# *Non-competitive markets*

Book or Report Section

Accepted Version

It is advisable to refer to the publisher's version if you intend to cite from the work.  See Guidance on citing.

www.reading.ac.uk/centaur

# NON-COMPETITIVE MARKETS

**Nikolaos Georgantzís**
School of Agriculture Policy and Development, University of Reading

**Giuseppe Attanasi**
Department of Economics, Univerity of Strasbourg

## Introduction

A market is not competitive when the agents acting in such market have the power to directly or indirectly influence the price, something that does not occur under perfect competition. Generally, these agents have market power because they are few, they have access to relevant information, and they can foresee the interdependence between their strategies and those of others.

Among all the paradigms in economic theory, the theoretical predictions of oligopoly were the first to be examined in the laboratory. In the origins of experimental economics one can find the works of Chamberlin (1948) and of Smith (1962, 1964), who designed experiments to study a market with few agents that could reach the competitive equilibrium (see Chapters 10 and 11).

In this chapter, instead of surveying all the experiments with few sellers,[1] we will adopt a narrower definition of the term "*oligopoly*", and we will focus on the experiments that were directly inspired by the basic oligopolistic models of Cournot (1838), Bertrand (1883), Hotelling (1929), Stackelberg (1934), and some closer extensions. We will omit, therefore, other experiments such as those of Chamberlin and Smith, which were designed with the aim of testing the predictive power of the competitive equilibrium model.

Most of the experiments we consider in this chapter have been run in the last three decades.[2] This literature can be considered as a new wave of experimental works aiming at representing basic oligopolistic markets and testing their properties. These works represent a systematic effort of studying a similar but not identical question to that tackled by Chamberlin (1948) and Smith (1962, 1964). While the latter compared the results in the

---

[1] According to the Greek etymology of the word, oligopoly ($o\lambda\iota\gamma o\pi\omega\lambda\iota o$) is a market with few sellers ($o\lambda\iota\gamma o\iota\pi\omega\lambda\eta\tau\acute{e}\varsigma$).

[2] The first experimental tests of Industrial Organization Theory can be found in Plott (1982). Later, Holt (1995) presented a summary of the experimental results in oligopolistic markets.

laboratory with predictions of the *competitive equilibrium*, the series of experiments we revise here compare the observed behavior with the corresponding *oligopolistic equilibria*.

The chapter is divided into independent sections referring to different parts of the oligopolistic theory, including both monopoly as well as a number of extensions of the basic models, which have been chosen with the aim of providing a representative list of the experimental findings in such theory.

**Monopoly, price competition and product differentiation**

The simplest and most frequently corroborated hypothesis regarding price setting behavior in markets argues that, by relaxing the usual assumptions, we may converge to the equilibrium price of Bertrand. That is:

- If there are (alternative assumptions): few agents, with no experience and limited cognitive ability, with insufficient information of the conditions of the market,

- is the equilibrium reached through learning by trial and error?

That is, if the experimental subjects reach the same price predicted by the theoretical models that assume (usual assumptions) perfect information and infinite cognitive capacity.

The simplest case is that of *monopoly*. Assume that you are participating in an experiment in which you are a monopolist and you face a demand function unknown to you. In fact, this function could be, for instance, $Q = 100 - 2p$, which assumes that sales in your firm decrease when the price increases. Given that this demand function is unknown, you can only try to guess the price that maximizes your benefits by testing what happens as you set different prices. For simplicity, let us assume that your cost is $C = 0$, thus your payoff from the experiment coincides with your benefits.

With *unknown demand function*, you cannot calculate the optimal price, as you would do during a microeconomics class. As anticipated above, one way to calculate as fast as possible which price maximizes your benefits is to set any price and observe the sales and the benefits. Then you would change your price to see the reaction in sales and benefits. Subsequently, you would use the results of these first two periods to choose the price for the third period, and so on. By accumulating information, you could start noticing how to get closer to the benefit-maximizing price. Classroom experiments with college students have shown that the optimal price $p^* = 25$ is reached after 6 to 10 trial periods.

Therefore, for a monopoly with no information on the demand function, laboratory experiments confirm that learning by trial and error, leads to convergence to the perfect information prediction. This happens with few repetitions and without requiring specific cognitive abilities.

However, the result is different when some complexity in the problem of the monopolist is introduced. For instance, suppose that, as a subject participating in the experiment, you are asked to simultaneously set the *prices of two products*.[3] To better understand the additional difficulty, consider a firm that aims at finding the optimal prices for its two substitute products/services, such as for instance two different flights to one same destination operated by the same airline. In this framework, experiments have demonstrated a significant deviation in the strategies a subject plays with respect to the one predicted by the theory. The deviation lasts even after several attempts, unless the subject receives information on the cross effects of the demand of a product on that of the other product.[4]

In the real world the monopolists frequently face decision-making problems that are even more complex, like when they have to set prices to manage a dynamic system as, for instance, a renewable resource. García-Gallego *et al.* (2008) study a market of this sort, and finds that subjects systematically fail to learn, and are unable to converge towards the optimal level of resource preservation, not even when playing for 50 periods.

In summary, we can argue that human subjects can learn how to set the optimal price in a monopoly without the (extremely high) level of information and rationality assumed by the theoretical models in the textbooks. However, this is true as long as the complexity of the environment does not overcome a certain limit. Above this limit, a trial-and-error learning procedure is not enough to let experimental subjects play the monopolistic equilibrium price.

