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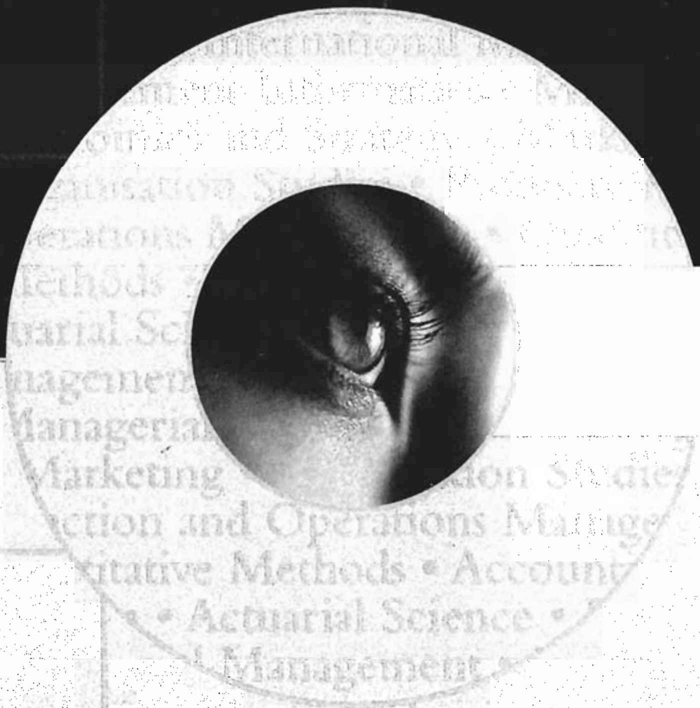

RESEARCH REPORT

INDUSTRIAL ORGANIZATION AND THE ECONOMICS OF BUSINESS STRATEGY

RAYMOND DE BONDT • JAN VANDEKERCKHOVE

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Raymond DE BONDT and Jan VANDEKERCKHOVE

Department of Applied Economics
Catholic University of Leuven, Leuven, Belgium

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Abstract

Industrial organization (IO) has an important role to play in inspiring the competition and regulation policies of the government. At the same it can be used to clarify the economics of business strategies. The idea here is not to give a comprehensive review, but to draw attention to some striking tendencies, prospects and problems of the field of IO as a source of inspiration for competitive strategies. A first focus will be on credible market strategies and asymmetric information, with implications for internal organization, vertical foreclosure and markets with switching costs. A second point will look at detection of not so obvious possibilities, as there are lower prices with cooperation, disadvantageous mergers, positive side effects for rivals, and disadvantageous price discrimination. Finally some approaches will be discussed to problems concerning high requirements on rationality and lack of robustness. An example will be discussed of a search for robustness in strategic investment models in oligopoly settings with leaders and followers.

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1. Introduction

The original contributions of the field of industrial economics or industrial organization, IO hereafter, are situated just before the Second World War. The pioneers of IO used very simple theoretical models and detailed case studies. The main focus was on the analysis of industries. The idea was that it is often not possible to achieve perfect competition, and moreover it may not be desirable. Likewise monopoly often has, expect in special circumstances of natural monopoly, more economic disadvantages than advantages. A search was launched for the lines of structure and conduct that could define a window of workable competition, with better economic performance. An important underlying idea was that competition policy cannot be left to politics alone. There exist sound and robust economic reasons why certain windows of structure and behavior are better than others. The main task of the field of IO is to find, explain and apply those reasons, taking into account the relevant legal and economic policy environment (Carlton and Perloff (2005)). And today the mainstream IO is still traveling this very important road. A related branch tries to analyze the economic and political rationality of government regulation and non market strategies of firms (Baron (2003)).

From 1980 on, scholars at the Harvard Business School began to employ IO inspired thinking and analysis to understand and to develop market strategies (Porter (1980, 1988)). Such strategies are focused on achieving sustainable economic profits in competitive environments. Business strategies can of course develop along several routes and the IO based approach has to share influence with many other disciplines, such as strategic management and organizational behavior. Five competitive forces were identified originating from the rivalry between existing competitors, the threat of entry and substitutes, and the bargaining with suppliers and customers. The idea was that better insights into the structure and conduct of relevant competition would help to identify generic profit enhancing strategies, such as low cost and differentiation. This approach was a step forward compared to popular portfolio matrices or learning curve strategies, that were either silent on the link with the competitive environment or employed a too simple framework (Ghemawat (2001)). The IO inspired approach to strategy is alive and well. It is particularly strong in providing a better logic to competitive market strategies, taking into account the complexity of the environment and the organization of the firm (Besanko et al (2000)).

The applications of IO have grown, but so have the employed methodologies for theoretical analysis and empirical verification. The intention here is not to present an overview of the vast and expanding contributions. The idea is simply to draw the attention to some striking tendencies, prospects and problems of the field of IO as a source of inspiration for competitive business strategies. The focus will be on credible market strategies, coping with asymmetric information, and detecting not so obvious possibilities. Problems that will be discussed concern the high requirements on rationality, the low operational impact of some contributions and the lack of robustness.

2. Credible market strategies

The importance of credibility has been highlighted in many cases, such as, for example, situations where market protection may be attempted.

