 1992). Over the simulation, non-trivial endogenous cyclical fluctuations arise from competitors’ collective decisions. Our work reveals the conditions under which anti-crowd competitors can capture sustainable abnormal returns through entry-timing decisions.

Our research provides several contributions. First, we contribute to recent advancement on entry timing (Klingebiel and Joseph 2016) by analyzing a situation with multiple “time windows” to enter and exit the same markets. Thus, we provide a simulated empirical setting that allows us to examine the relationship among successive market entry, entry-timing strategies and firm performance. Second, we identify a mechanism for explaining systematic strategic differences among firms entering markets at different times that does not depend on competitive isolating mechanisms but rather on heuristic-based decision-making. In addition, we examine how this mechanism interacts with traditional isolating mechanisms. Finally, we fill a theoretical and managerial need for understanding the sources of competitive advantages in natural resources industries.

## ANTECEDENTS

Entry timing literature explores the potential competitive advantages enjoyed by firms entering a new industry or a new market early or late relative to their competitors (Echambadi, Bayus, and Agarwal 2008; Zachary et al. 2014). In manufacturing, consumer products or technological industries, the main risk for pioneers is entering too early due to product underdevelopment or a lack of consumer demand for the new product or service (Min, Kalwani, and Robinson 2006). Moreover, while industry standards are still in flux, pioneers might become trapped in a product design that customers do not want (Min et al. 2006). On the other hand, the risk for late entrants is the difficulty of catching up with pioneers if the initial product design is successful. These two alternative approaches result in different levels of uncertainty and multiple interdependent decision options among competitors, leading to different strategic recommendations.

Besides the interdependence of firms' decisions, which generates an opportunity window, another fundamental aspect of the concept of entry timing is the path-dependent nature of isolating mechanisms, the basic mechanism that allows early movers to build entry-timing advantages. For example, if agents can benefit from learning economies in an industry, early movers can decrease unit costs in a cumulative fashion, giving late entrants a strong competitive disadvantage. The same rationale can be extended to network externalities. Firms that build a community of users (e.g., in the operating systems or e-commerce industries) achieve a cumulative advantage that is very difficult for late movers to reverse. The typical competitive dynamics in an industry

generate a long-term decline in real prices due to increasing rivalry, which raises pressures on unit margins (Klepper 1996, 1997). As real prices fall, the strength of the isolating mechanism increases, eventually forcing late entrants either to exit the industry or to occupy a niche position (Agarwal, Sarkar, and Echambadi 2002; Suárez and Lanzolla 2007).

For multiple industries, this type of opportunity window opens just once over the entire industry life cycle (Suárez, Grodal, and Gotsopoulos 2015), and those companies that miss it face severe competitive disadvantages. Environmental conditions might lengthen or shorten this opportunity window and the difficulty of entering the industry during this period (Suárez and Lanzolla 2007). The pace of market evolution and technology evolution can also affect the sustainability of isolating mechanisms. When they evolve gradually, the effect of isolating mechanisms will be the strongest; when environmental variables are volatile (i.e., high-velocity environments), the effect of the isolating mechanism decreases substantially (Suárez and Lanzolla 2007).

However, not every industry follows the patterns described above. In natural resources industries, the product is usually a commodity that barely evolves over time, markets generally move at a slow pace, and technology disruptions are scarce and, when they occur, mainly related to production. This market dynamic manifests in alternating periods of high and low unit margins, which move in cycles rather than following a clear long-term trend (Erten and Ocampo 2013; Jacks 2013). Moreover, while supply-side isolating mechanisms exist in several natural resources industries in the form of scale

economies, demand-side isolating mechanisms are nearly absent, as is technological leadership.

Despite these characteristics, which would seem to diminish entry-timing advantages, the entry- and exit-timing decisions are fundamental for differential performance in renewable natural resources industries. This differential performance occurs due to the negative correlation between the prices for alternative products that could be produced from using a scarce renewable resource. For example, in the case of the owner of a vineyard he/she must decide whether to produce grapes for red or white wine. He/she has access to present prices but cannot anticipate future prices, since they depend on the entry decisions of other competitors. Also, the decision to switch markets has an implicit time lag – and therefore an opportunity cost – until the new product reaches full production (e.g., fruit and grapevines must grow for several years from before grapes can be harvested). If only a minority of firms enter one market, while most competitors remain in the other market, the minority group may have the opportunity to earn higher revenues as prices rise in the former, non-crowded market.

## **ENTRY-TIMING DECISION-MAKING THEORY**

Game theory (Camerer 1991) was among the first theories to address the decision to join one of two groups of competitors in an industry: the crowd group or the anti-crowd group (Cavagna 1998; Challet and Zhang 1998; Lo et al. 2000). An odd number  $N$  of competitors successively compete to join the anti-crowd group. As the game progresses, non-trivial fluctuations arise in competitors' collective decisions.

These can be understood in terms of the dynamic formation of a crowd group, consisting of competitors using procyclical strategies, and an anti-crowd group, consisting of competitors using anticyclical strategies.

We build on the concepts developed in the minority game by examining what happens after the crowd and anti-crowd groups are formed. Specifically, we explore the conditions that make minority players' decision-making mechanism a source of competitive advantage. Thus, we move from a rational approximation that aims to determine equilibrium conditions to a theory of behavioral decision-making. We describe a competitive setting where competitors have limited information-processing capacity and adopt simplified mental strategies, or heuristics, to cope with complex, uncertain environments (Barberis, Mukherjee, and Wang 2016; Porac, Thomas, and Baden-Fuller 1989; Powell, Lovallo, and Fox 2011). In this context, decision-making is not strictly rational; rather than collecting and objectively evaluating all relevant information, the decision-maker focuses on certain aspects of the complex reality and necessarily ignores some others (Tversky and Kahneman 1974). These heuristics offer efficient ways of solving problems even if they are associated with systematic cognitive biases (Barnes 1984; Bateman and Zeithaml 1989; Schwenk 1984), breeding an internal repetitive strategic inertia that persists in the long term (Amburgey and Miner 1992; Cyert and March 1963).

We frame our analysis around two groups of competitors with two different heuristics: the crowd group and the anti-crowd group. Subjective perceptions and interpretations in weighing the relative costs and benefits of strategic alternatives lead

the crowd group and the anti-crowd group to respond differently to the same objective stimuli (Daft and Weick 1984; Powell et al. 2011). The crowd group – the majority – consists of competitors using cyclical strategies. These competitors may be following the natural learning tendency to avoid risky decisions that have a high likelihood of producing poor outcomes; alternatively, they may be staying in a stable suboptimum due to environmental adaptation, consequently reducing their propensity to engage in new and risky activities (Denrell and March 2001). Loss aversion may also be at play – it has been shown that the mental penalty associated with a loss is greater than the mental reward from a similar-size gain (Kahneman and Tversky 1979). The anti-crowd group consists of competitors using anticyclical strategies, eager to take the risk of switching markets in their quest for potential future gains.

These two distinct decision-making strategies affect the timing of market entry, which in turn determines firms' performance. Anti-crowd competitors will seek to achieve entry-timing advantages, entering a market when demand and prices are low. Firms in this group face a fundamental trade-off, sacrificing immediate revenue for possible higher revenue in the future. However, the potential for higher future revenue depends on the number of competitors that follow a cyclical strategy; that is, future revenue is contingent on other competitors' decisions and, consequently, always uncertain. Given this uncertainty, the majority of competitors – the crowd group – place a higher value on guaranteed immediate revenue and choose to follow cyclical strategies, waiting until demand and prices rise before entering a new market.

In establishing these two groups, we sustain the existence of repetitive strategic momentum. Regardless of performance outcomes, decision-making remains stable in the same heuristic pattern (Amburgey and Miner 1992). Mindsets or ideologies affect perceptions of the environment and constrain the conceivable strategic actions, eventually reinforced by the common strategic maps of the dominant coalition (Amburgey and Miner 1992; Daft and Weick 1984). Additionally, in the specific context of entry-timing patterns, it has been shown that organizational timing preferences across multiple entry decisions remain stable (Klingebiel and Joseph 2016).

Entry-timing advantage is subject to various contingencies (Suárez and Lanzolla 2007; Zachary et al. 2014). Defining these contingencies might be an even more fruitful avenue of inquiry than simply elucidating the timing-performance relationship (Klingebiel and Joseph 2016). Given that entry-timing advantage is a dynamic concept, it is best specified through interactions rather than direct effects (Lieberman and Montgomery 2013). We focus on three important environmental enablers: environmental dynamism, production restrictions, and rivalry level, which are represented in our model by the following measurable variables: competitors' price sensitivity, the time required to switch between markets (setup time), and the number of competitors in the industry, respectively.