Let us now analyze the problem of price setting in the case of an *oligopoly*. Fouraker and Siegel (1963) run the first experiments on this topic. Their focus was on the importance of the type of information transmitted between subjects playing in the role of firms in an oligopolistic market. Their objective was to evaluate the predictive capacity of the theoretical oligopolistic equilibrium. Their experiments confirm two results of enormous interest:

   i.   When subjects receive private information on their own benefits, they tend to converge towards the Nash equilibrium prices (Bertrand-Nash equilibrium).

   ii.  If subjects also have available information on the benefits of their competitors, then they will set prices higher than those predicted by the non-cooperative Nash equilibrium: their behavior show a certain level of collusion.

The level of *collusion* dramatically increases if experimental subjects are given the possibility to communicate among them. Fonseca and Normann (2012) compare pricing behavior with and without the possibility to communicate among firms, in Bertrand oligopolies with various numbers of firms. They find strong evidence that *communication* helps to obtain higher profits for any number of firms in the market: communication supports firms in coordinating on collusive pricing schemes. However, the gain from communicating is non-monotonic in the number of firms, with medium-sized industries

---

[3] Kelly (1995) is one of the first examples of a multi-product monopoly experiment.
[4] See for instance García-Gallego *et al.* (2004).

having the largest additional profit from talking. They also find that industries continue to collude successfully after communication is disabled.

Let us now focus on the *demand side*: the most recent oligopoly experiments have adopted mechanisms of market clearance where the buyers' behavior is simulated with continuous demand functions.[5] For instance, García-Gallego (1998) uses a system of symmetric demand functions, composed by $n$ equations as the following one:

$$q_i = a - b \cdot p_i + \theta \cdot \sum_{j \neq i} p_j,$$

where $p_i$ is the price of the variety $i$, $n$ is the number of varieties available in the market, (each variety offered by a different firm), while $j$ represents each of the substitutes of variety $i$.

The function tells us that the demanded quantity $q_i$ of the good of variety $i$ decreases as its price increases ($b$ is a positive number), but it also increases as the price of any other variety increases. The parameter $\theta$ indicates the level of interdependency between varieties, in this case between variety $i$ and the other $n - 1$ varieties. Such a demand system, where $\theta$ is positive and lower than $b$, corresponds to the case where each variety can be imperfectly substituted by any other variety in the market. Further, the unitary cost $c$ is assumed to be constant and the same for all varieties, and there are no fixed costs.

In the experiment of García-Gallego (1998), even though subjects systematically attempt to tacitly coordinate in setting prices at a level above that of the non-cooperative equilibrium, it is found that the Bertrand-Nash equilibrium strongly attracts individual strategies, especially in the second half of the market periods. This work shows that a 35-period horizon is sufficient to allow most subjects to converge surprisingly close to Bertrand's prediction, with some experimental sessions where the predicted and observed behavior coincide. Figure 12.1 show the evolution of prices in a typical session of the experiment.

---

[5] In other experiments subjects are provided with discrete payoff matrixes, which are the reduced version of the original oligopoly games with continuous strategies. The choices for a more or less realistic experimental design depend on the principles followed by the experimentalist and on his/her research objectives.
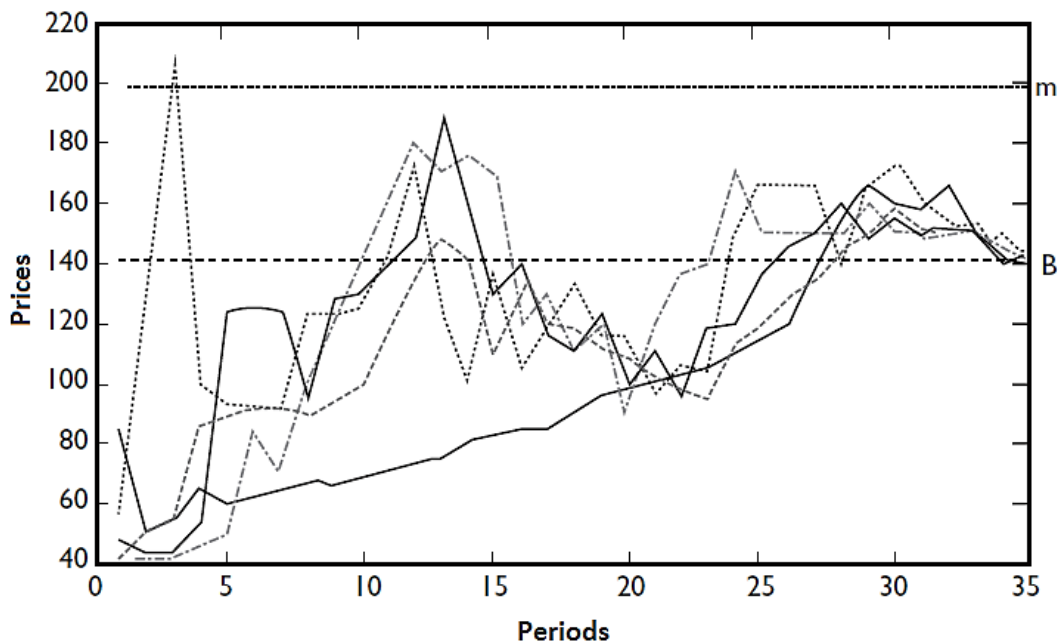
**Figure 12.1.** Bertrand-Nash *vs.* actual behavior in a differentiated oligopoly with 5 varieties. After few periods of price volatility, subjects' strategies clearly converge to the Bertrand-Nash prediction (*B*) and move away from the monopoly (collusive) price (*m*). Source: García-Gallego and Georgantzís (2001b).