2.1. Strategies with potential entry

The IO methodology was invaded around the 1970's by the Samuelson decision theoretic tradition. Rather complicated mathematical optimization techniques (e.g. calculus of variation and control theory) were used to analyze some of the major pioneering theories, such as limit pricing (Kamien and Schwartz (1981)). This influential theory had been developed in the 1950's on both sides of the Atlantic. It claimed that incumbent firms would set a limit price, which is the highest price that would not attract new entry (Bain (1959)). This price and the resulting profits would be higher the higher the barriers to entry, resulting from economies of scale, product differentiation and absolute cost advantages. Sophisticated decision theoretic models refined and by and large confirmed the predictions on the effects of barriers to entry. They also found, however, that firms typically will not want to set a limit price. They may practice some price restraint in an attempt to discourage the fast appearance of new rivals, without attempting to exclude new rivalry forever. Short run maximization, with marginal revenue equal to marginal cost, would only apply with blockaded or with (almost) free entry (De Bondt (1976)). This is probably what common sense and casual empiricism suggested. The more sophisticated theoretical analysis thus was able to build a better bridge to real world pricing strategies in markets with imperfect competition. Case studies of incumbent pricing behavior for new main computer systems and for plain paper copiers, as well as extensive empirical work, subsequently confirmed the relevance of these theoretical contributions.

The decision theoretic models were to disappear quickly from the top chart of methodologies. Contributions to a new IO began to flourish in the 1980's. This new IO began to employ heavily the methodology of game theory, with focus on games of strategy and implications of information asymmetries. Old questions were revisited. Is it rational for an incumbent firm, for example, to practice price restraint to discourage future entry? Earlier decision theoretic models incorporated features that steered towards a positive answer. But a game theoretic approach of this problem provided different and richer insights. With a lack of uncertainty and no information asymmetries a low price can not credibly signal low prices and low profitability in the given future. It may then be better for a rational incumbent to accommodate entry and rational entrants will anticipate this. A credible strategy for the incumbent is to maximize short run profits and let entry in. The established firm will search for other non price strategies to limit new competition. These include, for example, excess capacity, advertising and patent protection. Only with asymmetric information or uncertainty could price restraint emerge. The new IO thus predicted that price restraints in the spirit of limit pricing would not be used very frequently. Surveys of market protection strategies used by marketing and production managers confirmed these tendencies.

In markets with consumer switching cost a more sophisticated play with entry and exit emerges (National Economic Research Associates (2003)). Switching costs are related to transactions costs (e.g. change bank accounts), compatibility costs (e.g. software and hardware), learning cost (e.g. investments in product specific knowledge), contractual provisions (e.g. loyalty discounts), uncertainty cost (e.g. with experience goods), and psychological adjustment costs. In many settings there is a start up phase followed by a mature phase (e.g. computer equipment to educational market segments to generate future sales from current students). Customers that are locked in because of consumer switching costs will have lower price elasticity in the mature phase. But prices in the initial phase will have to be lower to generate sufficient base of locked in clients. It may even be possible to price below cost in the first phase, as the second phase allows a price above cost ("bargain followed by rip off"). Very high switching cost act as a classic barrier to entry. New entrants have to set a too low price to overcome the difficulties of switching and this may prevent recouping sunk costs. But moderate switching cost may encourage entry, because post entry profits are expected to be higher in the mature phase. This is because incumbents will react less aggressively in response to entry, while the size of entry is likely to be small, since it has to focus on a limited segment of customers that are not locked to the incumbent.

It thus became possible to understand better the rationale of a wide set of business strategies and tactics. Dynamic strategies on capacity choice, for example, have fruitfully been applied through the careful and detailed study of cases and game theoretic analysis. At the same time it also became clear why non price strategies, such as excess capacity, very often will not be used in a strategic manner. With large-scale entry, for example, the incumbent may lose a lot. Building excess capacity to credible signal a price war may be justified and entry may be forestalled. But business strategies focused on pre-emption tend to be unwise with rapid or uncertain growth of demand, or when capacity can easily be deployed elsewhere, when a small scale entrant has little cost disadvantage, or when the incumbent can easily expand output ex post. They tend to be a better idea with natural monopoly situations, slow growth in demand, low uncertainty, irreversible investments, and first mover advantages because of a head start and learning curve tendencies. All in all successful pre-emption tends to be relatively rare (Lieberman (1987)).

2.2. Credible contracting

New insights into competition policy also emerged, for example with respect to foreclosure (Rey and Tirole (2003)). In the Chicago tradition an upstream monopolist could not extend its monopoly position into a competitive downstream industry. Only one monopoly profit is to be gained and the monopolist can achieve this, by engaging in appropriate contracts with downstream buyers. It can, for example, extract sufficiently high prices (or tariffs). There is, in other words, no need to exclude downstream firms from the usage of the monopoly input. In reality, however, the contracts and the negotiations between the upstream monopolist and each of the downstream suppliers may be secret. Credible contracts may no longer allow the extraction of all monopoly rents. With two upstream suppliers, for example, the monopolist may only be able to extract the Cournot-Nash type duopoly profits. With more than two suppliers the total downstream profits that can be extracted go down further and the monopolist has an incentive to limit the supply of its input.

The upstream monopolist faces a credibility problem in negotiating and writing the contracts with downstream firms. (A monopolist selling a durable good to rational consumers faces a similar problem). It may negotiate a contract with two downstream firms, extracting for example a high fixed fee with the promise that no one else will obtain supply. But once the contract is signed, the monopolist has an incentive to break his promise. Supplying additional firms will give additional profit to the monopolist. This to the disadvantage of the earlier two suppliers, but that is their problem. Of course, if the downstream firms can anticipate this opportunistic behavior of the monopolist, they will not agree in the first place. The upstream supplier thus has an incentive to seek a credible promise to give exclusivity. In other words this firm will seek to foreclose all but some downstream firms. This is done not to extend its monopoly power, but simply to obtain the profits of its existing monopoly position. The monopolist can use for this several instruments such as exclusive dealing, vertical integration, retail price floors, developing and maintaining reputation for exclusive dealing, and limitation of its productive capacity.

3. Coping with asymmetric information

Modern game theory allows studying games of strategy with limited information of participants in markets and firm organizations.

