# The Rationale for Using the Classic Cournot Mechanism in Merger Control

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## 1 Introduction

This paper aims to theoretically establish, justify and show the possibilities for the application of the classic quantity competition model within industries where firms before they start with the price competition, are required to choose some level of capacity. It is a model developed by French mathematician and economist Augustin Cournot in the nineteenth century, which can be considered as a reduced (short) form of such a two-stage game.[1]

The inspiration for this topic comes from the need to perform a more significant inflow of economic theory into the domain of horizontal merger control, which can be of assistance to authorities in charge of competition protection in gathering evidence for cases that they investigate. This is a particular area of competition protection policy, where the unilateral effects of horizontal mergers (hereinafter, mergers or concentrations) on the conditions of competition in the relevant market are determined ex-ante. Accordingly, a judgement is made whether the merger should be approved or blocked, and under what terms. Thus, a theoretical framework would be developed for the right *application* of the stated economic model. We hope that the mentioned authorities (hereinafter, commissions) would, therefore, gain a valuable tool for determining the short-term merger effects. The application of this model is considered especially useful for the horizontal merger simulation method.

This paper does not aim to suggest the perfectness of the tool it offers. On the contrary, it should be regarded only as complementary analytics which clarifies or questions other evidence, gathered by traditionally present analyses used by the commissions. First of all, we refer to the definition of the relevant market and the

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[1]See Cournot (1897).

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consequential judgement based on market shares and measures of market concentration.

Mergers can cause two types of adverse effects on competition. Those are the mentioned *unilateral effects*, which are in the focus of this paper, and the *coordinative effects*, which can be the subject of some further analysis. In any case, it is important to differentiate between the two.

The coordinative effects stem from the fact that concentration, by its nature, decreases the number of market players, thus increasing the market concentration, also raising the possibility for a *cartel* to be created and to endure.[2]

The focus of this chapter will be, as already mentioned, on the unilateral effects that exclusively refer to the entity created by horizontal merger. European legislation sees the dominant market position as an indicator of the possession of market power. In that sense, gaining a dominant position is considered as motivation for firms to obtain and strengthen their market power through such steps, at the expense of the consumers, rival companies and suppliers, which is considered to be an *abuse of the dominant position*. Thereby, to prevent the occurrence of such abuse, since it assumes already violated competition conditions, it is the task of the commissions to predict the unilateral merger effects.

The starting point is that unilateral effects are exclusively connected to the participants of the concentration, but not to their rivals. In this sense, these effects could formally be defined by applying the Nash equilibrium concept, which is at the heart of the Cournot model.[3]

This chapter consists of two connected and rounded parts. First, it is necessary to discuss the circumstances within which the Cournot model can be considered as a good approximation of reality. Therefore, there is a need to also consider its existing role in the domain of merger control. Second, having discussed and chosen the competition model, we will offer a short algorithm for its application in merger simulations.

It is worth emphasising once more that the foremost purpose of these parts is to indicate the economic philosophy behind the carried-out analysis to the *young commissions* (without sufficient experience, expertise and other resources necessary for carrying out merger control). The general aim is to indicate the possibilities of making positive breakthroughs towards an increase in the quality of the economic analysis that is being performed, which would decrease decision-making errors of the first and second kind, which are an inevitable part of this sphere of competition policy.

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[2]For the definition of the coordinative effects see Begović and Pavić (2012, p. 97).

[3]See Werden and Froeb (2008, pp. 45–46).

## 2 The Rationale for Cournot Mechanism

The practice of this type is shaped by oligopoly theory, which lies at the very heart of the industrial organisation. The limitations inevitably faced in practice must be taken into account when considering the importance and the limits of the particular role of this economic theory. Practice is restricted by rigorous legislative norms (e.g. the short time-frame for collecting evidence), scarce resources (quantity of staff, accumulated knowledge, and insufficient financial funds), as well as limited availability of data needed to carry out the analysis. Because of this, it is logical to implement those economic tools, which under the given circumstances, reduce the space for making the stated errors.

A perfect simulation would assume that the applied competition model is fully compatible with the characteristics of the relevant market. In other words, there should be as many different game modes as there are different markets. However, economic theory does not differentiate an infinite number of competition mechanisms. Also, the limits of merger control practice can lead to a simplified appearance of reality, through the assumption of Cournot or Bertrand competition, depending on what is considered the key strategic variable—quantity or price. The approximation of reality always carries the risk of making a wrong decision. This is something that the authorities must be aware of when choosing the adequate set of instruments for the analysis.

It is evident that the possibility of mistake cannot be eradicated since forecasting social process outcomes always comes with a dose of unexplained variability. The interest of the authorities should be to minimise those possibilities by using sophisticated economic tools, which they are capable of implementing. On the other hand, another limiting factor must be taken into consideration: judges do not like "black boxes" containing evidence, which is something that the application of complex economic theories might resemble. Of course, this is the case when the analysed merger case gets its day in court.

By offering an answer to why the Cournot model of quantity competition should be applied, it is implicitly assumed that this model represents a good approximation of the market game within which a merger is taking place. Is this actually the case and when? The answer to this question has at least two components. First, the dilemma which competition model should be applied depends on the decision which strategic variable is considered to be crucial for the analysed market. Most often these variables are quantities and prices. However, firms use both strategic variables in their business. The Kreps and Scheinkman (1983) model (hereinafter, KS model) is proof that the outcome of the strategic interaction in which the firm would first choose its capacities and later engage in price competition with the aim to employ capacities, creates an outcome which coincides with the outcome of the Cournot model. That is why it is wise to use the Cournot model, and not the Bertrand model, in the circumstances described by the KS model. Second, it is a fact that merger control practice significantly relies on the Cournot model when establishing the relationship between the indicators of market structure (e.g. the number of firms

within the industry, their market shares, and measures of market concentration) and the indicators of market performance (e.g. the Lerner index). Both of these reasons should be discussed in detail, as follows.

