CONFLICT OF INTERESTS IN DUOPOLY

Ilko VRANKIĆ
University of Zagreb, Faculty of Economics and Business, Trg J. F. Kennedyja 6, Zagreb, Croatia
ivrankic@efzg.hr

Iva VUKSANOVIC HERCEG
University of Belgrade, Faculty of Economics and Business, Kamenička 6, Belgrade, Serbia
iva.vuksanovic@ekof.bg.ac.rs

Tomislav HERCEG
University of Zagreb, Faculty of Economics and Business, Trg J. F. Kennedyja 6, Zagreb, Croatia
therceg@efzg.hr

Abstract
This paper offers a new perspective of the principal-agent problem in Cournot duopoly when the manager (Agent) of Company 1 is paid in share of the profit, but at the same time owns a share of the competitive company where he does not have executive authority. The latter fact might be misleading since, as it is shown in this paper, even without executive power the share in competitive company triggers a wide set of the effects on the Principal, the co-owners of the competitive company, competitiveness and consumer's welfare. A computational model was built, analysing behaviour of both the Principal and the Agent, but also the other market participants: co-owners and consumers. So far it has not been made in a computational form, but in the normative form only. The model has provided three ways of proving the findings presented in this paper: graphical analysis, algebraic analysis using calculus and numerical examples. They have jointly provided the following conclusions: the higher is the Agent's share in the competitive company, even though the Agent has no executive powers in that company, the lesser is the production level of the Principal's company, and the greater is the production level of the other company. Also, the higher is the share of the Agent, the higher has to be his share in profit given by the Principal, depleting Principal's profit and increasing the profit of the Agent's co-owners. It is also shown that, as compared to the basic Cournot model, the higher is the Agent's share in the competitive company, the lower is competition level measured in the equivalent number of companies. It also increases the price level. In this way consumers also suffer since the model has shown that the Agent's market share causes prices to increase and the overall market coverage to fall.

Keywords: duopoly, principal-agent problem, conflict of interest, Cournot model, profit maximization

JEL classification: C62, C72, D43, M12

Introduction

The agency theory provides a theoretical framework for the relation between one party (the principal) delegating work to another party (the agent) (Daily et al., 2003). The theory has been used in many disciplines, notably in economics (Cooper, 1949, 1951; Ross, 1973), management

(Barnard, 1938; Eisenhardt, 1985, 1988; Kosnik, 1987; Kosnik and Bettenhausen, 1992), finance (Jensen and Meckling, 1976, Fama, 1980,), political science (Mitnick, 1982, 1990; Hammond and Knott, 1996, Kiser and Tong 1992), and sociology (Eccles, 1985; White, 1985, Shapiro, 1987). In economics and business, the agency problem arises due to separation of ownership from management as a consequence of information assymetry (Fama and Jensen, 1983,). In the broadest sense, the agency problem refers to the problem of transferring wealth from one party to another, to the detriment of the former (Berle and Means,1932). In practice, agency problem arises each time the agent (e.i. manager) does not act in the principal's (i.e. owner) best interest. The problematic behaviour ranges from the opportunistic behaviour (Williamson, 1975) to moral hazard (Arrow, 1984).

The research on agency problem have diverged in two directions, sharing common assumptions about people, organizations, and information, yet differing in their mathematical rigor, dependent variable, and style (Eisenhardt, 1989). This paper attempts to provide a mathematical model for a conflict of interest in a Cournot type of duopoly, showing quantitative effects of the principal-agent problem not only on themselves, but also on the other participants on the market: co-owners and consumers.

The paper is structured as follows. Following the introduction, the first part provides an overview of the literature covering the agency problem. The second part introduces a model which will be used as a background for further analytical research. Findings are presented in the third part. The last part concludes and provide future research paths.