3.1. In markets

A new entrant in a market, for example, may not be sure about the type of incumbent it faces. Maybe the incumbent is "normal" in that it will accommodate new competition, or maybe it is an "aggressive" type that will start a price war as soon as a new rival appears. Given that the entrant has information on payoffs it can compute for what kind of a priori assessments it should enter or stay out the market. With more periods and entrants the problem quickly becomes more complicated. Players have to know how to rationally update their beliefs. It is now possible that a normal entrant engages in aggressive behavior, while it would not do that in a world with complete information.

Along similar lines modern theories have explained circumstances where it may be rational to engage in limit pricing to signal low costs to the entrants (Bagwell and Wolinsky (2002)). Suppose that the incumbent can be of a low or high cost type and that initially only the incumbent knows it own type. Let the entrant initially believe that there is only a small probability that the incumbent is low cost. A high cost incumbent than is likely to face entry anyway and will set a short run monopoly price, to make hay while the sun shines. A low cost firm could practice some price restraint, but this will not discourage entry. When the entrant thinks that a low cost incumbent is rather likely, a high or a low cost type may both use low prices to signal low cost. The entrant will then learn nothing from this behavior and will not enter the market. The question remains whether it is ever rational for an incumbent to engage in costly signalling through sacrificing low profits. It could for example credibly reveal a cost situation through hiring accountants to certify cost.

A position exists teaching that predatory pricing (selling with a loss) is not rational. Large losses may have to be incurred today and it may be difficult to recoup them in the future. Customers may, for example, react to the attempts to monopolize, by supporting higher price victims. It may be difficult to raise future prices because they may invite new entry. It may be cheaper and more efficient to simply acquire rivals instead of driving them out; and so on ... But things are likely to be more complicated in markets with asymmetric information (Bolton a.o. (2000)). For example, engaging now and then, not often, in aggressive pricing may help to build a reputation for a tough incumbent. The intention here is not so much to drive out rivals in the markets where low prices are applied, but more to discourage new entry in markets that are still secure today. Setting low prices that smaller and weaker rivals have to follow may also scramble their relations with their banks. Profitability then looks less good than was planned. The banks or other capital providers do not know with certainty if this results because of bad management or simply bad luck. In any case they will want to be compensated for the increased risk and this will indirectly make the small rival a weaker rival. Or aggressive low prices may render market demand less high than was planned and this may lead central management to question the progress of the new business unit. Insights into these and related possibilities can help to develop counterstrategies, such as there are coalitions between the predator victim and its customers bypassing the predator, coalitions among victims coordinating a defensive strategy, counter-threats by the victim to enter the predator's other markets, customer stockpiling, and sale of victim's assets to a successor firm if the victim fails. All of these practices may be of relevance in "new" markets, such as those transacting high tech products, where asymmetric information is present, and where sustainable market structures still have to be determined and reputations still have to be built.

3.2. In firm organizations

The focus on asymmetric information in economic theory also stimulated a better understanding of internal organization. IO was traditionally concerned mainly with the external market environment. But business strategies also need to fit with the organization of the firm, i.e. with the people, architecture, routines and culture. More and more IO has expanded to look at both market and firm organization. Suppose, for example, one is interested in understanding the boundaries of the firm. Firms exist because they can do certain things better than the market. European firms may, for example, outsource production activities to China and other regions, while keeping other activities such as design and marketing in the company at home. Firms could as well do everything in the same firm, but using several firms and market transactions between them, allows generating more economic added value. The search for more added value thus results in using contracts and organizations. Transaction cost theory says that transactions can more easily be outsourced if they are simple, with easy to measure performance, little connections to other activities, and little use of specific assets. And the related theory of incomplete contracts learns that it is best to allocate ownership to the firm whose specific investments contribute most to the value of the transactions. This is given that these investments increase the value of the parties outside the relationship. If this is not the case it may be better to give access to the use of assets and not ownership. Casual empiricism or empirical tests confirm these predictions of (modern) transaction cost theory.

The expanded new IO has also been rather successful in explaining the impact of contractual stipulations on performance of individuals (or units). In many cases a principal (e.g. a boss) delegates some activity to agents (e.g. employees). In a first best world the principal would know everything all the time. But such a world entails usually very high costs of monitoring. In a second best environment, the principal accepts that he can not know with certainty what the agent is doing. The best the principal can do, then, is to give incentives to the agent such that the agent is willing to work and will do what he is expected to do.

Agency theory solves this problem and confirms that explicit pay per performance incentives sometimes can be used. The intensity of the explicit incentives should be lower, the more risk averse the agent is, the less the agent can contribute to performance, the higher the cost for the agent of increasing efforts and the higher the uncertainty that surrounds the relation between efforts and performance. With stronger incentives it is best to increase monitoring. When agents have to perform several tasks, however, it is often unwise to give strong explicit incentives. Indeed, it is often hard to fine tune strong incentives so that all tasks get equal attention. It may be better to give low or no explicit incentives (e.g. a fixed wage) or to assign different tasks to different individuals. The implications of these and similar results for firm organization and human resource management are clear and have been well documented (Baron and Kreps (1999), Roberts (2004)).

4. Detecting not so obvious tendencies

A good rule of thumb for an economist or manager is to be very critical of counterintuitive insights. They could be artifacts, resulting from some peculiar assumptions. Of course one can not extend this point to mean that simple intuition or common sense will always be the best guide. This can not be true either, since there is always the possibility that the reasoning overlooks something important. It does mean that if an unexpected claim turns up, it is best to see what drives it and to check whether or not some slight twist may alter the findings.