## 2.1 Cournot Mechanism as the Reduced Form of the Two-Stage Competition

According to available literature, it appears that as far as simulations are concerned, the question of choosing a competition model is still insufficiently explored. Typically, without going into detailed argumentation, it is pointed out that for homogeneous products the Cournot model of competition should be applied, while for the differentiated products the focus should be on the Bertrand model. A transparent approach to this issue can be found in influential papers, such as Werden and Froeb (2008), and Budzinski and Ruhmer (2009). By this simple division of authorities between the two models, it is implicitly presumed that in the case of homogeneous products the dominant strategic variable is quantity, while in the case of differentiated products it is price.

However, this division seems too strict in the case of limited capacities, where prices and quantities can be the variables of a single two-stage game, with the outcome which fits the classic Cournot model. Moreover, it turns out that in certain circumstances this result can be valid, for both the markets of homogeneous and of differentiated products.

The KS model was devised on the basis of the seminal Edgeworth (1925) model and the model that was later developed by Levitan and Shubik (1972), which introduce exogenously limited capacities into price competition. It introduces capacities limitations into price competition, but as an endogenous firm's decision. By making capacities endogenous within the frameworks of price competition, both variables, prices and quantities, are put in the context of one game, with the conclusions being fairly attractive to the topic of this paper. Namely, the price competition which precedes the firms' decisions regarding capacities will in certain circumstances have as a result the outcome of the Cournot model. This result significantly affirms the role of Cournot's competition as a tool for short-term predictions, which is exactly the case with merger simulations. In other words, it represents a theoretical basis for the application of the Cournot model, as its reduced form.

Therefore, the KS model assumes that the firms choose their capacities during the first period, while in the second period, starting from chosen capacities, they choose prices that will fully engage those capacities. It is assumed that the production for inventory is not possible. Once chosen, the capacities are binding for the firms, which introduces into the model the assumption of a significant leap in the marginal costs for every unit produced above capacity. The KS model proves that in the circumstances of limited capacities if firms believe that the result of the price

competition will be such, regardless of the chosen capacities, pricing policy will fully engage them. As a result, firm's supply will be found at the intersection of the Cournot's reaction functions.[4] The example of homogeneous products duopoly originally proves this result, with the assumption of a negative slope demand function, non-decreasing marginal costs of production, and marginal costs of capacities. Also, the so-called *efficient rationing rule* is applied, which assumes that the lower price firm, up to the level of its pre-committed capacities, will serve the customers with the highest willingness to pay, while the more expensive one will be faced with residual demand, which excludes those customers. This rule maximises the consumers' surplus since the lower price is always achieved by the customers with the highest willingness to pay.[5]

To illustrate the rationale behind the KS model, similar as in Shy (1998), a simple example of two symmetrical firms, which participate in this two-stage game (firms 1 and 2) will be used. The inverse market demand is linear and given by the form $p = a - q$, where $q = q_1 + q_2$ and $a > 0$. The per unit costs of capacities for both firms are constant at the level $\hat{c}_1 = \hat{c}_2 = \hat{c} > 0$, while $a > b$. On the other hand, the per unit production costs are also constant and equal to zero, up to the level of installed capacities, i.e. $c_1 = c_2 = c = 0$, and are infinite for every unit above that level.[6]

Differing costs of capacities and costs of production is an important characteristic of the two-stage KS model. While the costs of production are crucial for the second game period and the selection of price, the total costs (costs of capacities increased by the costs of production) are essential for the selection of capacities in its first period. The costs of capacities are a function of the level of installed capacities, where every unit of capacity enables the production of one unit of output. If the firm does not intend to generate inventories in equilibrium, nor to have unengaged capacities, but to always use them for the measure of intended production, it seems realistic to expect that $q_i = k_i$. This continual following of the capacities with quantities can lead to the conclusion that the per unit capacity costs $(\hat{c})$ can be characterised as per unit production costs $(c)$, which is *not* the case. The per unit production costs refer to the second game period. Thus, they are not directly connected to the decision concerning capacities if production is maintained within their limits. On the other hand, even related to capacities construction, total

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[4]For the technical details of this complex model, which most certainly surpass the scope of this paper, see Kreps and Scheinkman (1983). For a rather intuitive interpretation see Shy (1998, pp. 112–115).

[5]For a detailed discussion of logic of efficient rationing see Davidson and Deneckere (1986), and Tirole (1988, p. 213).

[6]The assumption on zero costs of production is in accordance with the original interpretation of the KS model. Kreps and Scheinkman (1983) state that with slight complications in the proof, the conclusions of their model would not change even for non-zero production costs. The infinity of the capacity costs for every overrun unit secures their perfect rigidity. Maggi (1996) has shown that even without the perfect rigidity, the same conclusions, as in the standard KS model, can be reached.

capacities cost $\left( \hat{c}\, k_i \right)$ cannot be treated as fixed, since it depends on the decision concerning the volume of production. If the firm were to retract its intention to invest, this kind of costs would not occur in the first place. It is important to notice that the decision on capacities is introduced at the beginning of the game, so capacity costs still do not exist up to that moment. Thus, the price paid for the capacities cannot refer to fixed costs. Since the character of capacity costs is known, the issue of their definition is logically raised. A reasonable answer is given by Varian (2010), by defining the *quasi-fixed* costs, since there are none if the decision concerns the absence of investment, or they are fixed when the investment decision is final, i.e. irrevocable.[7] Quantities can vary within the boundaries of the installed capacities. So, a wrong notion that capacities can do the same should be avoided. The decision on their magnitude will be made by the firms' rational expectation regarding the optimal production volume for the set game. Furthermore, in the second period, when the decision on capacities is irrevocable, these costs can be predominantly characterised as *sunk*. It is logical to believe that in the short time-frame the firm is not able to return the payments caused by these costs. Due to the all stated features, firms do not even consider capacity costs while deciding on the equilibrium price.