Environmental dynamism is a fundamental factor in entry timing competition (Suárez and Lanzolla 2007). In our setting, this dynamism depends on crowd and anti-crowd competitors' sensitivity to shifting between markets, since their aggregate market shifts will eventually alter supply and prices (Erten and Ocampo 2013; Jacks 2013),

endogenously influencing the commodity cycle. We expect that the commodity cycle will impact the outcomes of both the crowd and anti-crowd strategies.

Production restrictions can also affect the relative success of crowd and anti-crowd competitors, since firms' market entry decisions are affected by the setup time required to start selling in the new market. Depending on the commodity, this setup time might be shorter or longer, decreasing or increasing the duration of non-revenue periods.

Finally, competitive conditions – the rivalry level – influence the level of market munificence, which in turn affects the value of entry-timing strategies. In particular, when the value of being first stems from the opportunity to achieve higher margins in a crowded market, the number of competitors in the industry catalyzes potential gains.

Figure 1 describes this conceptual framework.

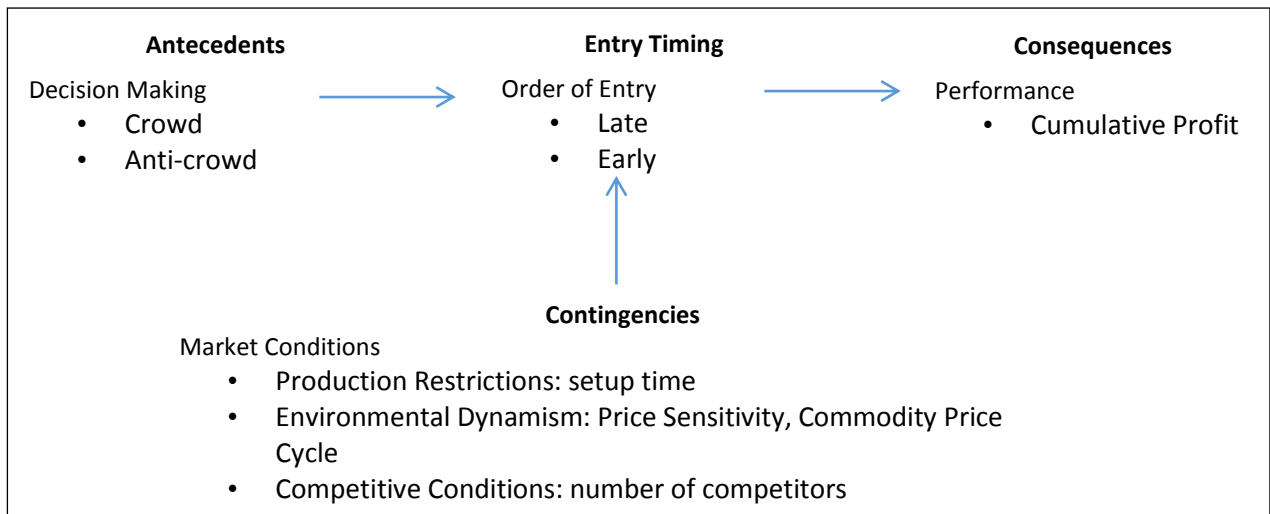


Figure 1: Conceptual Model

Based on this framework, we specify variables and relationships to gain insight into competitive dynamics. The expected relationships are non-trivial given the stochastic character of the decision-making mechanism and the endogenous nature of the price-quantity cycle. For that reason, we develop a mathematical simulation model and, subsequently, build a theory offering several propositions.

### **MATHEMATICAL SIMULATION**

Mathematical simulation is a useful methodological approach that helps in developing theory and bridging the gap between the main constructs and relationships and the empirical grounding of an analysis (Davis, Eisenhardt, and Bingham 2007; Harrison et al. 2007; Simon 1990). We are interested in how entry timing affects competitive advantage in a cyclical industry with no product differentiation and where prices are endogenous to competitors' investment decisions. Accordingly, we define a model that describes a system of multiple, interrelated agents in a path-dependent context under a cobweb process. The stochastic nature of these processes and interrelationships generates an intricate conundrum that inhibits the possibility of finding an analytical solution. Therefore, we opt for a mathematical simulation – a powerful tool for advancing theory on complex behaviors and systems when derivations cannot be carried out due to mathematical intractability (Davis et al. 2007; Harrison et al. 2007). In addition, a mathematical simulation is appropriate for analyzing competitive dynamics when the market is conceived as an open complex system and the economic agents—i.e., individual firms—are interrelated with each other in that system (Dopfer, 2004).

Computer simulations permit us a realistic representation of dynamic processes in an industry's history, including multilevel feedback effects or interactions and the heterogeneous composition of strategic decisions. Simulations also capture greater variance as they account for longer periods of the commodity cycle, and they allow for the formulation of powerful predictions for further empirical testing and tests of boundary conditions for prior theorizing (Pyka & Fagiolo, 2007).

We generate an agent-based stochastic model with a discrete time design. We keep the model design straightforward, following the guideline that the simpler the model, the easier it is to gain insight into the causal processes at work (Harrison et al. 2007; Raghu, Sen, and Rao 2003; Simon 1990). We describe the mathematical structure of the model below.

**Market.** The model simulates a standard cobweb situation with  $N$  competitors that are price takers in two markets ( $j$ ) for two undifferentiated products A and B. Each market faces a linear downward stochastic demand function:

$$P_{jt} = D(Q_{jt}) = (1 + \varphi)^t (Q_{jt})^{-1} \quad (1)$$

where  $t$  is the current time period,  $Q_{jt}$  is the aggregate production in market  $j$ , and  $\varphi$  is the demand shift, which varies every time period and follows a uniform distribution  $\varphi \sim U(0.95, 1.05)$ . For simplicity's sake, both demand functions have the same shape parameters.

The base model starts with the  $N$  competitors equally distributed between both markets. Some of them are already in the process of switching from A to B ( $S_{AB}$ ) and others are switching from B to A ( $S_{BA}$ ). The market and the firms have no storage

capability, and production level is zero when a competitor is in the process of switching from one market to the other. Therefore, the prices for both products A and B depend only on the quantity supplied.

**Production Process.** Firms own an asset capable of generating two different products, A and B. However, the asset cannot produce both products simultaneously, forcing decision-makers to choose one of the two. This situation is typical of renewable commodity industries where land is the primary asset, such as agricultural products, wine, fruits, pulp and paper, forestry, cattle and milk production. All of the producers have the same size and mean production  $\bar{Q}_{it}$ , variables that remain unchanged during the simulation period. The value of  $\bar{Q}_{it}$  is 1 when competitor  $i$  is in production, and 0 otherwise. However, firms' production  $Q_{it}$  varies from one time period to the next, following a uniform distribution  $Q_{it} \sim U(0.95, 1.05)$ , reflecting the natural changes that happens from working with renewable natural resources. These variations in firms' productivity are due to differences in the quality of the assets they own and to dissimilar capabilities and resources inside the firms. Technology adoption and learning economies are also sources of variance in productivity, and they are considered in the next sections.

When firms decide to switch from one product to another, a setup process of the system is required to initiate the production of the new product. During this period there will be no production output. In every period, all products are sold at market prices; none are carried over to the next period.

**Profits and Cumulative Performance.** Agents can choose to produce and sell the current product or invest in a new product given price and production expectations.

Producing and selling the current product – following the crowd strategy – will usually yield positive profit, whereas switching markets – following the anti-crowd strategy – will certainly yield zero revenue initially and carries an important opportunity cost in the setup time phase.

The model has a standard variable cost function. The variable costs are yearly production costs and, for simplicity, are initially set to be the same for both products. While a producer is in the process of switching production from one product to the other, no revenue is generated and no production costs are paid. The standard profit function for a firm  $i$  in time  $t$  is:

$$\pi_{it} = (P_{jt} - c_{ijt})Q_{it} \quad (2)$$

where  $c_{ijt}$  represents the variable cost of firm  $i$  at time  $t$  producing the product  $j$ . We will relax this assumption when we introduce learning economies as an isolating mechanism (see below).