Literature overview

Jensen and Meckling (1976) define an agency relationship as a contract in which one or more parties (principal) engage another party (agent) to allocate resources on their behalf, which entails delegating authority to make certain decisions. Assuming that both parties in the relationship are guided by maximizing their own wealth, there is good reason to believe that agents will not always act in the best interests of the principal. Hence, the agency problem arises when the desires or goals of the principal and agent conflict and/or it is difficult or expensive for the principal to verify what the agent is actually doing (Eisenhardt, 1989). The agent can pursue his/her own self-interests and thus take advantage of its position for his/her own benefit (Noreen, 1988; Cohen et. al, 2007). Also, agent can use the information asymmetry to take (hidden) actions for his/her own benefit that expose the principal to undesirable risk of loss (Holmstrom, 1979; Panda and Leepsa, 2017). The principal may limit divergence between interests by establishing an appropriate incentive system (Jensen, 1994; Laffont and Martimort, 2009) or by incurring oversight costs in order to prevent unwanted agent behavior (Donaldson and Davis, 1991; Bonazzi and Islam, 2007). It turns out, therefore, that it is impossible without costs (for the agent and the principal) to ensure optimal decision-making by the agent from the principal’s point of view. Jensen and Meckling (1976) defined agency costs as the sum of monitoring costs, bonding costs, and residual loss.

The agency theory is criticized for not capturing both sides of the relationship (i.e. principal’s relationship towards agents), thus failing to shed light to potential problem of exploiting of the agents by principals (Shapiro, 2008). In his stewardship theory, Perrow (1986) rejects the assumption that agents are work averse, self-interested utility maximizers. However, he admits there are certain situations that are more likely exposed to agency problem emergence.

The research on agency problem have diverged in two directions, the positivist theory (see Jensen and Smith, 2000) and principal-agent research (see Eisenhardt, 1989). Positivist theory focuses on identifying situations of conflicting goals and describing the governance mechanisms that limit the agent's selfish behavior; it is less mathematical and focuses almost exclusively on the special case of large, public corporation (Jensen and Meckling, 1976; Fama, 1980; Fama and Jensen, 1983). Principal-agent research has rather general view of agency relationship (i.e. has implications for different kinds of agency relationship such as client-lawyer, writer-publisher, owner-manager etc.), involves careful specification of assumptions, which are followed by logical deduction and mathematical proof (e.g. Demski and Feltham, 1978). The present paper attempts to bridge the two streams by providing mathematical model for special case of agency relationship between the owner of a company and its manager having ownership stake in another company in the same industry. The companies are producing homogeneous product. The market structure takes shape of oligopoly. The paper does not contradict to the alternative view of principal-agent relation (Donaldson and Davis, 1991) since it analyzes special case of high risk of agency problem occurrence (i.e. stewardship theory premise would not hold). Furthermore, present research provides empirical findings on the impact of agency problem on principal’s wealth (Crutchley and Hansen, 1989, Tosi Jr, and Gomez-Mejia, 1989, Lafontaine, 1992, Davidson III et al., 2004). Few researches cover broader social and institutional effects of agency problem. According to Hill and Jones (1992), area that remains relatively unexplored concerns the ability of agency theory to explain the nature of the implicit and explicit contractual relationships that exist between a firm's stakeholders (i.e. employees, customers, suppliers, creditors, communities, and the general public). This paper aims to contribute to this literature gap by providing a theoretical model for depicting the direct negative effect of agency theory on company’s performance and owner’s wealth, as well as indirect negative implications on firm’s stakeholders’ interests, notably consumers and general public.

The model

In Cournot duopoly model each company announces their own profit maximizing production level knowing their competitor’s production level. In Cournot equilibrium no company has an incentive for a unanimous change in their production level, which is the basic property of the Nash equilibrium. They produce homogeneous product and announce their production plans simultaneously. Their joint quantity produced affects the price with the following relation, where prices are standardized, in order to simplify calculations, while preserving the explanatory power of the model:

$$\boldsymbol{p = 1 - Y = 1 - y_1 - y_2} \tag{1a}$$

where $\boldsymbol{y_1}$ and $\boldsymbol{y_2}$ are nonnegative quantities produced by these two companies. Second simplification, which enabled the possibility of price standardization, is no cost assumption, which does not decrease the explanatory power of the model. Therefore, the basic model is:

$$\boldsymbol{\max_{y_1} \pi_1 = p y_1}$$

&

$$\max_{y_2} \pi_2 = p y_2$$

When maximizing profit ($\frac{\partial \pi_1}{\partial y_1} = 0$ & $\frac{\partial \pi_2}{\partial y_2} = 0$) the following reaction curves are obtained:

$$y_1 = \frac{1}{2} - \frac{1}{2} y_2$$

& (1b)

$$y_2 = \frac{1}{2} - \frac{1}{2}y_1$$

Their intercept provides Cournot-Nash equilibrium where quantities account for 1/3 of the perfectly competitive ones, 2/3 in total:

$$y_1^C = y_2^C = \frac{1}{3}, Y = \frac{2}{3} \tag{1c}$$

Price is $p = 1 - \frac{2}{3} = \frac{1}{3}$ and profits, equal to revenues, quantities multiplied with price:

$$\pi_1 = \pi_2 = \frac{1}{3} \cdot \frac{1}{3} = \frac{1}{9}, \pi = \frac{2}{9}. \tag{1d}$$

Second part of the problem is different from the canonical Cournot oligopoly model. One assumes a manager is employed by the company 1. The owner pays the manager a proportion of profit equal to $\boldsymbol{\vartheta_1}$. The manager has all executive powers. However, that manager owns a $\boldsymbol{\vartheta_2}$ share in the company 2, but without direct executive power, as long as she is a minor shareholder ($\boldsymbol{\vartheta_2 < 50}\%$). Therefore her income consists of a labour income (company 1) and a capital income (company 2):

$$\boldsymbol{V = W + R = \vartheta_1 \Pi_1 + \vartheta_2 \Pi_2} \tag{2}$$

In this way the manager's goal is incoherent with the goal of the owner of the company 1, which arises a specific kind of a principal – agent problem, where agent acquires yield from both market participants. Depending on $\boldsymbol{\vartheta_1}$ and $\boldsymbol{\vartheta_2}$, the agent would be more or less coherent with the principal's goal, maximizing her income. Since her executive power lies at the company 1 only, as long as $\boldsymbol{\vartheta_2 < 0.5}$, the decision variable remains $\boldsymbol{y_1}$ only:

$$\boldsymbol{\max_{y_1} V = \vartheta_1 \Pi_1 + \vartheta_2 \Pi_2} \tag{3}$$

$$\boldsymbol{\max_{y_1} V = \vartheta_1 p y_1 + \vartheta_2 p y_2} \tag{4}$$

$$\boldsymbol{\max_{y_1} V = p(\vartheta_1 y_1 + \vartheta_2 y_2)} \tag{5}$$

$$\frac{\partial \mathrm{V}}{\partial \mathrm{y}_1} = \frac{\partial p}{\partial y_1}(\vartheta_1 y_1 + \vartheta_2 y_2) + p\vartheta_1 = \vartheta_1 - 2\vartheta_1 y_1 - (\vartheta_1 + \vartheta_2)y_2 = 0$$

Which provides company 1's reaction curve:

$$\boldsymbol{y_1 = \frac{1}{2} - \frac{\vartheta_1 + \vartheta_2}{2\vartheta_1} y_2} \tag{7}$$

Note that this reaction curve is deducted from the individual interest of the agent. Company 2, on the other hand, makes independent decisions based on its profit interest:

$$\boldsymbol{\max_{y_2} \Pi_2 = p y_2 = (1 - y_1 - y_2) y_2} \tag{8}$$

$$\boldsymbol{\frac{\partial \Pi_2}{\partial y_2} = 1 - y_1 - 2y_2 = 0} \tag{10}$$

Reaction curve of the Company 2 is:

$$\boldsymbol{y_2 = \frac{1}{2} - \frac{1}{2} y_1} \tag{11}$$

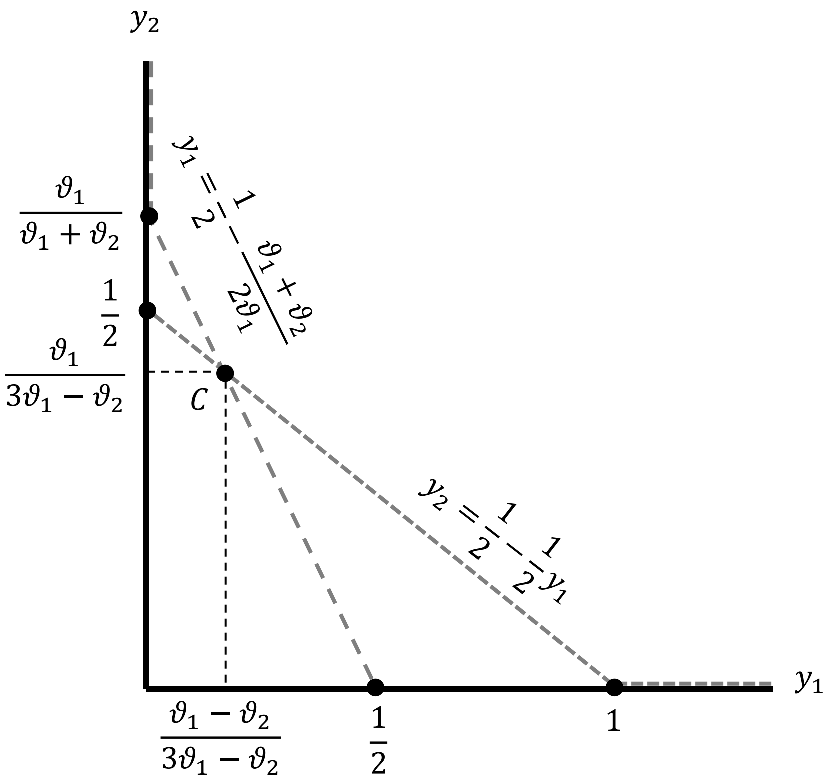
The two reaction curves, shown on Figure 1, lead to the Cournot equilibrium at their intercept (point C):

$$\boldsymbol{y_1^C = \frac{\vartheta_1 - \vartheta_2}{3\vartheta_1 - \vartheta_2}; y_2^C = \frac{\vartheta_1}{3\vartheta_1 - \vartheta_2}; Y = \frac{2\vartheta_1 - \vartheta_2}{3\vartheta_1 - \vartheta_2}} \tag{12}$$

Which yields the price:

$$\boldsymbol{p = \frac{\vartheta_1}{3\vartheta_1 - \vartheta_2}} \tag{13}$$

Figure 1: Cournot model in case of Agent's conflict of interests



Source: Authors' calculation.

Profits of these two companies are:

$$\pi_1 = \frac{1}{9} - \frac{\vartheta_2(3\vartheta_1+\vartheta_2)}{9(3\vartheta_1-\vartheta_2)^2}$$

$$\pi_2 = \left[\frac{1}{3} + \frac{\vartheta_2}{3(3\vartheta_1-\vartheta_2)}\right]^2$$

$$\pi = \frac{2}{9} + \frac{\vartheta_2(3\vartheta_1-2\vartheta_2)}{9(3\vartheta_1-\vartheta_2)^2} \qquad (14)$$

Results

Company 1 owner (Principal) has his own profit function which is equal to what is left after his manager (Agent) takes his profit share $\boldsymbol{\vartheta_1}$:

$$\max_{\boldsymbol{\vartheta_1}} \boldsymbol{Z} = (\mathbf{1} - \boldsymbol{\vartheta_1})\boldsymbol{\Pi_1} = \frac{(\mathbf{1}-\boldsymbol{\vartheta_1})\boldsymbol{\vartheta_1}(\boldsymbol{\vartheta_1}-\boldsymbol{\vartheta_2})}{(\mathbf{3}\boldsymbol{\vartheta_1}-\boldsymbol{\vartheta_2})^2} \qquad (15)$$