At least in the short term, the selection of capacities in the first period of the game is a binding decision by which the firm's possibilities to vary prices are limited. In that manner, a wrong impression can be formed that this type of game is reserved only for the establishing industries, where the players are just entering the industry and forming their capacities in order to get into the price competition subsequently. To avoid this impression, the perceptions of the meaning of capacities, both the short and the long term, must be additionally clarified. This clarification seems crucial not only for understanding the first-period capacity costs, but also the circumstances under which this type of competition can be expected. The following example can serve as a practical illustration for this purpose.

The example concerns production in the domain of homogeneous alimentary products (e.g. sugar, edible oil, flour). In this case, capacities are determined on the annual level by the volume of planting of the primary raw materials. Usually, producers of the stated products are vertically integrated. This is, for example, very characteristic of sugar refineries, where in addition to the core business (sugar production), there is also a primary agricultural production of the main raw material, sugar beet. In such a system, the overflow of capacities determined by the planned planting is not possible without significant costs (when resources are obtained from external suppliers), which makes the choice of capacities quite rigid. A fact should also be added that the transport of sugar beet is not possible at longer distances due to the natural characteristics of this "sweet" root, which is also why longer warehousing is not feasible. All those factors make the arranged planting almost entirely fixed from the aspect of the processor, within a given year. In that context, the fixed capacities (buildings, processing machines, transport means, etc.) assume the real

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[7]See Varian (2010, p. 373).

fixed costs, and as such, in the long term they are binding for the firm. On the other hand, every year, the choice of the planting volume, which depends on the sales plans for the final product based on expected price, withdraws quasi-fixed costs. Sugar refineries will not have this type of costs if they suspend the production for a year for some reason.

When it comes to sugar production, the infinity of production costs when production takes place above capacity can be observed through the fact that transport over longer distances is almost impossible. During transport, the quality of sugar beet decreases significantly. Therefore, all locations outside of the acceptable trans-port radius from the place of processing are excluded, and thus also importing of beets. During import, the entire profit would probably "drained-off" while waiting for the completion of the standard customs procedure.

Within the given example, it can be expected that the capacity choice is a simultaneous process. This phenomenon can be easily explained when it comes to sugar production since the simultaneousness is first of all the consequence of vegetation characteristics of the basic raw material. No firm can wait for the rival's decision on capacities since it would certainly be late with the planting, for which nature still holds the authority when it comes to determining the optimal period. It can be stated that by choosing capacities in this manner, the firm determines its short-run cost function. Alternatively, it could be said that by choosing the capacities, the firm *binds* itself to a certain short-run cost function, which is relevant for the two-stage game as a whole.

Within such a setting of demand and costs for $i = 1, 2$ and $i \neq j$, the outcome of the simultaneous Cournot game would assume reaction functions of both firms in the following form:

$$q_i(q_j) = \frac{(a - \hat{c})}{2} - \frac{1}{2} q_j. \tag{1}$$

According to that, the mechanism of the Cournot model will lead to the equilibrium outcome

$$q_1^* = q_2^* = \frac{(a - \hat{c})}{3}; \quad p_1^* = p_2^* = p^* = \frac{(a + 2\hat{c})}{3}. \tag{2}$$

The task is to show that the outcome of the two-stage game with capacities, and later with prices, will be equivalent to the stated outcome of the Cournot game. While solving the two-stage game, it is good to start with the second period, in this case, the pricing sub-game.

### 2.1.1 Second Stage—Pricing Subgame

Based on the efficient rationing rule, for the given capacities of Firm 2, Firm 1 faces the inverse residual demand, $p_1 = a - k_2 - q_1$. Within the pricing sub-game, the

firms maximise their revenue functions, and also profit functions, since the capacity costs are not relevant for making a decision in the second period, while the production costs are zero. For example, if the capacities of both firms were to be given on the level $k_1 = k_2 = a/3$, the unique price which would fully employ the capacities would be $p_1 = p_2 = p = a/3$.

It can be noticed that this outcome would represent the solution to the Cournot game in the absence of any costs. From the first order conditions for the maximum of the revenue function $R_1 = (a - k_2 - q_1)q_1$, Firm 1's reaction function to Firm 2's capacities would be obtained, which could be written as

$$r_0(k_2) = \frac{a}{2} - \frac{1}{2}k_2, \tag{3}$$

In the same manner, bearing in mind the symmetry of the example, the reaction of Firm 2 would be

$$r_0(k_1) = \frac{a}{2} - \frac{1}{2}k_1. \tag{4}$$

It remains to be proven that the price $p_1 = p_2 = p = a/3$ is the pricing sub-game equilibrium, i.e. that under conditions of limited capacities the firms will not have the motive to determine any other price. Assuming that Firm 2 will precisely stick to the price $p_2 = a/3$, it is necessary to prove that Firm 1 will determine the same, i.e. that the price variations compared to the choice which would be made by the Walrasian auctioneer for the given quantities are not profitable.