The existence of an entry-timing advantage should result in superior cumulative performance. We compute the cumulative performance for each producer in the straightforward form of cumulative profit:

$$CP_i = \sum_{t=1}^T \pi_{it}. \quad (3)$$

**Decision Rule for Crowd and Anti-Crowd Competitors.** Decision-making is a fundamental antecedent in explaining entry timing advantages (Zachary et al. 2014). The model defines two groups of competitors based on their decision-making heuristics: crowd ( $CR$ ) and anti-crowd ( $AC$ ). We randomly assign a heuristic to each competitor at the beginning of the simulation, introducing some quenched disorder. Since several

experiments demonstrate that fixed heuristics persist even in market settings with opportunities to learn (Kahneman, Knetsch, and Thaler 1990), competitors stay in the same group throughout the simulation. Moreover, Klingebiel and Joseph (2016) show that organizational timing preferences across multiple entry decisions remain stable, with some groups preferring to enter earlier and others later. Moreover, these experiments indicates that firms self-select into a timing position. In our case, all competitors maintain repetitive momentum, irrespective of performance (Amburgey and Miner 1992).

In our model, both groups have bounded rationality regarding the future but use different heuristics and rely on different sets of information. *CR* competitors time market entry by looking at current prices, while *AC* competitors look at current prices and at the current switch rate of competitors from one product to the other. Therefore, for *CR* competitors,  $Q_{CRt} = f(P_{At}, P_{Bt})$  and for *AC* competitors,  $Q_{ACt} = f(P_{At}, P_{Bt}, S_{AB}, S_{BA})$ .

The decision to switch depends on the relative prices and the producers' sensitivity to change. A *CR* competitor that is producing A will remain in the same product if

$$\lambda^{\left(\frac{P_{At}(Q_{At}) - P_{Bt}(Q_{Bt})}{P_{Bt}(Q_{Bt})}\right)} > RND \quad (4)$$

where  $\lambda \in (1, \infty)$  is the change factor (the propensity to change products), and  $RND$  is a random number that follows a uniform distribution  $RND \sim U(0,1)$ . If the condition defined in (4) is not achieved, the *CR* competitor will begin switching production from A to B. An *AC* competitor producing A will continue doing so if

$$\lambda \left( \frac{P_{At}(Q_{At} + \Delta_{BA}) - P_{Bt}(Q_{Bt} + \Delta_{AB})}{P_{Bt}(Q_{Bt} + \Delta_{AB})} \right) > RND \quad (5)$$

Where  $\Delta_{BA} = \sum_{i=1}^N k_i Q_i$  indicates the number of producers that have already switched from B to A and will be entering into production after the setup time period, and  $k_i = 1$  if the firm  $i$  is currently switching from B to A (and  $k_i = 0$  otherwise). If the condition defined in (5) is not achieved, the AC competitor will begin switching from A to B. The CR and AC competitors that switch production from product B to product A are parametrized in analogous ways, although the equations are not listed here. Once a competitor has decided to switch markets, it cannot switch again until completion of the setup period.

The objective of anti-crowd competitors is to follow an anticyclical strategy, entering markets when the price cycle is at its peak, thus maximizing long-term revenues. Both types of competitors have the same level  $\lambda$  of sensitivity to change. Higher values of  $\lambda$  are indicative of higher sensitivity to change, i.e. competitors are more prone to change markets.

**Learning Curve.** To allow for the existence of supply-side isolating mechanisms, we introduce a learning curve in the base model. As specified earlier, our profit function requires the definition of a cost function  $c_{it}(Q_{it})$ . We determine that our cost function follows the standard learning curve (Argote and Epple 1990) as follows:

$$c_{ijt}(Q_{ijt}) = \tau_{it} * (AQ_{ijt}^{-\beta_i}) + \delta Q_{ijt} \quad (6)$$

where  $\tau_{it}$  is the unit cost using the technology available at  $t$ ,  $AQ_{ijt} = \sum_{k=1}^t Q_{ijk}$  is the accumulated output of product  $j$  for firm  $i$  up to period  $t$ ,  $\beta_i$  is the parameter that

indicates the speed of learning, a constant characteristic of each firm determined randomly at the beginning of the simulation according to the distribution  $\beta_i \sim N(\bar{\beta}, \sigma_\beta)$ , and  $\delta$  the asymptotic limit of the learning curve, representing the maximum learning threshold.  $LR_{ij} = 1 - 2^{-\beta_i}$  is the learning rate of firm  $i$  in market  $j$  and is conceptualized as follows: when the cumulative output of product  $j$  doubles, unit costs decrease by a percentage  $LR_i$  of their former value. We additionally consider the existence of organizational forgetting (Argote and Epple 1990); when a competitor returns to a market in which it has competed previously, the accumulated learning cost advantage is cut to 70% of its prior value.

**Technological Innovation in Production Processes.** We also expand the model to account for the existence of technological innovation. In natural resources industries, this takes the form of innovation in production processes. In particular, we allow for a shift in the unit cost  $\tau_{it}$  based on the technology adopted by firm  $i$  at time  $t$ . To model this, we randomly split both groups (crowd and anti-crowd) into two halves, representing high- and low-tech competitors. Low-tech competitors, both crowd and anti-crowd, don't adopt any technological innovations, maintaining the same unit cost throughout the simulation. High-tech competitors, in contrast, adopt a new technology once every 20 years. Each such process innovation decreases their unit cost according to the uniform distribution  $\tau_{it} \sim U(0.9, 1)$ ; this lower unit cost is maintained for the remainder of the 20-year window. After 20 years elapse, another technology is adopted and unit costs decrease further; these reductions in unit costs continue in perpetuity, accumulating over time.

High-tech competitors must pay for new technologies; before they adopt any process innovation, the model verifies that they have enough cash to afford 5% of the total initial cost at  $t=0$ . If their financial reserves are insufficient, they must forgo the opportunity to adopt the new technology.

Because technological innovation in production processes is a source of structural changes, driving super-cycles in natural resources industries, our model will allow, indirectly, for the examination of the sustainability of anti-crowd strategies even in the case of such structural shifts.

**Entry and Exit.** Every year, competitors with negative performance exit the industry. They are eventually replaced by new entrants, which follow a normal distribution with a mean equal to the number of producers that exit the industry and a standard deviation of 10% of the mean. New firms entering the industry must wait the length of the setup time period before starting production and their entry unit cost  $\tau_{it}$  is stochastically defined as  $\tau_{it} \sim U(0.9, 1)$ , representing the level of their production technology.

**Scenarios.** We test our model in four different scenarios. All four contemplate the market entry of new competitors and the exit of firms that accumulate a certain amount of losses. All the scenarios have a stochastic aggregated demand and production, making it impossible to predict the future with certainty. In the first scenario (i.e. the base model), we examine competitive dynamics in the absence of traditional isolating mechanisms. In the second scenario, learning economies are introduced as a supply-side isolating mechanism. The third scenario also involves one isolating mechanism: process innovation technology. We divide both the crowd and the anti-crowd groups into two

cohorts, depending on their technological capabilities. The first cohort represents firms that are able to create or assimilate disruptive process innovations, reducing production costs. The second cohort comprises firms that are not skilled enough to take advantage of technology as an isolating mechanism. In the last scenario, firms are able to build isolating mechanisms via both learning economies and process innovation technologies.

**Parameters and Runs.** We program the model in Java and solve it with Monte Carlo simulation. A fundamental decision in mathematical simulation models is the selection of parameters that ensure a realistic grounding. Accordingly, we choose Australian grape farming as the reference model, focusing on red and white grape production. Table I reports the model parameters for the base case:

Table 1: Model Initialization Parameters

PARAMETER	INITIAL VALUES
Number of Crowd Competitors – $CR$	7700
Number of Anti-crowd competitors – $AC$	770
% of White Producers	57%
Unit Cost – $c_i$	5000
% of Crowd Competitor High Tech	50%
% of Anti-Crowd Competitors High Tech	50%
Learning Speed – $\beta_i$	0.044
Maximum Learning Threshold – $\delta$	85%
Learning Reduction upon Change	30%
Technology Adoption Interval (Years)	20

Cost of Technology Adoption (% of Initial Costs)	5%
Time Span of Technology Costs Amortization (Years)	7
Maintenance Cost (When Switching Production)	0
Demand Function Slope	-1
Competitors' Sensitivity to Change – $\lambda$ (Change Factor)	7.5
Simulation Span (Number of Years) – $T$	100
Warm-up Period (Number of Years) – $t$	10
Number of Producers Setting up during Warm-up Period	240
Setup Time – $s$	2
Number of Replications (Monte Carlo Runs)	70

The simulation runs for 100 periods with a warm up time of 10 periods, with 70 replications. Figure 2 outlines the model decision tree.