4.1. Lower prices with cooperation

Sometimes this can easily be done with a little help from IO. Suppose it is reported that an airline alliance between two companies result in lower prices. Before and after the alliance took effect airlines were competing in prices. Let us assume for the clarity of the exposition that no explicit cost savings can be detected and that the marginal cost of carrying an extra passenger is zero. Is it then possible for prices to be lower? Should cooperation not result in higher prices?

Cooperation would result in higher prices if the goods of the rivals are substitutes, i.e. if the airlines were to compete with output (capacity) on the same connections. But suppose the airlines serve connecting legs of a trip and compete with prices. The demand for the total flight would be

$$Q = Q\,(P_1 + P_2) \tag{1}$$

with negative slope and P_i the price of each leg of the trip, i=1,2. Suppose that each firm choses its price independently. It then gives a negative externality to its rival. With cooperation the sum of the prices will be lower, since the alliance will internalize this negative externality.

Cournot already pointed this out in 1838. The complementary goods pricing problem with (1) is the dual of the usual, better known, Cournot model with:

$$P = P\,(Q_1 + Q_2) \qquad (2)$$

and quantity choices Q_i, $i=1,2$. Empirical evidence supports the lower price tendencies for international airline alliances (Brueckner and Whalen (2000)).

4.2. Disadvantageous mergers

In other situations some more IO reflection is needed. Take the example of mergers (and acquisitions). Extensive empirical research and case studies show that many of the horizontal mergers result in lower sales and profits, in other words a negative synergy. Consider the analysis of a large data set of mergers in the world over a recent time span of 1981 - 1998 (Gugler a.o. (2003)). From the nearly 70.000 announced mergers across the world, about 45.000 were actually completed. On average significant increases in profits and reduction in sales resulted. But almost 10.000 divestitures were carried out and about 1/3 of the remaining mergers resulted in smaller sales and profits.

Various explanations for unprofitable mergers can be given, including herd behavior, empire building of managers, difficulties in realizing synergies ex post, etc. It is well known that looking at a simple Cournot-Nash industry adds another explanation: the reaction of outsiders may reduce ex post merger profits. Some relevant tendencies can be calculated for a homogeneous good oligopoly, with n members and m firms merging, $2 \leq m \leq n$. They reflect attempts to increase market power by merger. A merger results, by definition, in synergy when the contribution to profit of the merged entity is bigger than the sum of the profits of the members before the merger. This will be the case if and only if:

$$[(n+1)^2 - m \times (n-m+2)^2] > 0 \ , \qquad (3)$$

A merger of all firms, m=n, will generate synergy. But a merger say of half of the enterprises, m = n/2, would generate no synergy. The tendency within (3) is that 80 % or more of the firms should merge for synergy to result. This result is also driven by the assumed symmetry of the firms before the merger. It can also be verified that followers typically will benefit from the merger. They only adjust their output and reap higher benefits. For an industry with n=3, for example, this is easily explained. The merger of two firms leads to a reduction in their output in an effort to increase market price. The third firm continues to compete à la Cournot Nash and expands output. The end result is better for the outsider and worse for the merged enterprises. Only a merger of the 3 firms does generate synergy.

But disadvantageous mergers present some rather counterintuitive tendencies. After all rivals could just sit back and let others merge. Their profits would increase. One can of course modify the results to more reasonable tendencies, where mergers are profitable, by allowing the merger to realize cost savings or other sources of synergies. In a more complicated setting, for example, where cooperation of m<n firms in R&D precede quantity rivalry, one can show that even a small efficiency improvement within the joint venture, through better knowledge transfer, would result in synergy and better profitability than outsiders.

But the framework can also be adapted to allow the merged firms to act as Stackelberg leaders. Two scenarios can be looked at:

- The merger of m firms results in one company that is going to act as a Stackelberg leader. The n – m outsiders choose independently from each other output as followers. After the merger n – m + 1 firms remain,
- the merger brings two followers in one company. That company will choose output as a Stackelberg leader together but independently from choices of k existing leaders. The number of remaining followers is n – k – 2 = (n – 1) – (k+1). And n - 1 enterprises remain after the merger.

Both settings are mathematically identical when m=2 is set in the first scenario together with k=0 in the second. With linear demand and unit cost it is possible to explicitly compute the relevant performance variables. This exercise suggests a number of tendencies. In the first scenario a merger results in a price increase. The merger will typically allow a synergy, only with m= (n+1)/2 there is no positive or negative synergy. For example, a merger of 2 firms generates no synergy in a Cournot Nash industry with 3 enterprises. But if the merger acts as Stackelberg leader it has no effect on synergy. But a merger of 2 firms in a 10 firm industry would result in synergy if the merged firm acts as a leader. With many firms merging and acting as a leader it is possible that outsiders do better and so stability of the merger needs to be investigated (e.g. no member wants to leave and nobody wants to join). In the second scenario the merger also creates synergy (see also Daughety (1990)) and followers do worse than leaders. The merger results in a price decrease if the existing group of leaders is small. Otherwise price will increase.

One of the problems with the analysis above is that the choices of output are not subgame perfect. The Stackelberg leaders only correctly anticipate the reaction function of the followers. But given the output choice of the latter they typically will want to change their original output choice. Perhaps high cost of adjustment could prohibit such a change. But lacking the power to commit the Stackelberg outputs could unravel into the Cournot Nash equilibrium and mergers could result in lower profits and sales. More sophisticated treatments of endogenous coalition formation are thus needed and have been developed in IO contributions.

4.3. Negative or positive side effects for rivals

Competitive strategies will often tend to change the game that rivals play. In case, for example, that a firm decides to rapidly expand capacity it may be trying to pre-empt the market or credibly signal its willingness to flood the market should entry occur. Firms may then choose capacities that are larger than non-strategic profit maximization dictate and this will hurt profitability of rivals. But this, of course, is not the only possibility. One can construct taxonomy of possibilities with the aid of a strategic investment model (Tirole (1988)). It turns out that firms may also adopt strategies that benefit rivals. Demand enhancing or cost reducing R&D, for example, may create large positive knowledge spillover to rivals. These spillovers may benefit the profitability of rivals. R&D efforts will then be lower than those that ignore the strategic interactions.