Figure 1 helps in understanding the firms' choice in the second game period. It also demonstrates the way of forming the residual demand function, based on the efficient rationing. The left graph in the figure shows the given inverse demand, $p(q)$, while the right graph demonstrates Firm 1's residual demand, $p_1(q_1)$, assuming
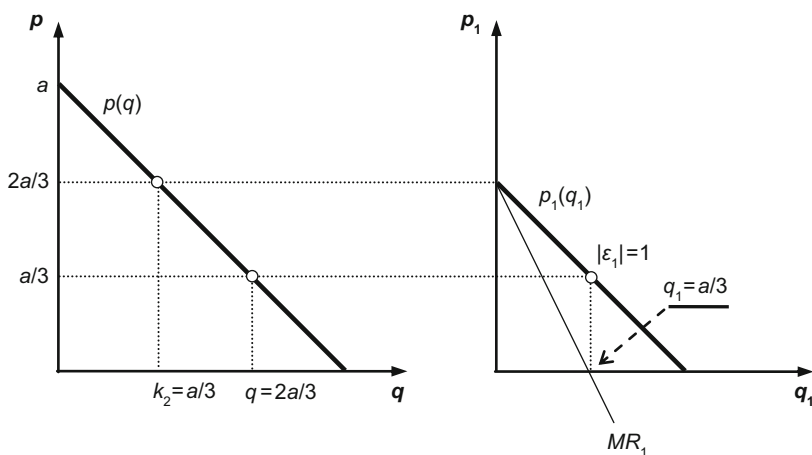


**Fig. 1** The pricing sub-game equilibrium and residual demand formation

a given efficient rationing rule for $k_2$. Firm 1's marginal revenues function, $MR_1(q_1)$, is a logical consequence of such obtained residual demand.

First, Firm 1 will not set the price below the level of its competitor, since it is not in the position to produce and sell more compared to the level of installed capacities, i.e. in this case compared to $k_1 = q_1 = a/3$. The inability to increase sales due to the price decrease assumes that the revenues will be lower if the price reduction occurs. The same quantity will be sold as before, but at a lower price. From Fig. 1 it is clear that for $p_1 < p_2 = a/3$ we have that $MR_1 < 0$.

Second, it is necessary to prove that a price increase by Firm 1, compared to the level $p_2 = a/3$, is also not profitable. It is worth noting that if Firm 1 sets the price $p_1 > p_2 = a/3$, it can count on the residual demand obtained from the application of the efficient rationing rule. Since the residual demand is obtained in a manner that the cheaper firm's capacities are subtracted from the market demand, formally $q_1 = a - p_1 - k_2$, it turns out that $q_1 = 2\,a/3 - p_1$. In the inverse form, the residual demand is $p_1 = 2\,a/3 - q_1$, so the function of the marginal revenues equals $MR_1 = 2\,a/3 - 2\,q_1$. It turns out that $MR_1 \geq 0$ for $p_1 \geq a/3$, which indicates movement on the elastic part of residual demand. This undoubtedly shows that a price increase would cause the decrease of the total revenues. Therefore, a conclusion can be reached that Firm 1 will not find it in its interest to raise the price above its rival.

It is obvious that it will not be profitable for Firm 1 to either increase or decrease the price compared to the price of its rival. Since the firms are symmetrical, the same conclusions would be valid even if the analysis were to be carried out from the perspective of Firm 2. Hence, it would be easy to check whether for any combination of *sufficiently small* capacities which satisfy the condition $k_i \leq r_0(k_j)$ for $i = 1, 2$ and $i \neq j$, the equilibrium price must fully employ such capacities. Formally, this price can be written as $p\,(k_1 + k_2)$. In the example, the previous condition could be reduced by claiming that the unique equilibrium price, $p\,(k_1 + k_2) = a - k_1 - k_2$, can be formed if $k_1 + k_2 \leq 2a/3$.

If $k_i \geq a$ for $i = 1, 2$, the capacities of both firms would be *sufficiently large* to be considered as unlimited. The firm with unlimited capacities, as a cheaper one, can flood the entire market. In that case, the firms would determine the zero price, just like in the Bertrand equilibrium. As an extreme case, far from reality, Bertrand solution for unlimited capacities is not of the KS model particular interest.

Finally, within the range between the sufficiently small and sufficiently large capacities, the firms would enter into the Edgeworth price cycles. The equilibrium solution, in that case, would assume the application of mixed (pricing) strategies since capacities are large enough to disable the unique price choice. By addressing issues related to solving the Edgeworth cycles, defining the equilibrium within the pricing sub-game gets significantly more complicated, which certainly exceeds the extent of this paper. Therefore, this issue will not be further addressed.[8] In any case,

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[8]For a complete analysis of the pricing subgame, see Levitan and Shubik (1972) and Kreps and Scheinkman (1983).

even without the mixed strategies issue, it can be claimed that for sufficiently small capacities the firms will surely opt for the unique price to be fully engaged.