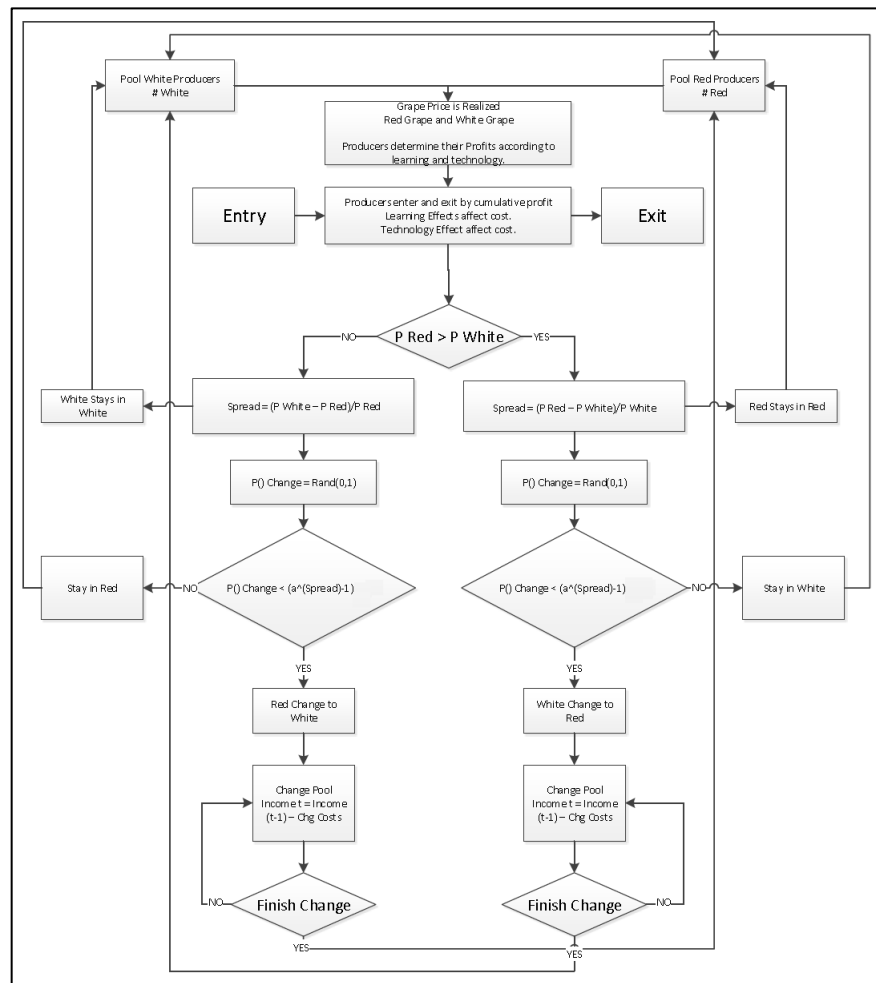


Figure 2: Model Decision Tree Red and White Grape Producers Minority Game

## SIMULATION RESULTS AND PROPOSITIONS

The model renders a cobweb process that generates a system of cyclical prices, resulting in a continuous movement of producers from one product to the other. Figure 3 presents the price and production dynamics in each market.

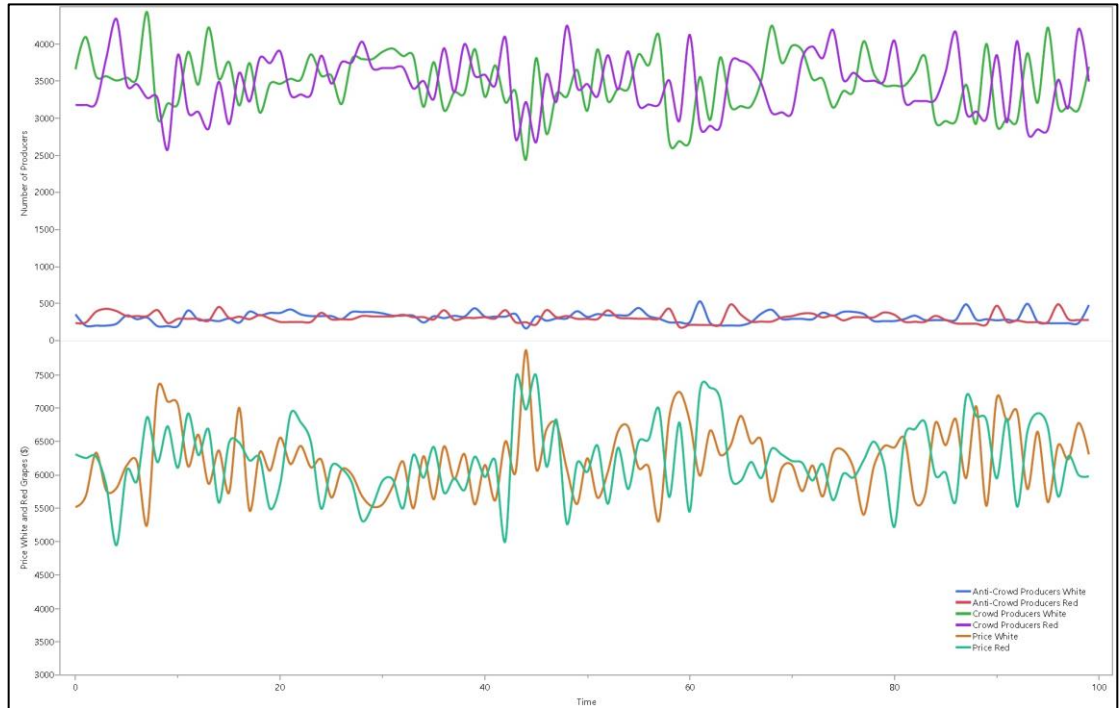


Figure 3: Price and Production Dynamics

Prices behave in a cyclical fashion, negatively correlated with the total market quantity. This market structure generates a price cycle consistent with that observed in commodities (Erten and Ocampo 2013), which becomes a key process affecting performance (Nicholson and Stephenson 2015). Oscillations in the price cycle last between 2 and 8 years, similar to what has been observed for wine grapes, fruits, grains (Jacks 2013), cattle (Mundlak and Huang 1996), and the milk industry (Hunt and Kern 2012). The aggregate market quantities mirror price behavior, given that boundary conditions imposed by the model fix the total demand and the number of competitors throughout the simulation.

We note that the price cycle lasts longer than the setup time, although this relationship varies across industries. For example, biological restrictions in the cattle industry impose a minimum two-year lag between gestation and the sale of a heifer in the market, but the industry's price cycle lasts around 10 years in the US.

**Anti-Crowd Strategy as an Entry-Timing Sustainable Advantage.**

Our main claim is that a fundamental determinant of performance in natural resources industries is entry timing, which eventually leads to sustainable competitive advantage. In a context of endogenous price oscillation, the existence of a lag time between the decision to switch markets and the start of full production generates opportunities for intertemporal arbitrage based on decision-making heuristics. This competitive context is validated in both the presence or absence of traditional competitive isolating mechanisms. Competitors gain an advantage from strategically timing market entry, but this advantage is temporary, until imitation pressures push prices downward. The basic trade-off anti-crowd players face is agreeing to zero or negative revenue in the short term in exchange for uncertain future gains. The absence of revenue results from the decision to stop producing and selling the higher-priced product during the transition period until the new product enters into full production. Future gains may eventually result from the higher prices anti-crowd competitors can charge for the new product before crowd competitors enter the market.

It is worth noting that, in the base model, no cost differences exist between competitors. Therefore, the only source of competitive advantage is the ability to obtain higher average prices based on entry timing. The determinants of entry timing and,

consequently, of competitive advantage, are the singular heuristics used by both groups (crowd and anti-crowd). Since crowd competitors look only at prices, they behave cyclically. Anti-crowd competitors, who also take into account other competitors' investments in the new market, tend to behave counter-cyclically. At the individual level, competitors cannot alter market prices, but when their decisions are aggregated, they generate supply changes at the industry level. The two distinct decision rules generate an intertemporal disequilibrium in the market.

Figure 4 reports the average cumulative performance for each crowd and anti-crowd competitor in the base simulation scenario, with just one differing parameter: the competitors' sensitivity to change (i.e., differing change factors). Figure 4a depicts cumulative performance for high sensitivity and Figure 4b for low sensitivity.