Strategic moves may also share similar characteristics and seeing this helps to classify and to understand. Consider for example the practice of technological tying. Some software programs work best together; toners are specific to printers, etc... Suppose that a firm has a monopoly position for a product A. It also supplies product B, but so do other companies in competitive conditions. The monopolist has the choice between selling the products independently or tying them (sell them as a bundle). The price of the bundle can not be higher than the sum of the prices if sold independently. And the price of the unbundled B must equal the competitive price. Hence tying can give no additional profit. Thus there is no point in trying to extend the monopoly position in A through tying to the market B?

But tying may help to maintain the monopoly position in A. Through credible technological tying the monopolist creates a tendency to offer a lower virtual price of B in the bundle. Price rivalry in an oligopoly that supplies B will thus result in lower prices. In other words, rivals will have to respond to the bundle with lower prices. In the presence of high fixed cost this may render their economic profits negative. They may be foreclosed from the market. Tying then result in a lower profitability today, for the monopolist, but in a higher value of discounted cash flows, because rivalry is reduced in the future. So in a strategic setting, firms will practice technological tying more than non-strategic reasoning implies, and this will also reduce profitability of rivals. These features are similar to the ones that accompany build excess capacity.

4.4. Disadvantageous price discrimination

Firms practice price discrimination to capture a larger part of created economic surplus. A firm price discriminates when the ratio in prices is different from the ratio in marginal cost for two similar (possibly identical) goods offered by the firm. It is often called price customization in business pricing literature (Dolan and Simon (1996)). Price discrimination can take various forms depending on whether it is directly or indirectly applied, or whether the different prices refer to different customers (interpersonal) or to the same person (intrapersonal) (Stole (2001)). It requires some form of market power, a capacity to segment consumers, while arbitrage across differently priced goods must be infeasible.

The classic case of so-called third degree price discrimination involves uniform prices varying across distinct consumer groups so it is purely interpersonal. A monopolist can always improve its profitability by applying this, rather than a uniform price for all customers. This provided that price elasticities (at the optimum) differ for the various groups. The optimum prices follow from the inverse elasticity-pricing rule that states that the ratio (P – c)/P, with c constant unit cost, should be equal to 1/absolute value of the price elasticity.

In a Bertrand-Nash equilibrium the optimal rule still applies, say in a duopoly where each rival is serving two market segments, with low and one with high demand. The relative divergence above marginal cost c in each segment for each rival is then equal to the inverse of the absolute value of the rivals demand in that segment. The symmetric prices in the low segment P^L will be lower than a uniform price over all segments P^U. This price will be lower than the price in high segment P^H, or :

$$P^L < P^U < P^H \qquad (4).$$

And it can be shown that $(P^U - c)/P^U$ is smaller than the average of $(P^L - c)/P^L$ and $(P^H - c)/P^H$. But this does not imply that the price customization with P^L and P^H is always better for the profits of the duopolists than the uniform price P^U. Price discrimination may improve but may also reduce profitability in duopoly or oligopoly markets!

IO theory describes the circumstances that make price discrimination disadvantageous in oligopoly. It is possible to see the non-trivial character of this phenomenon by looking at a simple example (Besanko (2001)). Suppose two firms Alfa and Beta each have a loyal market of 500 customers that will stay with them as long as they pay a price below 3$. There is also a market with 1000 shoppers. Alfa gets a share of the shoppers that is equal $[½ - 0{,}4 \times (P_\alpha - P_\beta)]$. The share of Beta is

[½ - 0,4 x (P_β - P_α)]. Marginal costs are zero. It is possible to compute the contributions to profits corresponding to a strategy of a uniform price for loyal customers and shoppers, or a different price for both groups of customers, see Figure 1.

The dominant strategy is to price discriminate. But if all of rivals do so they will be worse of then with a uniform price. So it looks like the possibility of disadvantageous price customization is not an artifact to be ignored. Marketing people seem to be aware of this possibility, for example in the context of coupons. Coupons entitle customers to a lower price in the store. They tend to segment the market in

		Beta	
		uniform	discrimination
Alfa	uniform	2500 2500	2611 1736,11
	discrimination	1736,11 2611	2125 2125

Figure 1. : Contribution to profits in duopoly with loyal customers and shoppers.

a segment with price conscious customers (with high price elasticity) and another segment with customers that care more about quality and do not bother to search for the lowest price (with lower price elasticity). Consumers self select to what segment they belong. But a widespread use of coupons by all rivals may result in lower profitability for all of them. Firms will then try to commit to more uniform prices, for example through a policy of firm listed prices, every day low prices, little or no coupon activity and limited sale frequencies.

A similar unexpected prisoner's dilemma has been detected in the context of vertical integration. It is well known that an upstream monopolist manufacturer has an incentive to vertically integrate with a downstream monopolist distributor. This integration is one mechanism (not the only one) to eliminate double profit margins, also called double marginalization. But suppose one looks at a duopoly in manufacturing, with each rival delivering goods to one of the two downstream distributors. Then it may well turn out that vertical integration is a dominant strategy, but no vertical integration would still be better for both upstream rivals (Wu (1992)). This may suggest that other reasons such as a search for exclusivity or transaction cost consideration may be more important in real world vertical integration strategies.