### 2.1.2   First Stage—The Choice of Capacities

In order to reach the equilibrium of the first stage and to answer the question which capacities will be chosen by the duopolists, it is necessary to add the price $p\,(k_1 + k_2)$ to their first stage profit maximisation problem. In other words, pricing policy is deliberate not to leave capacities unengaged. By solving these problems, every firm will reach its *capacity best-response function*. In this context, the capacity best-response function of firm $i$ for $i = 1, 2$ and $i \neq j$ is

$$r_{\hat{c}}\left(k_j\right) = \underset{k_i}{\mathrm{argmax}}\ \left[p\left(k_i + k_j\right) - c - \hat{c}\,\right] k_i. \tag{5}$$

Since $c = 0$, from Eq. (5) it is clear that the firm's objective function in the first stage corresponds to that characteristic of the Cournot model. The difference is that instead of production volume, capacities are used. In this sense, the capacity selection in the first stage of the KS model must correspond to the selection of quantities in Cournot's static equilibrium. It turns out that supply forming at the very margin of capacities is the optimal solution for both firms. In the example of linear demand and constant capacity costs, the capacity best-response function of the firm $i$ would be

$$r_{\hat{c}}\left(k_j\right) = \frac{\left(a - \hat{c}\,\right)}{2} - \frac{1}{2}\,k_j, \tag{6}$$

which corresponds to Cournot's reaction given in Eq. (1) for the supplied quantities at the level of capacities. It should also be noted that including the costs of capacities in the first stage of the game, leads to $r_0\left(k_j\right) > r_{\hat{c}}\left(k_j\right)$ for $b > 0$, so in the first stage equilibrium, the following is valid: $k_i \leq r_0(k_j)$, for $i = 1, 2$ and $i \neq j$. In addition to the fact that any combination that fulfils this condition would lead to price $p\,(k_1 + k_2)$, the *stable game equilibrium* would be achieved for $k_i = r_{\hat{c}}\left(k_j\right)$ and $k_j = r_{\hat{c}}\left[\,r_{\hat{c}}\left(k_j\right)\right]$, which precisely coincides with the equilibrium quantities within Cournot's game. Based on the capacity best-response function given in Eq. (6), $k_1^* = k_2^* = k^* = \left(a - \hat{c}\,\right)/3$ can be obtained, so we have that $p_1^* = p_2^* = p^*(2k^*) = \left(a + 2\hat{c}\,\right)/3$. If the firms intend to fully engage their capacities, which is logical even more taking into account that their construction assumes positive costs, the outcome of the two-stage game will coincide with the equilibrium of the classic Cournot model. Therefore, by completing this two-stage journey, we have returned to the very beginning of this analysis and the outcome given in Eq. (2).

An influential critique of the KS model, given by Davidson and Deneckere (1986), has proven that the model is vulnerable to the change of the assumption of

the demand rationing, which is always necessary in the case of homogeneous products. This critique has certainly not lowered the importance of the KS model, but it has rather stimulated further research in the field of this significant result of oligopoly theory in the decades to come. Therefore, models given by Maggi (1996) and Schulz (1999) have proved that the KS model with differentiated products leads to the same outcome as Cournot's mechanism applied to differentiated products. Hence, applying the KS model in the differentiation issue has relativised the influence of former critiques, by also pointing out the significance of quantity competition in differentiated products markets.

The principal objection to the application of the KS model is based on the mere fact that the equilibrium capacity following mergers cannot be adapted within a reasonable time frame. Since the capacities are fixed prior to the merger (for both the merger participants and their rivals), the only thing that players can do after the merger is to raise prices unilaterally.[9] Although logical at first glance, such a sequence of actions seems to be too short-sighted. The aforementioned sugar industry example can give an illustrative argument. Obviously, prices are subject to the daily basis changes, but the choice of capacity, and therefore the short-term cost function, is binding to the firm. Even though the two variables (price and quantity) can be considered as endogenous to the firms in question, however, the dominant one in such cases is quantity. Application of Cournot's mechanism, as the reduced form of the two-stage game, seems entirely reasonable in this sense.

The previous discussion was aimed at developing the necessary philosophy of the Cournot model application within the economic analyses of the competition protection authorities, whenever the capacities represent the limitations of the firms' pricing policy. However, it is valuable to ask the question to what extent Cournot model is already present in the economic analyses of the commissions. The answer follows.

## 2.2 Cournot's Mechanism and Traditional Unilateral Effects Reasoning

By using the classic Cournot's mechanism as in Shapiro (1989), it would be useful to link market structure and market performance indicators. To establish this link, the oligopoly of $n$ firms would be used, with the market range defined by the inverse demand function $p = p(q)$, with $q$ equivalent to $q = q_1 + q_2 + \ldots + q_n$. The total costs function of the firm $i$, for $i = 1, 2, \ldots, n$, is $C_i(q_i)$, so the marginal costs can be expressed as $c_i = dC_i/dq_i$. Based on familiar logic formulated by Cournot, the equilibrium of the oligopoly game can be reached when each firm seeks to maximise its profit, moving along its reaction function for any given rivals' quantities. Since the reaction function is derived from the first-order conditions for firm's profit

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[9]See Werden and Froeb (2008, p. 50).

maximisation problem, the equilibrium outcome of this game is obtained by solving $n$ first order conditions—one for each firm. Formally, the firm $i$'s profit function can be written as

$$\pi_i = p(q)q_i - C_i(q_i). \tag{7}$$

Differentiation of the previous term with respect to $q_i$, and with simple fact that $dq/dq_i = 1$, gives us

$$\frac{d\pi_i}{dq_i} = p(q) + q_i \frac{dp(q)}{dq} - \frac{dC_i(q_i)}{dq_i} = 0. \tag{8}$$

By additional rearranging, the previous term can be transformed into

$$p(q) - c_i(q_i) = -q_i \frac{dp(q)}{dq}, \tag{9}$$

which can be divided by $p$, and only the right side multiplied by $q/q$, in order to form the Lerner index—undoubtedly the best-known measure of a firm's market power

$$L_i = \frac{p(q) - c_i(q_i)}{p(q)} = \frac{s_i}{|\varepsilon|}. \tag{10}$$

By starting from the result of Cournot's competition, it can be concluded that the firm's profit margin is proportional to its market share and inversely proportional to the absolute value of the price elasticity of market demand.[10] Hence, the higher the market share of the firm, and lower the market elasticity of demand in absolute terms, the more market power it possesses. The previous statement is probably one of the fundamental premises in the economic analysis of the commissions. As a trivial rule, mergers of entities with larger market shares attract greater attention of the competition authorities than those with smaller shares. This also applies to all circumstances where it is estimated that consumers are insensitive to price changes in the absence of close substitutes, and consequently lack of competition in the analysed partial markets. In addition to these unambiguous conclusions, Eq. (10) can tell even more about other significant moments that characterise this quantity game.