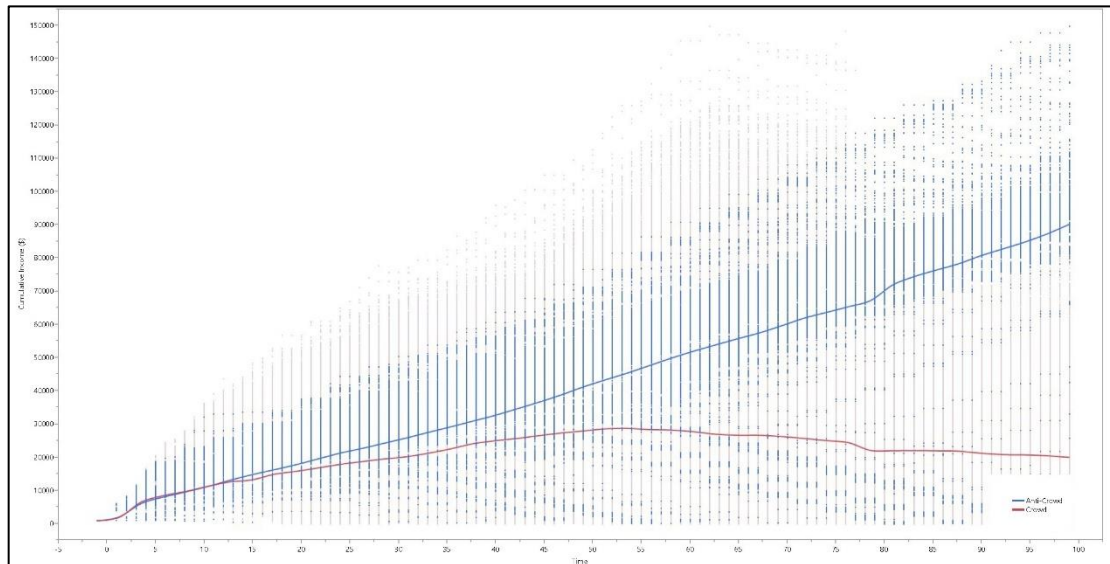


Figure 4a. Cumulative Profit Comparison Crowd vs. Anti-Crowd. Change Factor = 15

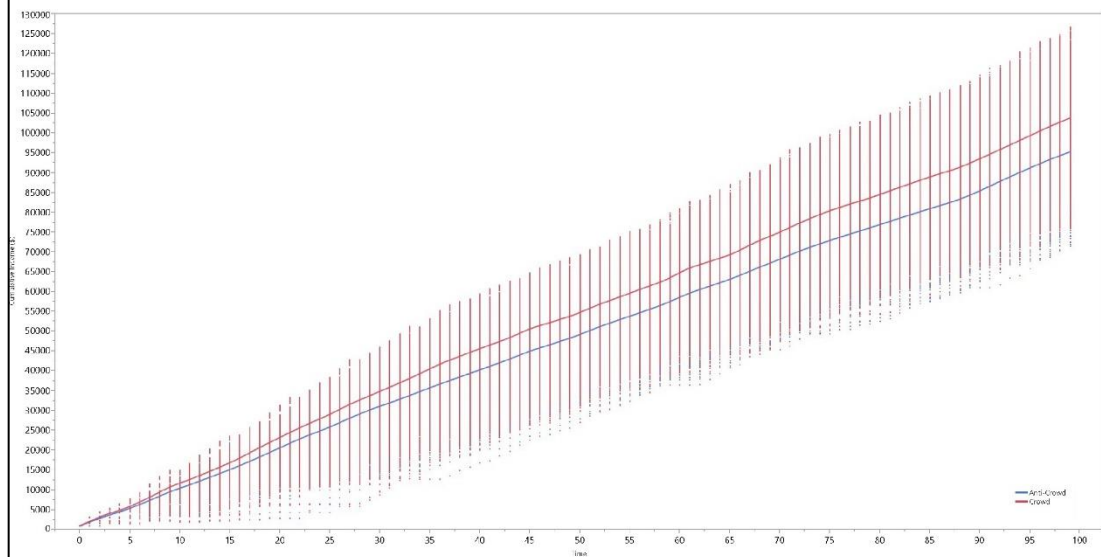


Figure 4b. Cumulative Profit Comparison Crowd vs. Anti-Crowd. Change Factor = 3.5

Figure 4: Cumulative Profit Comparison Crowd vs Anti-Crowd Groups

First Scenario, Base Model: Decision-Making Heuristics, no Isolating Mechanisms.

*Simulation parameters:* Setup Time = 2 years, Number of Crowd Competitors = 7700, Number of Anti-crowd Competitors = 770.

The potential for anti-crowd competitors to outperform their counterparts stems from their ability to detect an increase in the number of firms entering the most attractive market (i.e. the market with higher product prices). As the number of competitors increases, prices begin to decline. Beyond a certain threshold, anti-crowd competitors switch to the product with lower prices. They forgo revenue during a temporary setup period, but this loss is eventually compensated by future higher revenues from the new market, which had been previously abandoned by the crowd. Therefore, under certain conditions, anti-crowd competitors outperform crowd competitors. Consequently, we propose that:

*Proposition 1a: Firms following an anti-crowd strategy can achieve an entry-timing competitive advantage when competing in cyclical industries.*

*Proposition 1b: Firms competing in cyclical industries can achieve entry-timing advantages even in the absence of traditional supply-side and demand-side competitive isolating mechanisms.*

The second question we address is to what extent these results persist after introducing supply-side isolating mechanisms. We select two mechanisms observed in natural resources industries: learning economies and technological innovation in production processes. For this purpose, we create three additional scenarios as described in the prior section.

We first introduce learning economies. Learning economies generate heterogeneity in competitors' cost structures, reinforcing the cost advantages of competitors that remain in the same product. In principle, this seems to discourage

arbitrage opportunities. However, learning economies penalize switching activities at a decreasing rate. That is, learning economies substantially reduce costs during the initial periods of producing the same product, but their marginal effect decreases across time. Furthermore, given the oscillation of prices in a context of nonexistent product differentiation, the advantage bestowed by learning economies is necessarily temporal, lasting only until an alternative product becomes more valuable than the one the firm is producing. Moreover, the cost advantages stemming from learning economies improve competitors' performance, initially reducing the number of companies that exit the industry, increasing aggregate supply, and pushing prices down faster.

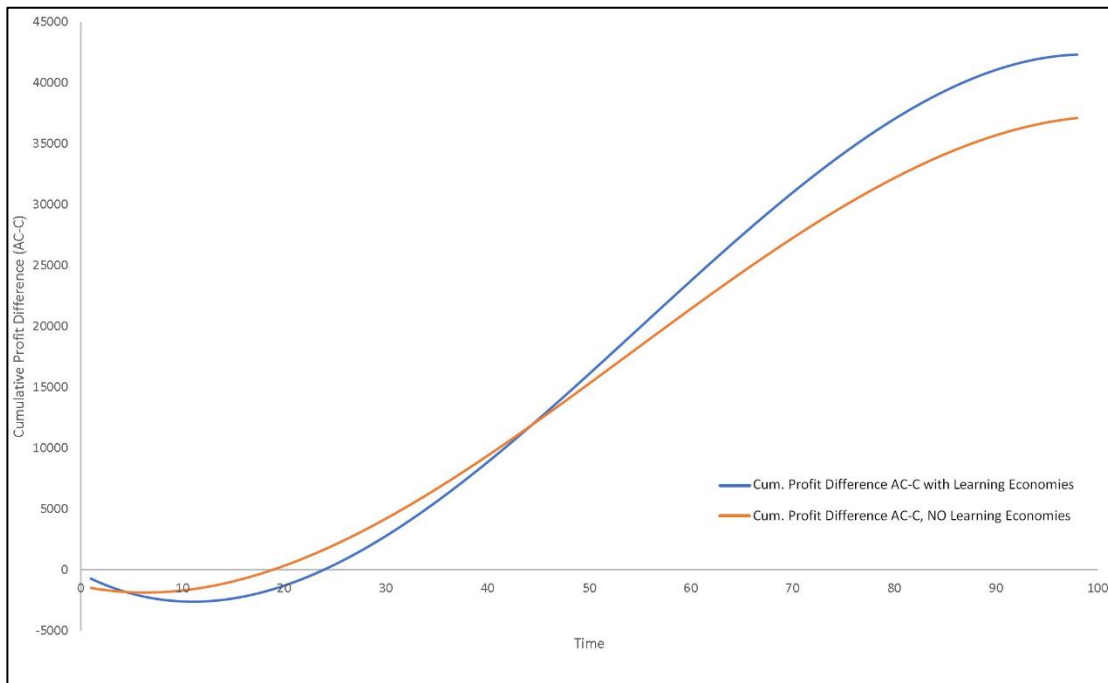


Figure 5: Cumulative Anti-crowd- Crowd Profit Difference in the Presence of Learning Economies

Second Scenario: Decision-Making Heuristics & Learning Economies as Isolating Mechanism.