Subsequently, García-Gallego and Georgantzís (2001a) implement the same conditions of demand and costs as those in García-Gallego (1998) to test the predictive power of Bertrand-Nash with *multiproduct firms*. The theory predicts that if the same multiproduct firm jointly produces two or more substitute goods, their prices will be higher than if independent competitors offered the goods. Although the problem of a multiproduct firm is much more complex than that of a firm with a single product, the existence of a multiproduct firm leads to the prediction of an asymmetric Bertrand equilibrium, where the firms producing more goods tend to set higher prices. Surprisingly, the experiments in García-Gallego and Georgantzís (2001a) teach us that multiproduct firms do not understand the strategic benefits they can derive from their multiproduct market power. This is why they behave as if they were competing with one of their products against the other.

Therefore, trial-and-error learning in an oligopolistic market with uniproduct firms leads to strategies that are close to the Bertrand-Nash equilibrium. However, in the multiproduct case, trial-and-error learning does not support the corresponding asymmetric Bertrand-Nash equilibrium. Davis and Wilson (2005) have reinterpreted this result in terms of its consequences on merging policy: if firms do not realize their market power, behavior after the *merger* can be as competitive as before the merger.[6]

---

[6] Fonseca and Normann (2008) provide a thorough analysis of the impact of *mergers* in experimental Bertrand oligopolies. They consider as treatment variables the number of firms (two, three) and the distribution of industry capacity (symmetric, asymmetric). They find that, even though they are more

However, García-Gallego and Georgantzís (2001a) also carry out a treatment imposing an exogenous norm that limits the multiproduct firm to change its own prices all in the same direction (*price parallelism*). In this treatment, subjects tend to adopt the limit strategies of the Bertrand-Nash multiproduct equilibrium (that is, close to the collusive equilibrium)[7]. Figure 12.2 presents examples of sessions with multiproduct oligopolies.
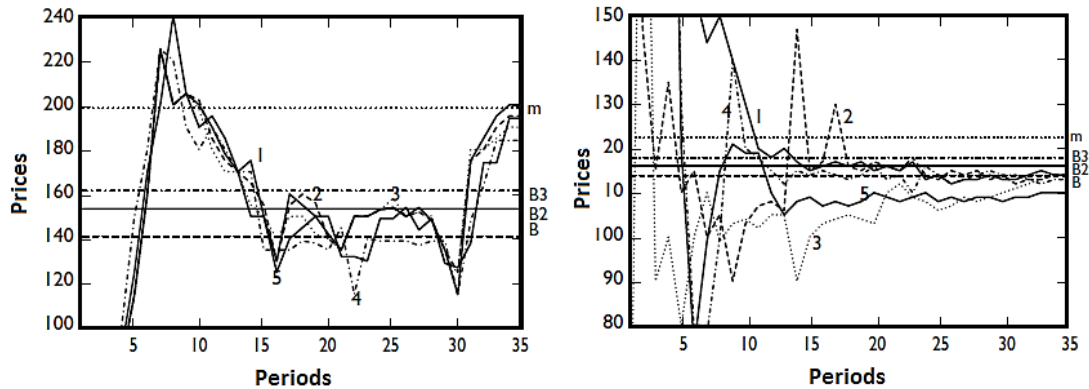


**Figure 12.2.** Multiproduct oligopoly. Left: Convergence to the collusive equilibrium price (*m*) in a differentiated oligopoly with multiproduct firms, five varieties, and the price-parallelism norm. Right: Failure in reaching the collusive equilibrium price (*m*) because of no adoption of a price-parallelism norm. Source: García-Gallego and Georgantzís (2001b).

The reader must identify that the prediction of the Bertrand-Nash multiproduct equilibrium for a firm that jointly sets the prices of three varieties (B3 in Figure 12.2) is the highest, followed by the same prediction for two varieties (B2), and that both of them are greater than the Bertrand-Nash equilibrium with uniproduct firms (B). In Figure 12.2 on the left hand side, a typical session is portrayed where, thanks to the exogenous imposition of the price-parallelism norm, firms' prices converge to the collusive equilibrium. On the right hand side, a session is portrayed where, without such exogenous imposition, multiproduct firms do not adopt price parallelism and cannot avoid converging to the Bertrand-Nash equilibrium with uniproduct firms.

Likewise, firms can affect the level of market competition by strategically choosing to differentiate one from the other. In the standard *product differentiation* model of Hotelling (1929), firms decide first on their *location*, which represents a variety in a continuous and closed product space, and then they compete in price setting.

---

concentrated, asymmetric markets exhibit lower prices than symmetric markets with the same number of firms. Consistent with the static Nash-equilibrium prediction, duopolies charge higher prices than triopolies. However, although the overall impact of a merger is anti-competitive, the price increase is not significant. This last result, in a sense, confirms the findings of Davis and Wilson (2005).

[7] Price parallelism has been previously studied in uniproduct firms by Harstad *et al.* (1998) in a context specifically designed to tackle this question. It was found that the conscious adoption of price parallelism by the competitive sellers had the effect of increasing prices towards the collusive prediction.

As in the case of several other phenomena for which it is very difficult to empirically test economic theories with real data, the models with product differentiation have also been examined in the laboratory. Brown-Kruse and Schenk (2000), Collins and Sherstyuk (2000), and Huck *et al.* (2002b) have experimentally studied spatial markets with two, three and four firms, respectively.

These three works describe experiments in which the participants only choose the location of their firm, while the *prices are exogenously imposed* to them. In this context, there two clear-cut theoretical predictions can be provided:

- There is a "minimal" product differentiation as in the non-cooperative equilibrium when subjects cannot communicate among them.

- There is an "intermediate" differentiation due to collusion when subjects can communicate between them.

Both theoretical predictions have been corroborated by the above-mentioned experimental studies. That is, firms that use location as the only strategic variable, in absence of communication tend to agglomerate in the middle of the product space (segment). Likewise, and as we will see in Chapter 18, political parties tend to adopt ideological positions close to the median-voter's preference. In the presence of communication, firms are located between the extremes and the middle of the segment.