1. In fact, each firm is aware that possesses *limited market power* since the market price is above its marginal revenue. In accordance with Eq. (8), firm $i$'s marginal revenue could be presented as $MR_i = p(q) + q_i p'(q)$, hence we have $p(q) - MR_i = -q_i p'(q) > 0$ for $p'(q) < 0$, which is always the case.
2. Cournot's equilibrium is *located between monopoly and perfect competition*. For $s_i = 1$ we have a monopoly market structure, while for $s_i \to 0$ the market structure tends to the standard definition of perfect competition.

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[10]A somewhat different approach to this relationship can be seen in Pepall et al. (2011, pp. 72–74). For the case of differentiated products see Perloff et al. (2007, pp. 89–90).

3. *Market share* is directly proportional to production efficiency. Production efficiency is based on the firm's marginal costs. The implication of this point is particularly useful. If there are reliable indications that the shares asymmetry is accompanied by a difference in the profit margins, namely that larger firms are more cost efficient than smaller ones, which is the result of Cournot's competition—it makes sense to claim that Cournot model is an adequate approximation of such a reality.
4. Firms that are *less efficient* than some others can also survive in such markets, by paying this less efficient position with a relatively smaller market share. Unquestionably, this is not the case in the Bertrand model, where, as the result of the merciless price war, less efficient rivals would be wiped out of the market, since all firms are ready to lower their prices up to the level of their marginal costs.
5. In the case of *symmetric oligopoly*, where the firm has equal and constant marginal costs $c$, Eq. (10) becomes

$$L_i \;=\; \frac{p\,(q) \;-\; c}{p\,(q)} \;=\; \frac{1}{n\,\mid \varepsilon \mid}. \tag{11}$$

It is well known that the Lerner index can take values from the closed interval $(0, 1)$. As the market structure approaches perfect competition we have $L \to 0$, otherwise, if it approaches monopoly we have $L \to 1$. Equation (11) indicates that for $n = 1$ the market power is characteristic of a monopoly, whereas for $n \to \infty$ market power complies with the conditions of perfect competition. In other words, increasing the number of symmetric firms in the industry is followed by an increase in the intensity of competition. Most of the practitioners (case handlers), involved in merger control, would probably agree with the previous statement, even without a clear understanding of the logic of Cournot model.

6. An interesting conclusion can be reached by calculation the *weighted average of the Lerner's indices* of all individual firms, with their market shares used as weights. For this purpose, Eq. (10) can be transformed as

$$s_1 L_1 \;+\; s_2 L_2 \;+ \ldots +\; s_n L_n \;=\; \frac{1}{\mid \varepsilon \mid}\; \left( s_1^2 + s_2^2 + \ldots + s_n^2 \right). \tag{12}$$

Note that the term in the brackets on the right side of Eq. (12) is equal to the Herfindahl-Hirschman Index (HHI), probably the best-known yardstick of market concentration. It can also be said that the HHI is both necessary and sufficient when it comes to market concentration metrics. This is particularly mentioned because of the frequent, sometimes misleading and mostly unnecessary fascination of practitioners in the field of competition policy by concentration metrics based on various functional forms of market shares. The HHI, as the convex combination of the market shares, meets all the criteria for a representative concentration measure. By altering such functional form, we cannot provide more information as long as the inputs in the analysis are same—market shares. In the market concentration analysis,

the use of the HHI alternatives does not contribute to the reliability of the analysis, and sometimes can even be methodologically wrong. A characteristic example of this is the use of the Lorenz curve, and Gini coefficient based on it, as a market concentration measure.[11]

Thus, Eq. (12) can be rewritten as

$$\bar{L} \;=\; \frac{HHI}{\mid \varepsilon \mid}. \tag{13}$$

It turns out that the industry-wide output-weighted average price-cost margin is directly proportional to the market concentration and inversely proportional to the market demand price elasticity. However, the previous statement, derived from the Cournot model logic, deserves special attention when it comes to the merger control practice.

Specifically, the level of pre-mergers market concentration and its post-merger increase should be subsumed as a *preliminary indication* of the potentially harmful effects of this business practice.[12] In accordance with the definition of unilateral effects, it is believed that with relatively high market concentration, prior to the merger and its increase after the merger, it is more likely that the merger will cause a significant decrease of competition. Such a merger case should certainly become a candidate for further in-deep analysis. One of the possible ways would involve using the merger simulation method based on the appropriately calibrated model of competition. It seems easy to conclude that for the purpose of this chapter we can nominate precisely the classic Cournot model as appropriate in a large spectrum of contexts. Later in this chapter, we will discuss the role of Cournot model in merger simulations by explaining its logic and mechanism. Unfortunately, in the case of the young commissions, metrics based on market shares and concentration measures is often the ultimate scope of the economic part of the analysis of merger effects.

We should notice that previous conclusions are derived from the assumption of product homogeneity in the relevant market. The reality is often more or less *differentiated* rather than *homogeneous*. From the point of view of the merger control practice, it turns out that the conclusions are the same, both for the homogeneous or differentiated products markets. The logic of reasoning based on the HHI is applied to all merger cases, without exception, regardless of whether the product market is homogeneous or not. The main explanation for this is the fact that the analysed forms in both cases must belong to the same relevant product market. Hence, a logical question arises. Why can't Cournot model be the backbone of the analysis in cases of differentiated products markets, when commissions already deduce as if it were so? Therefore, it would be useful to return to the KS model discussed in Sect. 2.1.