*Simulation parameters:* Setup Time = 2 years, Change Factor = 15, Number of Crowd Competitors = 7700, Number of Anti-crowd Competitors = 770.

Thus:

*Proposition 2: The existence of learning economies reduces anti-crowd advantages but does not eliminate them.*

Next, we introduce the possibility that competitors adopt technological innovations in the production process. Previous research on entry timing explains that by maintaining technological leadership (e.g. investing in learning and R&D), early movers can sustain survival, market share, and profit advantages. In natural resources industries, with no product differentiation, the main source of technological leadership is at the production process level, increasing productivity and reducing unit costs.

Significant process innovations in natural resources industries usually come from suppliers (Pavitt 1984), and competitors simply decide whether to adopt these innovations or not. In our model setting, four possible competitive behaviors emerge: crowd or anti-crowd competitors adopting new technologies or failing to do so.

Adopting a technological innovation reinforces cost advantages but has no direct effect on the average prices competitors receive. Unlike learning economies, technological leadership in production processes generates an advantage that is independent from the production amount. Therefore, the magnitude of this advantage does not depend on switching decisions. However, as with learning economies, the adoption of technological innovation in production processes does introduce indirect

competitive effects since it affects survival rates. In particular, it cleanses the market, forcing those that lag behind technologically to exit. High-tech crowd and anti-crowd competitors have higher survival rates, improving performance. The advantage of the anti-crowd strategy remains in the presence of technological innovations, and it is greater than that observed in the absence of isolating mechanisms.

Therefore, we observe that the introduction of a technological innovation in production processes does not eliminate the heuristic advantages of following an anti-crowd strategy but even increases the range under which this strategy is a source of competitive advantage.

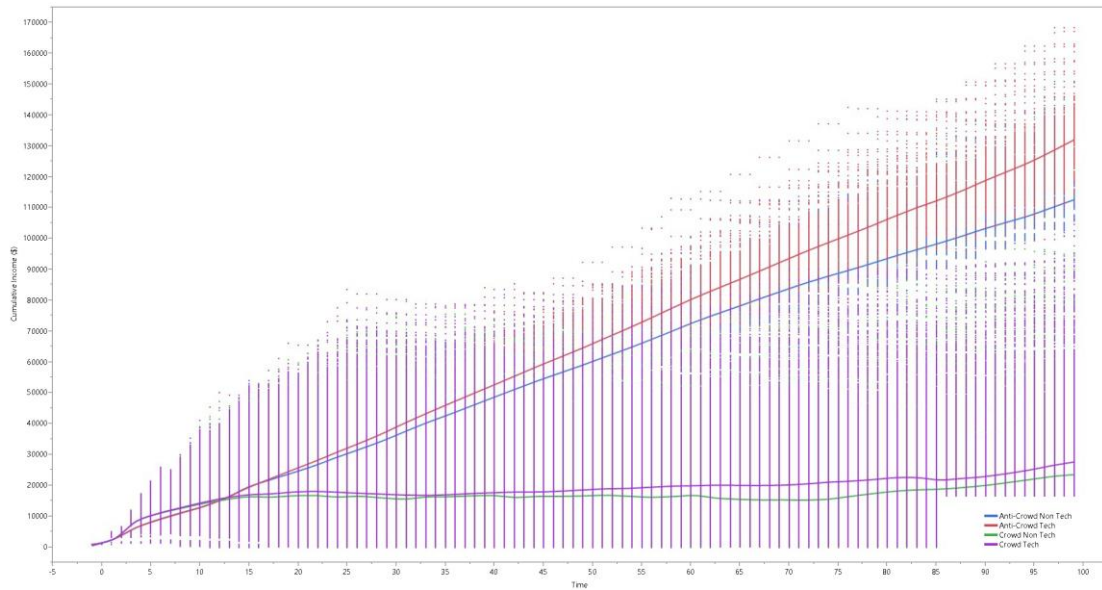


Figure 6: Firm Performance in the Presence of Technology Innovation

Third Scenario: Decision-Making Heuristics & Technology Innovation as Isolating Mechanism.

*Simulation parameters:* Setup Time = 2 years, Change Factor = 15, Number of Crowd Competitors = 7700, Number of Anti-crowd Competitors = 770.

*Proposition 3a: The existence of technological innovation in production processes reinforces the advantages of both crowd and anti-crowd competitors who adopt the new technologies (as compared to those that do not).*

*Proposition 3b: The existence of technological innovation in production processes does not eliminate the arbitrage advantages that emerge from anti-crowd heuristics.*

Our next question is: What are the environmental enablers that allow entry-timing advantages based on anti-crowd heuristics to develop? We argue that three main factors lead to sustainable entry-timing advantages for the anti-crowd group: industry rivalry, setup time and competitors' price sensitivity. In order to better understand the environmental forces leading to entry-timing advantage, we isolate the effect of each factor in the subsequent sections.

### **The Effect of Production Restrictions.**

A fundamental friction in many markets is the setup time between the decision to enter a market and the start of full production. This situation is typical in most natural resources industries, ranging from petroleum to agriculture. A vineyard needs around three years to start producing quality grapes, and it can take another three years before the wines have aged properly and are ready for the marketplace. The setup time is similar for several fruits, such as apples and avocados. In the paper and pulp industry,

the production setup time – time needed to grow trees – ranges from 18 to 25 years. Because setup time will vary depending on the distinctive exploration and production features of each commodity, we use this variable as a proxy to measure production restrictions.

We explore to what extent changes in setup time enhance or decrease the value of an anti-crowd strategy. The setup time determines the number of periods of zero or negative revenue. A surge in the setup time increases industry coordination problems: anti-crowd competitors face a higher opportunity cost of exiting the most profitable market, while crowd competitors face future longer periods of high prices. A drop in the setup time favors the anti-crowd strategy (assuming that anti-crowd competitors are in the minority), since they will be able to enjoy a future first-mover advantage while minimizing losses stemming from the decision to switch markets. Additionally, since setup time affects crowd and anti-crowd competitors equally, a shorter setup time encourages a bandwagon effect, as crowd competitors switch markets faster and more frequently to benefit from higher prices. This increases market volatility and consequently expands the opportunities for anti-crowd competitors to earn abnormal revenues.

Figure 7 shows the crossed impact of price sensitivity, setup time and total number of competitors on anti-crowd performance:

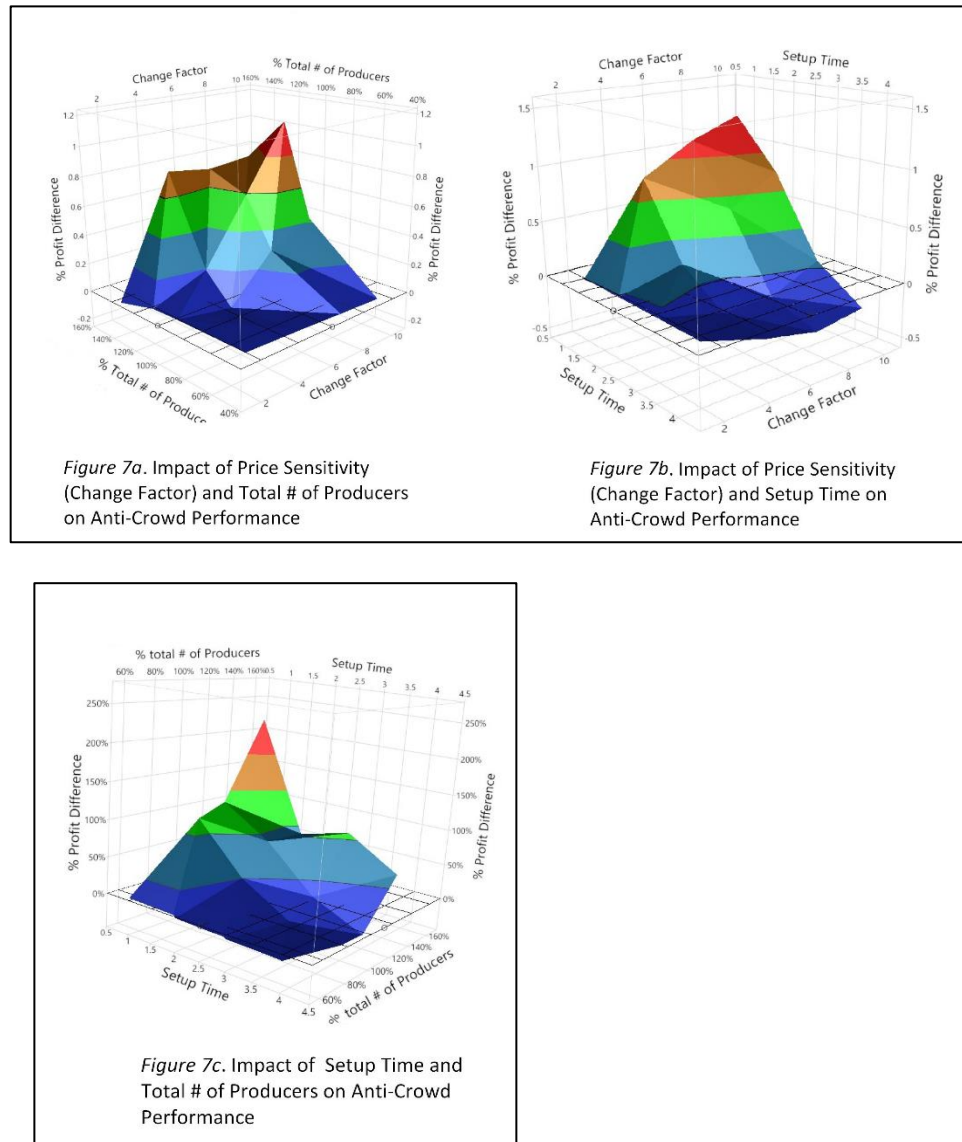


Figure 7: The Crossed Impact of Price Sensitivity, Setup Time and Total Number of Competitors on Anti-crowd Performance

Fourth Scenario: Decision-Making Heuristics & Learning Economies and Technology Innovation as Isolating Mechanisms. The reference value of Total # of Producers is 8,470, the total number of producers in the base model

Anti-crowd performance is measured relative to that of the crowd group; it is calculated as the profit difference between the two groups as a percentage of the average profit. The observed relationship among factors is nonlinear. The setup time ranges from 1 to 4 years; the competitors' price sensitivity, represented by the Change Factor, varies from 2 (low sensitivity) to 10 (high sensitivity); the total number of producers ranges from 4,235 to 12,705. In Figure 7b, we observe that setup time barely affects anti-crowd performance when competitors' sensitivity to change is low. However, a shorter setup time makes it possible for anti-crowd competitors to outperform the crowd group in a context of higher volatility. From Figure 7c, we observe that the anti-crowd performance is highest for short setup times in a competitive market (high number of competitors). In general, the effect of decreasing setup time is positive for the anti-crowd group, though flatter and less significant than the effects of market competitiveness and competitors' price sensitivity.

Therefore, we propose that:

*Proposition 4. The advantage of following an anti-crowd strategy increases as setup time decreases.*

### **The Effect of Environmental Dynamism.**

It is known that environmental dynamism influences entry-timing advantages in industries with isolating mechanisms in place (Suárez and Lanzolla 2007). We examine

to what extent environmental dynamism affects entry-timing advantages both with and without the presence of isolating mechanisms. In our analysis, this dynamism depends on competitors' propensity to switch markets, since the aggregate combination of market changes ultimately generates endogenous environmental instability in the form of supply and price cycles. This endogenous volatility is defined in the model as competitors' price sensitivity. Competitors differ in their price sensitivity, that is, in their willingness to switch markets when relative prices change. Lower sensitivity (i.e. competitors are less likely to switch markets) might reflect higher risk aversion, a longer-term orientation, or the expectation that the price cycle will last longer (i.e., the assumption that other competitors will react slowly to price changes).

Figure 3 shows the endogenous nature of cycles, with prices moving in a cyclical and negatively correlated fashion.

Low price sensitivity among competitors is associated with less extreme price oscillation. Aggregate production mirrors this behavior in an inverse manner. Figures 7a and 7b illustrate the effect of price sensitivity on the mean difference in profit between the anti-crowd and the crowd groups. When the change factor grows, price variability increases, which positively affects anti-crowd performance. Interestingly, not every change factor value allows for a window of opportunity for anti-crowd competitors. In fact, we observe that when Change Factor is low, the crowd group always outperforms the anti-crowd group, regardless of the value of the other factors. This occurs because, as the price sensitivity declines, so does the probability that the crowd competitors switch

markets; hence, price volatility falls, limiting anti-crowd competitors' opportunities.

Thus, we suggest that:

*Proposition 5: The higher the sensitivity of competitors to changes in relative prices, the greater the advantage of following an anti-crowd strategy.*

### **The Effect of Competitive Conditions.**

Competitive conditions are a well-established contingency to entry-timing advantages (Baum and Korn 1999; Fuentelsaz, Gomez, and Polo 2002; Zachary et al. 2014). Nonetheless, not all theories make the same predictions regarding entry into highly competitive markets. For instance, oligopoly theory establishes that markets with low rivalry are not attractive for new entrants since the existing competitors can coordinate their actions to prevent entry (Sherer and Ross 1990). Furthermore, a high level of rivalry can be indicative of a market with opportunities for high profits. Alternatively, the contestable markets theory does not recognize any significant effect of market concentration on firm performance. Finally, according to Mitchell, (1989), when rivalry levels are high, incumbents may react to new threats, reducing the profitability of new entrants.

In this context, we recognize two potential effects of the number of competitors on anti-crowd group performance. On one hand, when more competitors interact in the market, the anti-crowd group is likely to grow, diminishing the opportunity to follow a successful minority anti-crowd strategy. But at the same time, assuming a generalized risk aversion that is asymmetric between the crowd and anti-crowd strategy populations,

we expect a stronger effect from the expansion of the larger crowd group, reducing prices, increasing price volatility, and ultimately boosting potential gains for the anti-crowd group. In Figures 7a and 7c, we can observe that, as the number of competitors increases, the performance of the anti-crowd group improves. Nevertheless, this positive effect is limited to markets with high rivalry. In the fourth scenario shown in Figure 7, it is only when the total number of producers is greater than 6,776 (i.e., 80% of the total number of competitors for the base case), that anti-crowd competitors have a window of opportunity to outperform crowd competitors. In a market with lower rivalry, crowd competitors perform better below this threshold. Remarkably, even a highly competitive market does not assure a successful anti-crowd strategy; the potential success of such a strategy also depends on the interrelated factors of price sensitivity and setup time. Thus, we argue that:

*Proposition 6: As the number of competitors increases, so does the value of an anti-crowd strategy.*

## **DISCUSSION**

We analyze the extent to which entry timing in cyclical industries can generate a competitive advantage. Companies competing in renewable natural resources industries face a fundamental trade-off between exploiting prevailing high prices for a particular product and making investments in order to exploit future high prices for an alternative product.

We propose an entry-timing advantage that is independent of traditional isolating mechanisms. Antecedents illustrate the existence of a one-time opportunity window that favors a sustainable competitive advantage for early entrants. In contrast, we highlight the existence of repeated opportunity windows based on the oscillation of commodity prices. Companies have the strategic option to use this oscillation to build a sustainable competitive advantage that is related not to the existence of traditional isolating mechanisms but to decision-making heuristics. Still, since in our model we assume the existence of stable strategic inertia, heuristics remain the same over time, they cannot be treated as path-dependent, and consequently, their competitive effect differs from that of traditional isolating mechanisms.

The fact that the game generates entry timing competitive advantages in a certain industry can help us understand competition not only in natural resources but also in differentiated products industries. To the extent that a differentiated products industry has high capital investments, a long lead time and high potential for overinvestment, mastering timing of entry can also be a sustainable source of competitive advantage, even though prices may not oscillate as they do for commodities.

In our model, cycles are endogenously driven. However, cycles can also be driven by external factors, such as the behavior of financial commodity markets and macroeconomic growth (Cortazar, Kovacevic, and Schwartz 2015; Mayer 2009). Building entry-timing advantages is also possible with exogenously driven cycles. In fact, recent studies have started addressing the conditions under which the business cycle might alter order of entry advantages (García Sánchez, Mesquita, and Vassolo 2014).