However, the assumption of exogenous prices does not allow dealing with the usual intuition in the sense that a firm can improve its benefit by differentiating its product from that of its competitors with the intention of cooling down price competition. Recently, Barreda *et al.* (2011) have implemented experimental spatial markets with *endogenous price setting*. This work presents two interesting results:

- There is a positive relation between differentiation and price.

- Differentiation by location tends to be low.

Figure 12.3 presents the aggregate results of the location-seeting and the price-setting stage, respectively. The results appear to be robust to variations in the experimental conditions regarding the rule of division of the demand in case of a tie (automatized *vs.* human consumers).
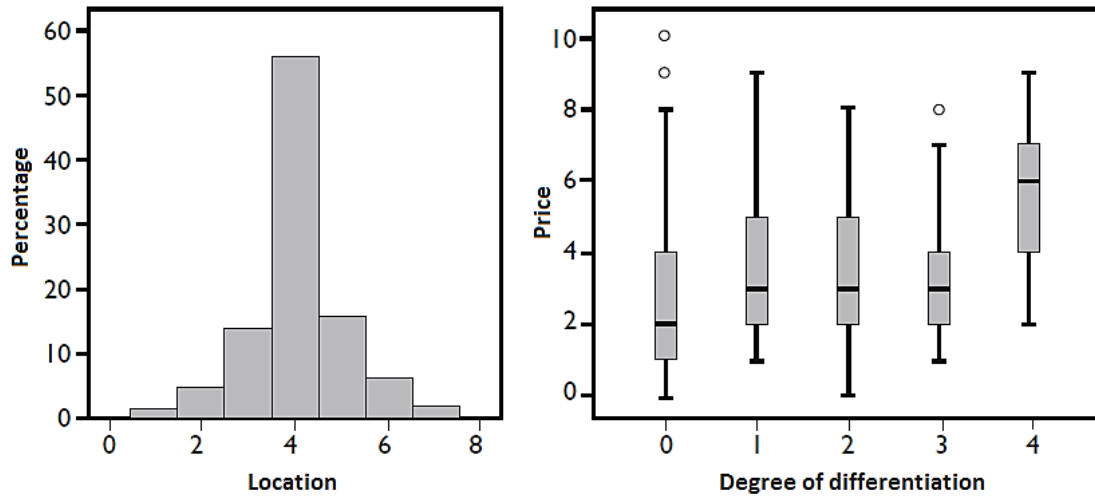
**Figure 12.3.** Spatial location with endogenous prices. Left: The prediction of minimal differentiation by Hotelling (1929) is confirmed by the modal choice in an experiment with endogenous prices. Right: The hypothesis that prices increase for higher levels of differentiation is confirmed. Source: Barreda *et al.* (2011).

In summary, we can state that the prediction of Hotelling's model arguing that firms will agglomerate in the center of the market is confirmed, both in experiments where it is possible to compete in prices as well as in contexts where the price is exogenously fixed. In addition, when price competition is allowed, subjects choose a product-differentiation strategy for they recognize its ability to sustain higher prices: it is very satisfactory for a researcher to observe the predictive power of the theory in such a complex setting, as is the two-stage game – location and price – in Barreda *et al.* (2011), where the predictions of Hotelling (1929) are confirmed.

Finally, Camacho-Cuena *et al.* (2005) move one step further: spatial markets with endogenous prices, but in a context where the *location of the consumers is also endogenous*. Their experiments show that trial-and-error learning is not enough for the consumers to understand that they should locate in the middle – between two sellers –, which would increase competition and reduce prices.

In both experiments with endogenous prices mentioned here, coordination failures constitute an obstacle for the sellers who attempt to avoid central locations to differentiate from the other sellers.

**Oligopolies with fixed quantities and extensions**

The oldest oligopoly theory is the model of Cournot (1838), which differs from what has been surveyed until this point due to the assumption that *firms compete in quantities* instead of prices. The markets of Cournot (1838) have been experimentally studied by Fouraker and Siegel (1963), Holt (1995), Rassenti *et al.* (2000), and Huck *et al.* (2000, 2001b).

As discussed at the beginning of the chapter, a very general result in Cournot experiments is that subjects, by adopting trial-and-error learning, show a behavior that tends to confirm the theoretical predictions of Cournot-Nash. Although this is true on average, there is also certain variability around these predictions. These persistent oscillations decrease the prediction power of the equilibrium. In addition, in repeated-game scenarios, the total quantity is frequently not significantly different from the collusive prediction. In some cases, the total quantity oscillates between the collusive quantity and that of Cournot.

In summary, although moderately positive results regarding the predictive power of Cournot equilibria have been found, it seems that there are fundamental differences in the patterns of the data obtained in the experiments based on *Cournot models* (strategic quantity-setting) and of in the one based on *Bertrand models* (strategic price-setting).

Huck *et al.* (2000) and Altavilla *et al.* (2006) both study markets of price and quantity setting, in a framework of differentiated products, where the Bertrand equilibrium is quite close to the Cournot equilibrium. Even though such experiments generally provide evidence that supports the Nash equilibrium predictions for the two types of markets (price setting and choice of quantity), these works show that the information derived from past strategies and results plays a crucial role.

*Collusion* in Cournot markets *vs.* Bertrand markets deserves a thorough discussion. Suetens and Potters (2007) show that behavioral outcomes in Cournot markets tend to be more competitive relative to equilibrium as compared to those in Bertrand markets. Hence, more collusive behavior is detected on average in price-setting than in quantity-setting oligopolistic markets, with prices in price-setting experiments being above equilibrium prices, and quantities in quantity-setting experiments being above equilibrium quantities (see also Holt 1995, and Engel 2007). Moreover, the scope for tacit collusion in both types of markets is strongly affected by the number of competitors. Basically, implicit collusion is frequently observed in markets with two firms, rarely in markets with three firms, and almost never in markets with four or more firms. This effect has been observed under both Cournot competition (see, e.g., Huck *et al.*, 2004b) and Bertrand competition (see Abbink and Brandts, 2005, 2008; Orzen, 2008).