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[11]Useful references for the issue of representativeness criteria for market concentration indices could be Hall and Tideman (1967), Tirole (1988, pp. 221–223) and Ristić (2012).

[12]For the rules of inference, based on the HHI, see European and American guidelines for the regulation of horizontal mergers, respectively, European Commission (2004), and the Federal Trade Commission and the U.S. Department of Justice (2010).

# 3    Cournot's Model and Calibrated Merger Simulation

By relying on certain axioms about the behaviour of the competitors, i.e. the type of competition, assumptions about the possible functional forms of demand and costs, and necessary data for calibration of the model parameters, simulations deduce the likely effects of the merger. Below we will present the main steps and logic of implementation of the simulation method, using Cournot's mechanism as the basis for the simulation.

It is presumed that the simulation was conducted subsequent to the implementation of the complete traditional economic analysis, in the abovementioned sense. Prior to the simulation we also presume that the commission has collected all available information, which specifies the nature of the relevant market, and that it has examined the strategic intentions of the parties to the concentration. In other words, in addition to the traditional analysis, we presume that the commission has collected all available qualitative evidence that can support merger simulation inference. Obviously perfect tools for merger control cannot be expected. This should be no surprise, bearing in mind that we are dealing with the specific social phenomena. Therefore, it is almost mandatory that the decision-making process be based on a wider range of analysis, in order to minimise regulatory errors. From an economic point of view, merger simulations are a natural step forward in enriching the evidence set, which does not necessarily have to be complicated or to require significant data or resources.

The simulation approach can follow four key steps,[13] namely: (1) the choice of the appropriate competition model, (2) selection of the functional forms for demand and costs, (3) calibration of the model parameters, and (4) calculation of the post-merger equilibrium and comparative static analysis.

In brief, the chosen model of competition is calibrated to predict market outcomes (prices and quantities), which can be observed in the present. This outcome is taken as the pre-merger equilibrium. By using the calibrated model, we can predict the unilateral effects of the merger simply, by comparing the equilibrium outcomes before and after the merger. Thus, through simulation, we are opposing the effects of the internalisation of competition with the expected merger efficiencies. Efficiencies can be manifested as the marginal costs reduction after the merger (e.g. as the manifestation of economies of scale, elimination of duplicate operations regardless of the production volume, rational use of resources, etc.).

Step (1) does not require any further comment since the preceding discussion provides the necessary erudition for its implementation. Therefore, we assume that we have the *relevant* market where it was quite *relevant* to choose Cournot's mechanism. Steps (2) and (3) require additional attention, while step (4) requires a concrete example, trivial for this discussion, so it will not be specifically addressed here.

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[13]See for example Werden and Froeb (2008), Budzinski and Ruhmer (2009) and Davis and Garcés (2010, p. 401).

## 3.1   Demand and Cost Functional Form

When it comes to the *choice of the cost function*, whose shape is mostly unknown, it is easiest to assume the constancy of the marginal costs, at least to the level of the firm's capacities. How biased are we that way? Since the analysis is limited to the short time frame, this assumption cannot be regarded as too rigorous, and thereby it greatly facilitates the practical application of the simulation method. If it is unknown, the marginal costs vector could be obtained by the process of model calibration.

Based on the mandatory accounting reports, data on the average variable costs is available and can represent a reasonable approximation of the short-term marginal costs.[14] If needed, such data can be used as the benchmark for our merger analysis. The significant divergence of the calibrated marginal costs and this benchmark point may indicate that we have wrongly calibrated our model.

Of course, the simulation method does not limit the choice of the increasing marginal costs function. This possibility will be re-visited later in the discussion related to the model calibration.

Unlike the costs functions, the choice of the adequate demand model is a bit more complicated. Primarily, there is a significant difference in the definition of market demand for homogeneous and differentiated products. In the homogeneous product case, things are much simpler since the only necessary thing is to define a unique demand function for the entire market. In that case, sufficient information is the market demand price elasticity ($\varepsilon_0$), the relevant market aggregate supply ($q_0$), and the unique price at which the product is sold ($p_0$), all of them based on data observable prior to the merger. In the homogenous goods markets, it can be noted that theoretical rule of one price does not perform properly. This may be the result of action sales which firms often conduct in the short term in order to differentiate their products just by price. In such circumstances, practitioners should take the average price over a broader time horizon, which can be considered relevant for the analysed case.[15]

In the differentiated products market, each considered product will have its own demand function. Hence, it is necessary to establish a system of demand functions, which will include all products from the relevant market. In this case, in addition to direct demand elasticities for each product, a lot of additional information about all cross-connections between the products, i.e. cross-elasticities of demand, will be needed. In order to keep things as simple as possible when it comes to the logic of the functional form selection, the further discussion will be related to the homogeneous products case.

The market demand price elasticity can be econometrically estimated or can be obtained from the firms' records. If the firms tend to maximise their profits, even if they do not know the specific functional form of market demand they are facing, they

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[14]See Werden and Froeb (2008, p. 69).

[15]For more information on the relevant time horizon and the choice of the dominant strategic variable for the purpose of merger control see Ristić (2015).

are probably aware of the possible price sensitivity of their customers—from their experience, or some other way. Also, this information, critical for a successful pricing policy, may come from engaging market research agencies to examine customer sensitivity to price changes. It should be noted that the same agencies may be engaged by the competition protection authority if needed.