For business cycles altering these advantages, there must be some isolating mechanisms in place. We explore two isolating mechanisms that exist in natural resources industries, mainly related to cost advantages (i.e. learning economies and technological innovation in production processes). The existence of these mechanisms might reinforce entry-timing advantages in the face of exogenous changes to relative prices. Our research formalizes the mechanisms behind anecdotal evidence suggesting that it may be possible to earn abnormal returns by determining the best times to start and stop producing a certain commodity product. In particular, several U.S. farmers producing milk sold their cows in early 2008, anticipating negative margins in 2009, and re-entered the market during 2010, earning abnormal returns (Nicholson and Stephenson 2015). Interestingly, they planned their expansion during 2009, when prices of cows and equipment were low, entering into production at the end of 2010, when prices started to recover.

Firms face a tension between current revenue and cumulative revenue when they decide to switch markets based on a countercyclical approach. The critical decision is whether to use current prices as a proxy of future values. Since aggregate investment decisions might drop prices in the future, optimal strategies require some degree of differentiation from competitors' decisions. Furthermore, behaving countercyclically brings fundamental uncertainties, primarily centered around competitors' aggregate decisions, in a context where switching from one product to another has a substantial opportunity cost and an unclear payoff.

However, simply following a countercyclical strategy by analyzing competitors' investments does not necessarily lead to a sustainable competitive advantage. Such

advantages exist primarily in competitive and volatile markets, where competitors are sensitive to price and enjoy moderate setup times. One of the conditions for a successful countercyclical strategy is that the anti-crowd cohort must be a minority. As the number of members in the anti-crowd group increases, the potential gains vanish. There are two reasons for this: First, it is not possible to follow a countercyclical strategy if a substantial group of competitors is following the same strategy. Second, producers' aggregate decisions affect the commodity cycle, reducing prices and thus cutting into early movers' revenues.

Our study has implications that go beyond natural resources industries. We complement the literature on asset reconfiguration (Chakrabarti, Vidal, and Mitchell 2011; Dierickx and Cool 1989), where returns not only depend on factors such as efficiency or differentiation but also on the timing of buying or selling assets, by introducing a new context: endogenously determined cycles.

## **LIMITATIONS**

The set of assumptions in our base model leads to multiple limitations on the generalizability of our results. First, the type of competitive advantage described here is likely to lead to some degree of industry consolidation. Nonetheless, although competitors enter and exit the industry, our model limits consolidation: companies that exit the industry are replaced by new entrants. If we relax this assumption, we might observe increasing industry concentration, ultimately altering our findings.

Another limitation of our model is that, although most variables are stochastic, since we consider the average of 70 runs of a Monte Carlo simulation, the results are

smoothed and therefore cycles in the model are somewhat regular. For most natural resources, cycle duration may vary more significantly, and anti-crowd competitors' performance would be negatively affected by such uncertainty, as their strategy is partially based on cycle regularity.

Moreover, given that the value of an anti-crowd strategy depends on a minority of agents following such a strategy, future research should explore the factors that lead to learning in the crowd group and the mechanisms via which competitors might switch groups. These future studies might eventually illuminate the debate between momentum and terminal trajectories (Amburgey, Kelly, and Barnett 1993; Amburgey and Miner 1992; Klingebiel 2017; McKinley, Latham, and Braun 2014). In our study, we assume the existence of repetitive strategic momentum. This assumption has been proven consistent with managerial behavior (Amburgey and Miner 1992) and simplifies the mathematical simulation by allowing decision-making to remain stable in the same heuristic pattern. However, it is also reasonable to expect a certain number of competitors to learn from the most successful strategies and adjust their personal heuristics.

Finally, we assume that producers already own the main asset (i.e., land) and that their main decision concerns entry timing related to alternative products that can be produced from this limited resource. However, producers can also choose to purchase more of the underlying resource (i.e., land); if they do so, they must decide when to make such purchases. For example, in non-renewable natural resources industries, the decision of when to purchase a mine or an oilfield is a critical one, and eventually

becomes a source of order of entry competitive advantage. This may also be the case for renewable natural resources, but we do not examine such a possibility in this manuscript, which adds another boundary condition to the study. This also provides an important avenue of future research.

## **CONCLUSION**

Entry timing has been a subject of extensive analysis since Lieberman & Montgomery's (1988) seminal work. We contribute to this area of research by studying a previously unexplored setting: natural resources industries. Specifically, we develop a mathematical simulation model that involves a certain number of competitors following a price-countercyclical strategy ("the anti-crowd"). The success of this strategy depends on the existence of a sufficient number of competitors who follow a procyclical strategy ("the crowd"). Our model offers a powerful tool for analyzing sustainable entry-timing competitive advantage independently of traditional isolating mechanisms.

## **GENERAL CONCLUSIONS AND FURTHER RESEARCH**

The simulation model developed in this research is a powerful tool to analyze the existence and improve the understanding of order of entry advantages. One of the most important findings of this research is that following an anticyclical entry strategy may generate abnormal returns and become in a source of competitive advantage. However, this order of entry advantage for anticyclical entry strategy does not always exists, it depends on certain contingencies: environmental dynamism, competitive conditions and production restrictions. These contingencies are modeled by the following parameters respectively: change factor, number of competitors and set up time. When the setup time increases this advantage decreases, the same occurs when increasing the number of anticrowd competitors. Meanwhile when increasing the sensitivity to change, the anticrowd advantage increases, the same occurs when increasing the total number of competitors (until certain threshold).

Another conclusion is that the order of entry advantage acquired for being anticyclical remains even in the presence of some supply side isolating mechanisms included in the model: learning effects and technological breakthrough. Both improve the performance of anticrowd and crowd groups, but the first diminishes the anticrowd advantage but does not make it disappear.

This work contributes to the existing order of entry literature in three aspects. First, the research is made for the context of natural resources industry, which as mentioned above has not given the same importance than other industries by researchers but it represents a significant part of global trade and one of the main for emerging economies. So by focusing on this industry, our work opens a wide field of research within order of entry and strategy literature.

As mentioned above, this industry has some characteristics which make it very different from other (almost none demand-side isolating mechanisms, biological restrictions, products as commodities, etc) and the academics based the order of entry advantages

mainly on isolating mechanisms and study the industry from the beginning, these aspects are very difficult to find in natural resources industry, so analyzing order of entry advantages and finding that these exist without the presence of isolating mechanism is surprising and breaks the paradigm of isolating mechanisms as the only driver of order of entry advantages. In addition, the research also considers two mechanisms who work as isolating mechanisms: learning effects and technological breakthrough, which are related to the processes rather than the products in natural resources industry. They capture the effects of the experience gained by years of production and the benefits of investing in new technologies, respectively which become relevant in competitive markets. Including, these mechanisms make the model more complete, realistic and broaden the conclusions obtained.

Third, this research utilizes a powerful methodology: simulation, this tool permits to design different scenarios, markets, competitors, it works as a laboratory in a computer and allows you to count with full information about every variable, incorporate endogenous relations, and observe the system behavior as a result of aggregated behavior of agents, so this approach has a considerable potential in strategy literature. However, this has not been frequently used and with our investigation we hope to encourage researchers of the area to consider it as a real and convenient option.

There are also some limitations of the investigation and its findings. There has not been yet an empirical validation which would help to contrast the findings and also calibrate more precisely the model, given it is a simulation, this step becomes relevant. Other limitation is that the model does not consider other exogenous events that affect commodities prices such as interest rates, speculation, economic crisis, weather effects, etc. Another one is that considering that the simulation span (100 years) it is very relevant how to compare different period profits. One way is to improve the performance measure from cumulative profit to a mechanism which allows to compare earnings in different periods, for example a discount rate.

There are several paths to continue the research in this topic, to include heterogeneity in the competitors: different levels of production, to have the possibility of growing by buying new assets or other competitors, considering the possibility of industry consolidation. In other hand, in many industries when changing from one market to another there is a cost to pay which could be included and would penalize the competitors following an anticrowd strategy as it changes more often than crowd competitors. On the other hand, it would be interesting to relax the assumption of static heuristics and to implement a heuristic learning in which each competitor can change from heuristic according to previous performance for example. Finally, it would be interesting to explore and incorporate other heuristics in-between crowd and anticrowd and creating a new cohort, since in the industry there is a wide range of pro and anticyclical levels.

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