A famous modification of the model of quantity competition of Cournot is due to Stackelberg (1934), which assumes that one of the two firms (the leader) chooses and commits in a credible way to produce a certain quantity, before the second firm (the follower) chooses its quantity. This model predicts that the total production will be greater than that of the symmetric Cournot model and that, in general, the leader will produce and earn more than the follower. Huck *et al*. (2001a) compare experimentally the markets of *Cournot* and *Stackelberg*. Their results confirm the existence of volatility in the chosen quantities similar to what is obtained in other experiments of production decision-making. In addition, the prediction that in Stackelberg markets a higher total quantity is produced is confirmed and, therefore, such markets are more efficient than Cournot markets. However, the asymmetric nature of the interaction between the leader and the follower

seems to hinder the convergence of the observed behavior towards the theoretical predictions of the Stackelberg model.[8]

Other experiments allow subjects to endogenously choose the moment they would make their strategic decision.[9] That is, before choosing quantities, the firms choose when to produce: in an early or a late period. In these experiments, simultaneous (Cournot) and sequential (Stackelberg) oligopolies can emerge endogenously. On the other hand, Huck *et al.* (2006) experimentally study a spatial market with *endogenous time choice*: in line with actual political campaigns, candidates can decide endogenously when and where to locate. Their results show that allowing for endogenous timing can eliminate some of the more unappealing equilibrium characteristics of the standard model.

In all these environments, the typical asymmetric results corresponding to the leader-follower structures receive less support than expected. In fact, the evidence is in favor of the symmetric results. This even occurs when the corresponding equilibria predict structures of the leader-follower type.

Cournot markets with *multiproduct firms* have received less attention in the experimental literature than corresponding Bertrand markets. A recent experiment by Hinloopen *et al.* (2014) analyzes the impact of product bundling in quantity-setting oligopolistic markets. One firm has monopoly power in a first market but competes with another firm à la Cournot in a second market. They compare treatments where the multi-product firm always bundles, never bundles, and chooses whether to bundle or not. They also contrast simultaneous (Cournot) to sequential (Stackelberg) moves in the duopoly market. Their data support the theory of product bundling: with bundling and simultaneous moves, the multi-product firm offers the theoretically predicted number of units. In the case of sequential moves, when the multi-product firm is the Stackelberg leader, the predicted equilibrium is better attained with bundling, although this equilibrium is the same with and without bundling.

Oligopolistic models with *vertical relationships*, such as that between a manufacturer and a retailer, have received less attention by the experimentalists than the models with horizontal relationships. The basic model predicts that firms that are vertically related and not coordinated will set a total price-cost margin higher than if they agreed on a joint margin. This phenomenon is known as *double marginalization*. Durham (2000) experimentally confirms the importance of the double marginalization phenomenon predicted by the theory. Martin *et al.* (2001) corroborate these ideas in the lab and confirm the predictions of the theory of vertical integration as a means to exclude competitors. Furthermore, Normann (2011) shows that Bertrand markets with a vertically integrated firm are significantly less competitive than those where firms are separate. However, he

---

[8] Kübler and Müller (2002) analyze experimentally markets with price setting designed with the aim of comparing simultaneous and sequential decisions. They highlight the difference between authentic sequential games and sequential strategies obtained through the "strategy method" (subjects are asked what they would do for each choice profile of the other subjects and then the binding case is randomly chosen).
[9] Huck *et al.* (2002a), Fonseca *et al.* (2005, 2006), and Muller (2006) are some of the experimental studies; see also Normann (2002) for a theoretical analysis.

shows that, while his experimental results violate the standard Nash-equilibrium notion, they are consistent with the quantal-response generalization of Nash equilibrium.

Other interesting extensions of the basic oligopolistic model are concerned with the *value of delegating* the strategic decisions of the firms to managers whose incentives are designed to either pursue or deviate from firm's benefits maximization. For instance, rewarding a manager according to the firm's production rather than according to its benefits makes the firm a Stackelberg leader. Huck *et al.* (2004a) test the influential theory of Vickers (1985) and that of Fershtman and Judd (1987) on the strategic role of delegation in oligopoly through the design of incentives for the managers. These experiments study a situation in which the owners of the firm choose whether their managers receive as compensation either a share of firm's benefits or a reward based firm's revenues. Surprisingly, the second option is chosen very few (5%) times.

Georgantzís *et al.* (2008) study an *endogenous compensation system* in an experiment where the firm owners can choose between offering their managers a compensation dependent on a linear combination of own firm's benefits and revenues or one dependent on own firm's benefits relative to the benefits of rival firms. As the theory presented in the paper predicts, the preferred remuneration system is the one based on own firm's benefits compared to those of rival firms.

## Other (ir)regularities

A recurrent aspect in all oligopoly experiments, although it does not constitute a central topic in most of them, is *learning*. In fact, the trial-and-error learning process determines, to a great extent, which outcome is obtained in an oligopolistic market.

Cyert and DeGroot (1973) made an important contribution in this direction, by relating learning to the ability duopolists have in reaching the collusive outcome. It may be that learning in this context does not imply a disclosure of the mathematical properties of the supply and demand model the firm faces. In simple terms: learning is a dynamic process in an individual's decision-making. It is a process that leads him/her from initially uninformed strategies towards the relevant region of the cooperative or non-cooperative equilibrium.