5. Bounded rationality

Economists assume that people and firms behave as if they are rational. This hypothesis has proven to be very useful to develop theories that allow a better understanding of complex phenomena. The level of sophistication of the underlying reasoning has not declined with the import of game theory and asymmetric information settings. Managers could clearly gain by thinking through the game played with their rivals when they design or think about their competitive strategies. But they do not seem to do much anticipating of this sort: according to one survey, for example, only 5% consider anticipated future competitive reactions important enough to incorporate them into strategic decision making. The most commonly cited reason is that the uncertainties of the real world make it far too risky to base strategic moves on such considerations. But even if this were correct - and there is no evidence that it is - competitors do not stand still, suggesting that ignoring their moves is not the answer (Cassiman and Ghemawat (2004)). It is also possible that the skeptical managers behave as if they take into account other strategies. They may adapt their choices depending on success and failure and may move towards some Nash equilibrium. This argument may rescue the rationality hypothesis when one is looking at simple Cournot Nash or Bertrand Nash equilibriums. But it should not give a peace of mind when looking at backward induction arguments. Experiments such as the ultimatum game, for example, suggest that people are not so good in thinking backwards through a game. Education of managers and economists using IO tools certainly does have a role to play. One should on the other hand not underestimate the possible degree of sophistication in the real world. Years ago, one of the authors was approached to help with a problem of fair division of cartel profits between some major European players. It required application of some known sophisticated concepts of cooperative game theory. What one would think is abstract theory, they already had computed and made operational.

Note also that modern game theory may provide new tools that make precise aspects of bounded rationality. People may herd in their behavior, for example. They may act according to a public belief independent of their private information. But this behavior is rational in some sense, it reflect a form of social learning and can be explained using Bayesian updating of probability assessments. The use of rule of thumbs can also be understood better. This can be illustrated as follows.

5.1. Rule of thumbs and cooperation

Cooperation between independent firms (or between individuals) is difficult because of the prisoner's dilemma problem. It is best to cheat on the agreement, whatever the other party does. But the outcome will be worse if everyone deviates than if cooperation prevails. This problem has been familiar to humans (and a number of animals) for thousands of years. Humans have figured out several solutions, including central command and enforcement, cultural norms and rules, contracts and reciprocity.

Note that a repetition of the same game doesn't make things simpler. Suppose the game is the standard prisoner's dilemma with each of the two players having two strategies: cooperate or defect. This game can be played in each period, where at the end of the period the choices of that period are revealed to the other player. If two periods are played each player has $2 \times 2^4 = 2^5 = 32$ strategies or plans of action. If 3 periods are played each player has $2 \times 2^4 \times 2^{16} = 2^{21} = 2.097.152$ strategies. With 4 periods each player has to look at $2 \times 2^4 \times 2^{16} \times 2^{64} = 2^{85}$ plans, which is an incomprehensible astronomical number. Now some of the strategies can be eliminated, but to do that one would presumably have to grasp them. Clearly this is impossible. And still most humans feel that cooperation is easier with repeated interactions. The reason may well be that people have figured out good rules of thumb (automata) to cope with the complexity of the repeated game. One rule is to start with cooperation and from the second period on, players reciprocate what the rival did in the previous period. Experiments and analysis suggests that this will generate cooperation without interference of the central authority. This means that it is perhaps not so difficult for firms to silently cooperate without them forming an explicit cartel like organization or authority. But it will not always work and hence there are incentives to collude explicitly even if it is illegal to do.

To understand why cooperation out of self-interest may work, it is convenient to look at a slightly simpler rule of thumb, known as a grim strategy. The grim strategy is also friendly in that it starts with cooperation and does not initiate defection. Once the rival cheated in one period, however, the grim strategy will defect forever. The grim strategy is a Nash equilibrium against the rival playing grim if:

$$B \times \beta > C \tag{5}$$

where B is the advantage and C the cost of cooperation, and $\beta = \delta / (1 - \delta)$, with δ the probability that the same game is played in a following period. To verify this Nash equilibrium one only has to consider counterstrategies that can be nasty or nice, or grim. Nasty is always defecting and nice plays grim for a number of periods and defects thereafter. Grim then does better against grim provided (5) applies. Suppose, for example, that if both players cooperate they each get 3. If one player cheats and the other cooperates, the deviant player gets 5 and the other 0. If both defect they all get 1. Then B = 3 - 1 = 2 and C = 5 - 3 = 2. Cooperation will result from both rivals playing grim if $1 > \delta > ½$. An equation similar to (5) exists in the behavioral ecology of animals. It can be used to explain altruism, with β the coefficient of (genetic) relatedness. For identical twins, for example, $\beta = 1$, and it is predicted that they will cooperate frequently!

5.2. Application to price wars

To apply equation (5) to IO, consider the traditional view that excess capacity is likely to promote price competition. This view is based on the observation that the incentives to cheat on output restrictions become larger if established firms can increase their output at a low marginal cost. This is typically the case with excess capacity. The new IO warns that things are more complicated (Church and Ware (2000)). In an industry with excess capacity firms can also punish cheaters with lower additional cost. Thus one needs to look at both sides of an equation like

(5). More excess capacity may entail a higher cost of cooperation: the additional profit from cheating is higher, or C in equation (5) increases. But at the same time the benefits of cooperation may also increase. Moving to punishment will result in very small (maybe negative) profits: so B will increase. The increase in B may be larger than the increase in C and then cooperation is more likely to be sustained (for an unchanged β). Or the increase in B may be smaller than the one in C and then the traditional prediction follows: excess capacity reduces the likelihood of successful collusion or cooperation. The traditional view is likely to prevail if demand drops and capacity has to be rationalized. Econometric evidence indicates, however, that excess capacity had a positive impact on industry average price-cost margins in the American aluminum industry for the period 1967-1981. This is consistent with the hypothesis that excess capacity promotes collusion.