Also, defining the higher order conditions of the demand function is of crucial importance for the outcome of simulations. Examples of linear and constant elasticity demand functions are typical for this type of analysis. For example, supply reduction is followed by a relatively larger price increases when it comes to constant elasticity demand function in relation to the case of linear demand. Apparently, predictions based on alternative forms of demand, with other things being equal, will vary. Hence, if precise information on the elasticity dynamics is missing, it is not superfluous to conduct simulations on all alternative forms. Model calibration represents the process of obtaining the concrete functional form of demand, based on the available information.

### 3.2  Model Calibration

Therefore, we will use the example of calibration given by Werden and Froeb (2008), which relies on Cournot model and the given information on the market price ($p_0$), the total supply in the relevant market ($q_0$), and the market demand elasticity ($\varepsilon_0$). A properly defined relevant market prior to the merger can provide such information. If we assume an inverse demand in the linear form $p = a - bq$ (for $a$, $b > 0$), based on the *definition* of price elasticity of demand, it turns out that the vertical intercept and the slope of this function can be expressed, respectively, as

$$a = \frac{p_0(\,|\,\varepsilon_0\,|\,+\,1\,)}{|\,\varepsilon_0\,|}; \quad b = \frac{p_0}{q_0\,|\,\varepsilon_0\,|}. \tag{14}$$

In order to obtain the marginal costs for all $n$ firms that belong to the scope of the relevant market, we will use the first-order equilibrium conditions already given in Eq. (8). If demand is calibrated in terms of expression (14), the first order condition can be rewritten as

$$\frac{d\pi_i}{dq_i} = p_0 - q_i b - c_i = 0. \tag{15}$$

By replacing $b$ with its calibrated term in the previous equation, the firm $i$'s marginal costs, for $i = 1, 2, \ldots, n$, would be

$$c_i = \frac{p_0(|\varepsilon_0| - s_i)}{|\varepsilon_0|}. \tag{16}$$

As expected, from the previous term, the firm's marginal costs are inversely related to its market shares. If constant, the marginal costs can be directly obtained from Eq. (16).

Since the parameters of demand and marginal costs are calibrated, the chosen model of competition is fully equipped and ready for short-term predictions of unilateral merger effects.

However, before running the model, its calibrated parameters must be tested whether they are logically consistent with the economic theory related to that particular model and compared to the available information from the set of abovementioned qualitative evidence, since the model is calibrated to explain actual reality. The question that should be asked is whether this model is able to do so. Undoubtedly, a key element in the checks is the marginal costs vector obtained in the calibration process.

If it turns out that the resulting marginal costs significantly differ from the marginal cost approximated by the other inputs to the analysis, it would be worthwhile to re-examine the key elements related to the calibration. Therefore, all variables exogenous to the model should be checked—first of all, the numerical value of the actual price elasticity. Attention should also be directed at the market shares because there is always a positive probability that the relevant market was not properly defined before the simulation. In that case, the analysis should start over from the beginning. Marginal costs should certainly be nonnegative values, while the resulting costs asymmetry should adequately correspond to the market shares asymmetry (larger firms—lower marginal costs, and vice versa).

## 4  Concluding Remarks

In this paper, we have shown that under the circumstances of limited capacity, prices and quantities can be variables in the same oligopoly game. Cournot model, as a reduced form of a two-stage capacity-then-price competition, turned out to be a good approximation of this reality. Moreover, it turns out that in practice Cournot model is implicitly implied in competition law, which seems to be a rarely known fact. The important role of Cournot model can be observed primarily in the context of merger simulation, applied to homogeneous products markets as well as to differentiated products markets.

Starting with the calibrated Cournot model, equipped to explain the observed equilibrium reality, as presumed, the next step is to reach the hypothetical post-merger equilibrium. The main novelty that needs to be incorporated into the calibrated model refers to the fact that merger reduces the number of players in the relevant market. In addition to this, expected post-merger efficiencies must also be taken into account, which will lower marginal costs of the merging parties. Expected

efficiencies are the fundamental argument in favour of mergers, and it should be seriously taken into consideration in the simulation process. Without efficiencies, almost every merger simulation will show a significant decrease in the aggregate consumer surplus. In such an environment, it is the natural interest of the merger parties to show relatively biased expectations regarding the level of efficiencies that could be considered realistic. It is up to the commission to decide what level of efficiencies can be accepted, based on all the available information for the given case. Analysts are not prevented from applying the simulation method to alternate post-merger marginal costs scenarios, even for the extremely optimistic scenarios predicted by the merging firms.

However, the utilisation of the simulation method could be perceived as a complementary analytical tool for controlling concentrations, capable of decreasing the likelihood of common regulatory mistakes—false positive or false negative conclusions. It does not require significant additional time, data or other resources. If the relevant market was properly specified, all elements are most likely already available. The simulation method certainly allows a significant influence of economic theory in merger control, which is in line with the wave of the so-called "more economic approach" in European Commission practice, by incorporating the intensity of the competition and merger efficiencies into one comprehensive economic model.

At the same time, calibration could be seen as a low-cost, and sometimes the only alternative to a full-scale merger analysis, by using econometry, in equipping the selected economic model for estimating demand and cost functions. Of course, this does not exclude the possibility of conducting econometric approach, when authorities have enough time, reliable data and resources for such an endeavour.

The simulation method, based on an adequate economic model, can complicate the day-to-day life of judges and lawyers accustomed to the use of simple per se rules. Sometimes the simulation method may look like the black box generating evidence. Without sufficient understanding of the underlying economic theory, it can certainly become one.

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