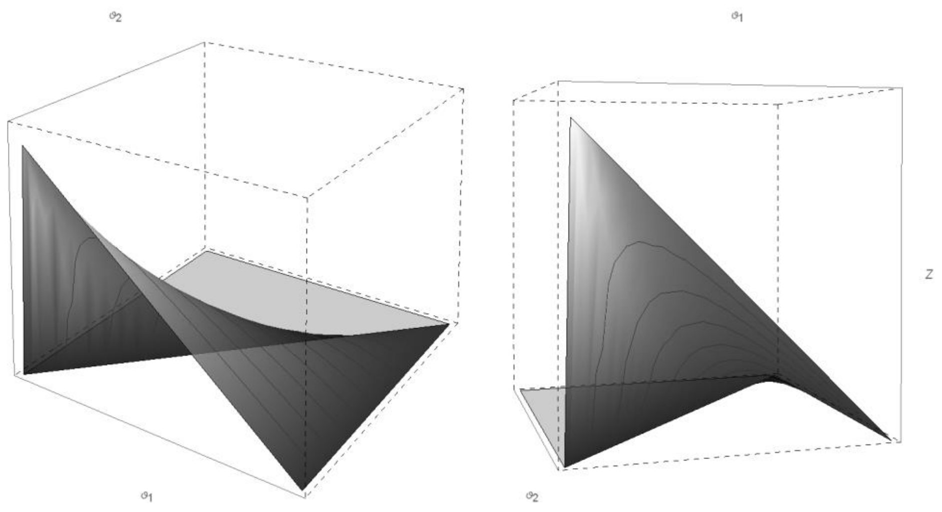
Figure 2 shows a three-dimensional graph of the Z function.

Principal then wants to find out the profit share $\boldsymbol{\vartheta_1}$which maximizes his own profit for a given level of $\boldsymbol{\vartheta_2}$ he cannot control:

$$\max_{\boldsymbol{\vartheta_1}} \boldsymbol{Z} = \frac{(\mathbf{1}-\boldsymbol{\vartheta_1})\boldsymbol{\vartheta_1}(\boldsymbol{\vartheta_1}-\boldsymbol{\vartheta_2})}{(\mathbf{3}\boldsymbol{\vartheta_1}-\boldsymbol{\vartheta_2})^2} \qquad (16)$$

Remember that $\boldsymbol{\vartheta_1}\boldsymbol{\epsilon}[\mathbf{0},\mathbf{1}]$ by definition. However, when looking at Figure 1, one notices that if $\frac{\boldsymbol{\vartheta_1}}{\boldsymbol{\vartheta_1}+\boldsymbol{\vartheta_2}} \leq \frac{\mathbf{1}}{\mathbf{2}}$ then Agent decides not to produce and competitive company 2 becomes a monopolist ($\boldsymbol{y_2^M} = \frac{\mathbf{1}}{\mathbf{2}}$).

Figure 2: Principal's profit function



Source: Authors' calculation.

Therefore, in order to maintain its presence on the market, Principal has to provide that:

$$\frac{\boldsymbol{\vartheta_1}}{\boldsymbol{\vartheta_1+\vartheta_2}} > \frac{\mathbf{1}}{\mathbf{2}} \Rightarrow \boldsymbol{\vartheta_1} > \boldsymbol{\vartheta_2} \tag{17}$$

Also, since $\boldsymbol{\vartheta_2 \epsilon [0, 1]}$, if $\boldsymbol{\vartheta_2 = 1}$ then it is not possible that $\boldsymbol{\vartheta_1}$ exceeds its value and Z = 0. Therefore the optimum share of profit rewarded to the Agent has to be found at $\boldsymbol{\vartheta_1 \epsilon \langle \vartheta_2, 1 \rangle}$

$$\frac{dZ}{d\vartheta_1} = \frac{-3\vartheta_1{}^3+3\vartheta_2\vartheta_1{}^2+\vartheta_2(1-2\vartheta_2)\vartheta_1+\vartheta_2{}^2}{(3\vartheta_1-\vartheta_2)^3} = 0 \tag{18}$$

The expression (18) can be solved as the cubic equation:

$$\boldsymbol{-3\vartheta_1{}^{*3} + 3\vartheta_2\vartheta_1{}^{*2} + \vartheta_2(1-2\vartheta_2)\vartheta_1^* + \vartheta_2{}^2 = 0} \tag{19}$$

Therefore a solution will be $\boldsymbol{\vartheta_1^* = \vartheta_1(\vartheta_2)}$ and can be obtained by solving a cubic equation for each given value of $\boldsymbol{\vartheta_2}$. Table 1 contains simulation for four different values of $\boldsymbol{\vartheta_2}$:

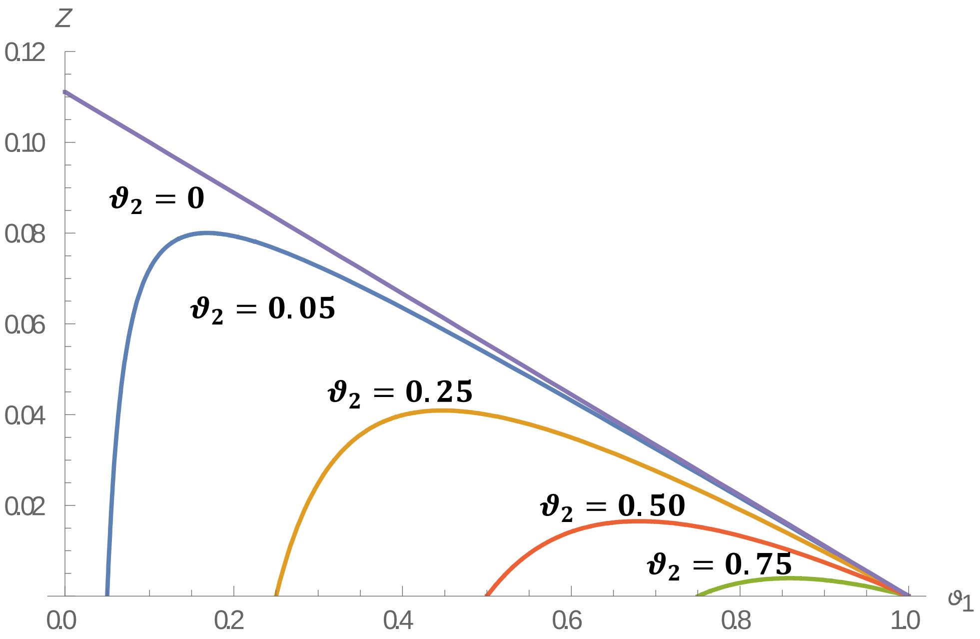
Table 1: Numerical examples for selected $\boldsymbol{\vartheta_2}$ values

$\boldsymbol{\vartheta_2}$	$\boldsymbol{\vartheta_1^*}$	$\boldsymbol{y_1}$	$\boldsymbol{y_2}$	***Y***	***p***	***Π₁***	***Π₂***	***Π***
0.05	0.16843	0.260120	0.36994	0.630060	0.369940	0.096229	0.136856	0,233084
0.25	0.44728	0.180686	0.409657	0.590343	0.409657	0.074019	0.167819	0,241838
0.50	0.68014	0.116942	0.441529	0.558471	0.441529	0.051633	0.194948	0,246581
0.75	0.85871	0.059530	0.470235	0.529765	0.470235	0.027993	0.221121	0,249114
Basic Cournot:		**0.333333**	**0.333333**	**0.666667**	**0.333333**	**0.111111**	**0.111111**	**0.222222**

where $\boldsymbol{\vartheta_2}$ values are randomly picked, $\boldsymbol{\vartheta_1^*}$ is solved by solving (19) for the given $\boldsymbol{\vartheta_2}$, the quantities are obtained by stubbing the $\boldsymbol{\vartheta_1^*}$ and $\boldsymbol{\vartheta_2}$ into (12), price from the expression (13) and profits using the expression (14). In the last row the values of price, quantities and profits are given for the plain Cournot model presented in (1). Z function for the scenarios given in the Table 1, as well as the $\boldsymbol{\vartheta_2 = 0}$ scenario (linear Z function), is given with the Figure 3.

Figure 3 shows that the larger is the Agent's share in the competitive company, the greater is the $\boldsymbol{\vartheta_1}$ share that the Principal has to give to the Agent, and the maximum payoff of the owner (Z) depletes gradually as $\boldsymbol{\vartheta_2}$ increases. Note that Figure 3 maps vertical cuts of the Z function shown on Figure 2.

Figure 3: Z function when $\boldsymbol{\vartheta_2 = 0, 0.05, 0.25, 0.50}$ ***and*** $\boldsymbol{0.75}$



Source: Authors' calculation.