The results discussed above also allow giving better advice on how to avoid price wars. Such wars may benefit consumers but can be very costly. The fare wars in American passenger airline transportation in the period 1979-1985, for example, on average involved price decreases of only 32%, lasted six months and were limited to 13 % of the connections. But profits of carriers were lowered by $8 billion (Morrison and Winston (1996)). Cooperative behavior is more likely when 3 R's are present: repetition, reciprocity and reasonable players. The probability of repetition needs to be high enough and the impatience of the players needs to be low, while the detection problem has to be solved. The players should start with cooperation and retaliate when provoked, but also cooperate in response to cooperation. The reciprocity should be applied clearly and creatively (e.g. indirect response). Players should also be reasonable, meaning they should understand the game, where getting rich and not winning is important. Short run benefits of cheating may not be too large. Players should temper hostile reactions through more generous or contrived versions of reciprocity, and should accept the limited role of a third player, to help for example eliminating misunderstandings or to start a new game.

More concrete guidelines may be relevant in this context as well. Firms may for example reveal low costs or price matching policies to signal the ability and willingness to retaliate. Or they may use a policy of everyday low prices with a meet competition clause. The customers will then inform them about lower rival pieces and the detection problem is solved. If some competitive price moves have been made, it is wise to avoid overreaction. This can be done by using selective price cuts, for example through changing customers' choices (e.g. move to bundling), modifying only certain prices, introducing fighting brands, or limiting price cuts to some channels of distribution. Using non price responses may also do the job. They include increasing product differentiation by adding features to a product, or building awareness of existing features and their benefits, while emphasizing the performance risk of low priced options. And sometimes it is better to give up market share and start new games, e.g. by moving to new products (Rao a.o. (2000)).

6. Robustness

A problem of modern theory of IO is the lack of robust insights. In many instances mathematics has become simply a new language to describe particular cases. Perhaps the richness of the economic reality at the micro level makes this to some extent inevitable. Multiple Nash equilibriums do exist and cannot always be sorted out by game theoretic refinements. In a duopoly, for example, many output or price combinations, improve on the Nash equilibrium values. It can be shown that all of them can in principle be equilibrium if the game has an infinite number of repetitions. But of course this doesn't help to predict what will happen: it only says that what will happen could be better than the outcome of the one shot game. Perhaps this is one of the reasons why the practical use of IO models is still limited. Does it really help to say that we can model everything? Should not science, by its very essence, cut down on the number of options or trade offs that have to be considered?

It may be difficult to choose on logical grounds between several reasonable outcomes, but perhaps their comparative static properties are similar. One response then is to search for robust broad generic tendencies in several related strategy games. This idea can be illustrated in the context of research familiar to the authors of this paper. Research and development (R&D) activities in profit seeking firms have several essential characteristics. They are associated with market and technological uncertainty, they generate knowledge spillovers to rivals and imitators, and they tend to change the usual product competition. Process innovations, for example, that reduce unit costs of the innovating firm, will create tendencies for this firm to increase output and market share. A number of contributions have investigated these features and shown, for example, that cooperation in R&D among otherwise independent firm typically will increase innovative efforts if spillovers are sufficiently high. Efforts will be highest with cooperation and perfect transmission, and lowest with rivalry and no cooperation. This emerges in racing settings with technological uncertainty as well as in settings where R&D is simply a strategic investment changing the subsequent output (or pricing) game (De Bondt (1997)). Careful empirical work has confirmed and refined a number of these predictions (e.g. Cassiman and Veugelers (2002)).

6.1. Strategic investments with leaders and followers

Most of the strategic investment models use a two period setting where in the first period firms simultaneously choose or cooperate in R&D, anticipating simultaneous choices of output in the second period. In reality, however, innovative firms and organizations often, almost by definition, lead followers that imitate. In addition investments in knowledge may or may not be quickly followed by output rivalry. This means among other things that imitators may react to knowledge or output decisions revealed by the innovating entity. And the question then is to what extent such settings, with sequential moves, change tendencies of the simultaneous choice games. To investigate this problem several scenarios are looked at in which firms choose a level x of cost reducing R&D and an amount q of output to be sold in a homogenous good market, see Table 1 and 2.

Cooperation in R&D by a subset of all industry members with subsequent Nash behavior in output is less profitable for the insiders than for the outsiders (scenario 0). A small knowledge advantage of the cooperative venture, however, will make the joint venture better for the insiders than for the outsider (De Bondt and Wu (1997)). These tendencies are reminiscent of the Cournot Nash tendencies. Mergers in a Cournot industry will reduce profits for insiders and increase profits for outsiders, when the merger only searches for more market power and is composed less than all of the firms. This is a consequence of the simultaneous choice of all output decisions.

6.2. Tendencies with leading players

The other settings of Table 1 and 2 assume that the leaders correctly anticipate the reaction functions of the followers. The computations of the equilibrium choices and performance values are tedious and produce rather long equations. The numerical analysis and algebraic analysis is still work in progress. In tables 3, 4 and 5 some interesting preliminary tendencies are reported.

Scenarios 1 and 2 are less strategic in nature and reflect decisions with a short run character. Given a new technology, for example, only some additional knowledge is needed to implement and decisions on this can be made more or less together with output decisions. In settings 3 to 6, on the other hand, a long run view brings in long term strategic thinking.