Multiple studies have attempted to identify possible systematic patterns in the learning strategies people have. Many researchers have analyzed adaptive learning (see, e.g., Nagel and Vriend 1999). A common result is that it does not seem that people learn through sophisticated or formal processes. For instance, García-Gallego (1998) and García-Gallego and Georgantzís (2001a) offered participants the opportunity of obtaining linear estimations (from an ordinary least squares model) of the underlying demand and, also, gave them various graphical representations (quantity-price, benefit-price, etc.) of the data from the previous market period. The conclusion in both studies is clear: subjects did not make any effort to systematically calculate the optimal strategy by using explicit optimization, despite the fact that participants were academically advanced students (some of them were even graduate students in economics).

However, learning significantly affects observed behavior, as in most experiments participants' strategies first show a high degree of dispersion (they look almost random), and evolve over time towards the reference solutions, such as the collusive or non-cooperative outcomes. This brings us to an important determinant of the collusive outcome in oligopoly experiments. Mason and Phillips (1997) confirm the importance information has in a duopoly with asymmetric costs. In general, it is important to distinguish between *two sources of information* provided to participants in an experiment:

- Information can be provided *ex-ante*, through the instructions (at the beginning of the experiment).

- Information can be provided *ex-post*, that is, it becomes available as a result of past choices (feedbacks given during the experiment).

Contrarily to what has been suggested by theorists, experimental treatments where information is given prior to the experiment have very little or no effect at all upon the observed behavior, because subjects hardly ever use information that is not immediately interpretable in their decision-making process. Therefore, information about the exact conditions of supply and demand, for instance, has very little effect on observed behavior. This is especially true when these conditions do not provide a "linear" interpretation to supply and demand.

On the contrary, informing participants about the strategies chosen, and even more importantly, about the outcomes obtained by their competitors in previous periods, has a significant effect.

Knowing the outcome of previous choices is not the only source of learning in oligopoly experiments. Various experiments have identified learning processes different from those assumed in the theoretical models. For instance, Huck *et al.* (1999) show that information about other players' strategies plays an important role in the emergence of collusive (rather than non-cooperative) outcomes. In addition, imitation of the most successful competitors appears to be supported by some experimental evidence.[10]

Another important aspect that systematically affects behavior in oligopoly experiments is *inequity aversion* (see Chapter 6). Inequity-averse subjects tend to pursue payoffs similar to those of the competitors, even when the experimental context is initially asymmetric. Admitting a certain level of participants' inequity aversion can explain all those cases in which the theory fails to predict the observed behavior in asymmetric oligopoly experiments. The result of Huck *et al.* (2001b) explicitly relates inequality in payoffs with lack of stability in the Cournot setting. Altavilla *et al.* (2006) find that informing the oligopolists about past prices setted by their competitors leads to quantities closer to those predicted by the Cournot-Nash equilibrium, while providing information about the average benefits of the entire industry leads to higher levels of cooperation.

---

[10] See Offerman and Sonnemans (1998), Offerman *et al*. (2002). For a contrary option see Bosch-Domènech and Vriend (2003).

*Aspiration levels* of the oligopolists also constitute an important factor when looking at the divergence between theoretical and experimental outcomes. Huck *et al.* (2007) show that aspiration levels can be used to explain the merging paradox – where the merged firm ends up earning less despite there is fewer competition in the market after the merger – observed in the laboratory. Indeed, the aspiration-level hypothesis predicts that after the merger a firm has a target profit in mind, the one obtained before the merger, and it will act in order to maintain it also after the merger.

Finally, the role that *risk aversion* has on strategic behavior is evident in Sabater-Grande and Georgantzís (2002), showing how more risk-averse individuals have a lower probability of cooperating in a Prisoner's Dilemma (see Chapter 7): the latter can be interpreted as a limit case (with only two strategies per player) of a Bertrand or a Cournot standard duopoly. Management literature is full of business cases identifying too risky decisions made by the managers. If we acknowledge that the managers may deviate from the pure benefit maximization due to their aspiration levels, to personal and psychological reasons, or due to the incentives in their management contracts, the idyosincratic effects observed in oligopoly experiments can be especially relevant in the decisions firms make in the real world.

The issue of whether the results of laboratory experiments on oligopolistic markets also extend to comparable (real) situations *outside the laboratory* is discussed in Potters and Suetens (2013). They correctly underline that there are several dimensions to this concern. In particular, decision-makers in firms are not students, and firms' decisions are usually not made by one individual acting on his/her own account. About the latter concern, some experimental studies have begun to explore the decisions by groups of individuals (boards) and how these depend on the decision-making procedure in the group. As Potters and Suetens (2013) report, in some cases individuals seem to act very differently from groups, whereas in other cases few differences are found.

**Conclusions**

Experiments on oligopolistic markets have aimed at testing the predictive power of oligopoly theory in explaining observed behavior in experimental settings that implement the conditions established by each model. Although such aim may appear to have limited relevance to the world outside of the laboratory, this line of research has taught us some very interesting behavioral principles. For example, the oligopolistic equilibrium may be the limit towards which the strategies of economic agents who learn by trial and error converge. Further, such learning process has a higher probability of supporting symmetric than asymmetric theoretical predictions. Finally, this learning process, as well as some idiosyncratic features of the experimental participants, help or hinder the corroboration of the theoretical predictions. In any case, in this chapter we have tried to make clear that we are still closer to the beginning than to the end of this thrilling process of understanding about how imperfect markets work.

**References**

Abbink, K. and Brandts, J. (2005) Price competition under cost uncertainty: a laboratory analysis. *Economic Inquiry*, 43, 636–648.

Abbink, K. and Brandts, J. (2008) Pricing in Bertrand competition with increasing marginal costs. *Games and Economic Behavior*, 63, 1–31.

Altavilla, Carlo, Luigi Luini and Patrizia Sbriglia. 2006. "Social Learning in Market Games" *Journal of Economic Behavior & Organization,* 61: 632-652.