Table 1 : 2 Period possibilities strategic investment x and output q choices in n firm industry

	• All firms Nash in x and • then all Nash in q
0	• k firms cooperate in x Nash with n-k rivals n-k rivals Nash in x • then all Nash in q
1	• k leaders Nash in simultaneous x and q • then n - k follow with Nash in simultaneous x and q
2	• k leaders cooperate on simultaneous x and q • then n - k follow with Nash in x and q

Table 2 : 4 Period possibilities strategic investment and output choice in n firm industry

3	• k leaders Nash in x • n-k followers Nash in x • k leaders Nash in q • n-k followers Nash in q
4	• k leaders cooperate in x • n-k followers Nash in x • k leaders Nash in q • n-k followers Nash in q
5	• k leaders Nash in x • k leaders Nash in q • n-k followers Nash in x • n-k followers Nash in q
6	• k leaders cooperate in x • k leaders Nash in q • n-k followers Nash in x • n-k followers Nash in q

Mergers that lead tend to perform better in games with output competition. The incorporation of strategic investments does not change this tendency. The counterintuitive tendencies of simultaneous move games tend to disappear: cooperation and leading results in better profitability compared to rivalry or imitating, even without better

Table 3: Strategic investment x and output q, in scenarios 1 through 6. The π symbol indicates profits, i.e. contribution to profitability. Welfare is the sum of consumer surplus and the total industry profits.

Tendency	Deviations°
x leading firm **>** **x** follower	• Possible **<** in 2, 4 * • and in 3, 5 *
q leading firm **>** **q** follower	• Possible **<** in 2*
π leading firm **>** π follower	• Possible **<** in 2*
Welfare ↑ with number of leading firms	• Possible ↓ in 1, 2, 4** • and in 3, 5.

° Preliminary, * : Only detected with large number of leading firms.
** : Detected with small spillovers.

knowledge transfer in the joint venture. This is a reflection of the robust tendency of leaders having a larger output than the followers.

With a large number of leading firms, the leaders may have a smaller output and lower profitability than followers, in situations where leaders choose simultaneously investment and output and followers do later likewise. This may occur in scenario 2, where leaders have a stronger incentive to restrict output. Numerous independent leaders may also result in each of them having lower investments than a follower in long run settings 3 and 5. But this does not appear to undermine their better prospects for larger output and profits. Static welfare is only sure to increase with the number of leading firms given that spillovers are large and that they are not too numerous.

Table 4: Effects of knowledge spillovers on strategic investment x, output q and contribution to profits π, scenarios 1 through 6.

	Tendency		Deviations°
	Leader	Follower	
Overall spillovers ↑	$\left.\begin{matrix}\mathbf{x}\\ \mathbf{q}\\ \pi\end{matrix}\right\} \downarrow$	$\left.\begin{matrix}\mathbf{x}\\ \mathbf{q}\\ \pi\end{matrix}\right\} \uparrow$	• Possible ↑ for leader with cooperating leaders
Additional spillovers leaders ↑	$\left.\begin{matrix}\mathbf{x}\\ \mathbf{q}\\ \pi\end{matrix}\right\} \uparrow$ Stronger ↑ with cooperating leaders	$\left.\begin{matrix}\mathbf{x}\\ \mathbf{q}\\ \pi\end{matrix}\right\} \downarrow$ Stronger ↓ with cooperating leaders	

° Preliminary

The effects of industry wide spillovers or of additional knowledge transfers between the leaders are summarized in Table 4. The exceptions detected so far concern situations where leaders cooperate.

Table 5 : Cooperative and independent behavior of leading firms with strategic investment x and output q, scenarios 1 through 6.

Tendency		Deviations
Leader	Follower	
x cooperation **>** **x** independent	**x** leaders cooperating **<** **x** leaders independent	• Possible **<** for leader in 1,2*. • Possible > for follower in all comparisons**
q cooperation **>** **q** independent	**q** leaders cooperating **<** **q** leaders independent	• Possible **<** for leader in 1,2 • Possible > for follower in all comparisons**
π cooperation **>** π independent	π leaders cooperating **<** π leaders independent	• Possible > for follower in all comparisons**
Welfare leaders cooperating **>** **welfare** leaders independent		• Possible **<** in 1,2*

*: For 1-2 detected with small overall and additional spillovers.

** : For 3-4 and 5-6 only detected with large overall spillover and very small additional spillover among leading firms.

Larger industry wide spillovers may also stimulate efforts of cooperating leaders. Of interest is the finding that additional spillovers among leaders strongly discourage followers in situations where leaders are cooperating. Joint ventures and alliances on R&D may thus be bad news for followers. This suggests that the latter may have a strong interest to react, but this feature is not looked at here.

Some effects of cooperating leaders are reported in table 5. With simultaneous choices cooperation tend to in larger R&D efforts only with large spillovers. But cooperating leaders typically will invest more than with independent behavior even if spillovers are less important. And for followers the reverse applies: they will put more effort in case leaders act independently. But with large spillovers they may also perform more if leaders cooperate than if they act independently. A detailed study of the main tendencies and deviations for the followers is probably useful.

7. Conclusion

The most influential ideas in IO have emerged, in cases where deep insights could later be subjected to more sophisticated analysis. The concept of the Nash equilibrium and some of its refinements, have greatly enlarged and enriched the box with tools to analyze firm and market organizations. A discussion of some of the many striking results gives convincing evidence on the possibilities of using the new IO as a basis for the understanding of the economics of business strategies. In the future more attention could be given to behavioral approaches (with some bounded rationality) and to the search for more robust tendencies. This in itself could enhance the operational significance of the field.

An effort in this spirit relates to strategic investment models, where strategic R&D efforts and output decisions are analyzed in oligopoly settings. Some of the tendencies on lower profitability and lower investment efforts with R&D cooperation that earlier models suggested, were found to be a consequence of their simultaneous move assumptions. These tendencies tend to disappear in settings where cooperating or independent innovative firms are leading and imitation follows. Hopefully therefore, also this example can convince the reader of this paper, that a large effort to develop a little more IO, can highlight important aspects of firm business strategies.

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