Barreda Tarrazona, Ivan, Aurora García Gallego, Nikolaos Georgantzís, Joaquin Andaluz and Augustin Gil. 2011. "An Experimental Study of Spatial Competition with Endogenous Pricing" *International Journal of Industrial Organization*, 29, 74-83.

Bertrand, Joseph F.L. 1883. "Thèorie mathèmatiques de la richesse sociale" *Journal des Savants*, 499-508.

Bosch-Doménech, Antoni, and Nicolaas Vriend. 2003. "Imitation of Successful Behavior in Cournot Markets" *Economic Journal*, 113: 495-524.

Brown-Kruse, Jamie, and David J. Schenk. 2000. "Location, Cooperation and Communication: An Experimental Examination" *International Journal of Industrial Organization*, 18: 59-80.

Camacho Cuena, Eva, Aurora García-Gallego, Nikolaos Georgantzís and Gerardo Sabater Grande. 2005. "Buyer-Seller Interaction in Experimental Spatial Markets" *Regional Science and Urban Economics*, 35: 89-105.

Chamberlin, Edward H. 1948. "An Experimental Imperfect Market" *Journal of Political Economy*, 56(2): 95-108.

Collins, Richard, and Katerina Sherstyuk. 2000. "Spatial Competition with Three Firms: An Experimental Study" *Economic Inquiry*, 38: 73-94.

Cournot, Augustin A. 1838. *Recherches sur les principes mathèmatiques de la thèoriedes richesses*. París: Hachette.

Cyert, Richard, and Morris H. DeGroot. 1973. "An Analysis of Cooperation and Learning in a Duopoly Context" *American Economic Review*, 63: 26-37.

Davis, Douglas D., and Bart J. Wilson. 2005. "Differentiated Product Competition and the Antitrust Logit Model: An Experimental Analysis" *Journal of Economic Behavior & Organization*, 57: 89-113.

Durham, Yvonne. 2000. "An Experimental Examination of Double Marginalization and Vertical Relationships" *Journal of Economic Behavior & Organization*, 42: 207-230.

Engel, C. (2007) How much collusion? A meta-analysis of oligopoly experiments. *Journal of Competition Law and Economics*, 3, 491–549.

Fershtman, Chaim, and Kenneth L. Judd. 1987. "Equilibrium Incentives in Oligopoly" *American Economic Review*, 77: 927-940.

Fonseca, Miguel A., Steffen Huck and Hans-Theo Normann. 2005. "Playing Cournot Although They Shouldn't" *Economic Theory*, 25: 669-677.

Fonseca, Miguel A., Wieland Müller and Hans-Theo Normann. 2006. "Endogenous Timing with Observable Delay in Duopoly: Experimental Evidence" *International Journal of Game Theory*, 34: 443-456.

Fonseca, M.A., and H.-T. Normann (2008), Mergers, Asymmtries and Collusion: Experimental Evidence, *Economic Journal*, 118, 387-400.

Fonseca, M.A., and H.-T. Normann (2012), Explicit vs. Tacit Collusion - The Impact of Communication in Oligopoly Experiments, *European Economic Review*, 56, 1759-1772.

Fouraker, Lawrence, and Sidney Siegel. 1963. *Bargaining Behavior*. Nueva York: McGraw Hill.

García-Gallego, Aurora. 1998. "Oligopoly Experimentation of Learning with Simulated Markets" *Journal of Economic Behavior & Organization,* 35: 333-335.

García-Gallego, Aurora, and Nikolaos Georgantzís. 2001a. "Multiproduct Activity in an Experimental Differentiated Oligopoly" *International Journal of Industrial Organization,* 19: 493-518.

García-Gallego, Aurora, and Nikolaos Georgantzís. 2001b. "Adaptive Learning by Single-Product and Multiproduct Price-Setting Firms in Experimental Markets" Instituto Valenciano de Investigaciones Económicas *WP-AD 2001-2013*.

García-Gallego, Aurora, Nikolaos Georgantzís, and Praven Kujal. 2008. "Experimental Insights into the Efficiency of Alternative Water Management Institutions" *Game Theory and Policy Making in Natural Resources and the Environment*. Dinar, A., J. Albiac and J. Sánchez Soriano, eds. 209-235. Londres/Nueva York: Routledge, Taylor & Francis Group.

García-Gallego, Aurora, Nikolaos Georgantzís, and Gerardo Sabater Grande. 2004. "Identified Consumers: An Experiment on the Informativeness of Cross-Demand Price Effects" *Cuadernos de Economía*, 27: 185-216.

Georgantzís, Nikolaos, Constantine Manasakis, Evaggelos Mitrokostas, and Emanuel Petrakis. 2008. "Strategic Delegation in Experimental Duopolies with Endogenous Incentive Contracts" *Working Papers 0809*. University of Crete, Department of Economics.

Harstad, Ronald, Stephen Martin, and Hans-Theo Normann. 1998. "Intertemporal Pricing Schemes: Experimental Tests for Consciously Parallel Behavior in Oligopoly" *Applied Industrial Economics.* L. Phlips, ed. 123-151. Cambridge: Cambridge University Press.

Hinloopen, J., Müller, W., and H.-T. Normann (2014), Output Commitment Through Product Bundling - Experimental Evidence, *European Economic Review*, 65, 164-180.


Holt, Charles A. 1995. "Industrial Organization: A Survey of Laboratory Research" *Handbook of Experimental Economics.* Kagel, J., and A. Roth, eds. 349-444. Princeton: Princeton University Press.

Hong, James T., and Charles R. Plott. 1982. "Rate Filing Policies for Inland Water Transportation: An Experimental Approach" *Bell Journal of Economics,* 13: 1-19.

Hotelling, Harold. 1929. "Stability in Competition" *Economic Journal*, 39: 41-57.

Huck, Steffen, Wieland Müller, and Vicky Knoblauch. 2006. "Spatial Voting with Endogenous Timing" *Journal of Institutional and Theoretical Economics*, 162: 557-570.

Huck, Steffen, Wieland Müller, Kai Konrad, and Hans-Theo Normann. 2007. "The Merger Paradox and Why Aspiration Levels Let it Fail in the Laboratory" *Economic Journal*, 522: 1073-1095.

Huck, Steffen, Wieland Müller, and Hans-Theo Normann. 2001a. "Stackelberg Beats Cournot-on Collusion and Efficiency in Experimental Markets" *Economic Journal*, 111: 749-766.

Huck, Steffen, Wieland Müller, and Hans-Theo Normann. 2002a. "To Commit or Not to Commit: Endogenous Timing in Experimental Duopoly Markets" *Games and Economic Behavior*, 38: 240-264.

Huck, Steffen, Wieland Müller, and Hans-Theo Normann. 2004a. "Strategic Delegation in Experimental Markets" *International Journal of Industrial Organization*, 22: 561-574.

Huck, Steffen, Wieland Müller, y Nicolaas J. Vriend. 2002b. "The East End, the West End, and King's Cross: On Clustering in the Four-Player Hotelling Game" *Economic Inquiry*, 40: 231-240.

Huck, Steffen, Hans-Theo Normann, and Jorg Oechssler. 1999. "Learning in Cournot Oligopoly: An Experiment" *Economic Journal*, 109: 80-95.

Huck, Steffen, Hans-Theo Normann, and Jorg Oechssler. 2000. "Does Information About Competitors Actions' Increase or Decrease Competition in Experimental Oligopoly Markets?" *International Journal of Industrial Organization*, 18: 39-57.

Huck, Steffen, Hans-Theo Normann, and Jorg Oechssler. 2001b. "Market Volatility and Inequality in Earnings: Experimental Evidence" *Economics Letters*, 70: 363-368.

Huck, S., Normann, H.-T. and Oechssler, J. (2004b). Two are few and four are many: number effects in experimental oligopolies. *Journal of Economic Behavior and Organization*, 53, 435–446.

Kelly, Frank. 1995. "Laboratory Subjects as Multiproduct Monopoly Firms: An Experimental Investigation" *Journal of Economic Behavior & Organization*, 27: 401-420.

Kübler, Dorothea, and Wieland Müller. 2002. "Simultaneous and Sequential Price Competition on Heterogeneous Duopoly Markets: Experimental Evidence" *International Journal of Industrial Organization*, 20: 1437-1460.

Martin, S., Hans-Theo Normann, and C.M. Snyder. 2001. "Vertical Foreclosure in Experimental Markets" *Rand Journal of Economics*, 3: 466-496.

Mason, Charles F., and Owen R. Phillips. 1997. "Information and Cost Asymmetry in Experimental Duopoly Markets" *Review of Economics and Statistics*, 49: 290-299.

Müller, Wieland. 2006. "Allowing for Two Production Periods in the Cournot Duopoly: Experimental Evidence" *Journal of Economic Behavior & Organization*, 60: 100-111.

Nagel, Rosemarie, and Nicollas J. Vriend. 1999. "An Experimental Study of Adaptive Behavior in an Oligopolistic Market Game" *Journal of Evolutionary Economics*, 9: 27-65.

Normann, Hans-Theo. 2002. "Endogenous Timing with Incomplete Information and with Observable Delay" *Games and Economic Behavior*, 39: 282-291.

Normann, H.-T. (2011), Vertical Mergers, Foreclosure And Raising Rivals' Costs – Experimental Evidence, *Journal of Industrial Economics*, 59, 506-527.

Offerman, Theo, Jans Potters, and Joep Sonnemans. 2002. "Imitation and Belief Learning in an Oligopoly Experiment" *Review of Economic Studies*, 69: 973-997.

Offerman, Theo, and Joep Sonnemans. 1998. "Learning by Experience and Learning by Imitating Successful Others" *Journal of Economic Behavior & Organization*, 34: 559-576.

Orzen, H. (2008) Counterintuitive number effects in experimental oligopolies. *Experimental Economics*, 11, 390–401.

Plott, Charles R. 1982. "Industrial Organization Theory and Experimental Economics" *Journal of Economic Literature*, 20, 1485-1527.

Potters, J., and S. Suetens (2013). Oligopoly experiments in the current millennium. *Journal of Economic Surveys*, 27, 439-460.

Rassenti, Stephen, Stanley S. Reynolds, Vernon L. Smith, and Ferenc Szidarovszky. 2000. "Adaptation and Convergence of Behavior in Repeated Experimental Cournot Games" *Journal of Economic Behavior & Organization*, 41: 117-146.

Sabater-Grande, Gerardo, and Nikolaos Georgantzís. 2002. "Accounting for Risk Aversion in Repeated Prisoners' Dilemma Games" *Journal of Economic Behavior & Organization*, 48: 37-50.

Smith, Vernon L. 1962. "An Experimental Study of Competitive Market Behavior" *Journal of Political Economy,* 70: 111-137.

Smith, Vernon L. 1964. "The Effect of Market Organization on Competitive Equilibrium" *Quarterly Journal of Economics*, 78: 181-201.

Suetens, S., and J. Potters (2007). Bertrand colludes more than Cournot. Experimental Economics, 10, 71-77.


Vickers, John. 1985. "Delegation and the Theory of the Firm" *Economic Journal*, 95: 138-147.

Von Stackelberg, H. 1934. *Marktform und Gleichgewicht*. Berlín: Julius Springer.