There are interesting tendencies that can be observed in the Table 1. First set of observations observes relation between Principal and the Agent. It can be seen that, when $\boldsymbol{\vartheta_2}$ increases, then 1a) $\boldsymbol{\vartheta_1^*}$ increases too; 1b) production of company 1 tends to fall, as well as its profit, which are both below basic Cournot level of production and profit. The tendencies of the payoff of the owner are graphically shown on the Figure 3, showing that it keeps being flatter (from blue to green), and the optimum level of $\boldsymbol{\vartheta_1^*}$ increases as $\boldsymbol{\vartheta_2}$ increases.

Second group of tendencies is related to the performances of the competitive company and in turn all of its owners, not only the Agent: 2a) as $\boldsymbol{\vartheta_2}$ increases, production of the competitive company 2 increases, as well as its profit which is further above the basic Cournot level of profit the higher is the $\boldsymbol{\vartheta_2}$ share (2b). It suggests that the Principal – Agent problem affects not only Principal and Agent, but also the other market players, thus increasing their market power and moving further away from the competitive market.

Third set of observations show that the increase in $\boldsymbol{\vartheta_2}$ causes the prices to increase (3a) as well as the overall profit (3b). Along with the fact that the market power increases, it shows that the higher is the conflict of interests (rising $\boldsymbol{\vartheta_2}$) the worse off are consumers. To sum up, conflict of interests causes not only deterioration of the Principal's profit and market position, but also contraction of the overall market, rise in prices and fall in produced quantity. This in turn causes a loss of the consumer's surplus and boosts profits of the Agent's co-owners.

The above observations can also be proven using arithmetics. Observation 1a) relates $\boldsymbol{\vartheta_1^*}$ and $\boldsymbol{\vartheta_2}$. The initial point is the identity equation given with (19). Its differentiation with respect to $\boldsymbol{\vartheta_2}$ gives:

$$\left[9{\vartheta_1^*}^2 - 6\vartheta_2{\vartheta_1}^* - \vartheta_2(1-2\vartheta_2)\right]\frac{d{\vartheta_1}^*}{d\vartheta_2} - 3{\vartheta_1^*}^2 - 2\vartheta_2 - \vartheta_1^*(1-4\vartheta_2) = 0 \qquad (20)$$

From which $\frac{d{\vartheta_1}^*}{d\vartheta_2}$ can be provided:

$$\frac{d\boldsymbol{\vartheta}_1{}^*}{d\boldsymbol{\vartheta}_2} = \frac{3\boldsymbol{\vartheta}_1{}^{*^2} + 2\boldsymbol{\vartheta}_2 + \boldsymbol{\vartheta}_1^*(1-4\boldsymbol{\vartheta}_2)}{9\boldsymbol{\vartheta}_1{}^{*^2} - 6\boldsymbol{\vartheta}_2\boldsymbol{\vartheta}_1{}^* - \boldsymbol{\vartheta}_2(1-2\boldsymbol{\vartheta}_2)} = \frac{\boldsymbol{A}}{\boldsymbol{B}} \tag{21}$$

The next step is to determine the sign of A. By multiplying A with $\boldsymbol{\vartheta}_1^*$ the following expression appears:

$$\boldsymbol{A\vartheta}_1^* = \mathbf{3}\boldsymbol{\vartheta}_1{}^{*^3} + \mathbf{2}\boldsymbol{\vartheta}_2\boldsymbol{\vartheta}_1^* + \boldsymbol{\vartheta}_1^{*^2}(\mathbf{1} - \mathbf{4}\boldsymbol{\vartheta}_2) \tag{22}$$

After expressing $\mathbf{3}\boldsymbol{\vartheta}_1{}^{*^3}$ from (19) and replacing the bolded part of (22) the following is obtained:

$$A\vartheta_1^* = (1-\vartheta_2)\vartheta_1^{*^2} + \vartheta_2(3-2\vartheta_2)\vartheta_1^* + \vartheta_2{}^2 > 0 \tag{23}$$

After it is determined that A$\boldsymbol{\vartheta}_1^*$ is positive, one has to determine the sign of B, which should be positive if observations of the Table 1 are proper:

$$B = 9\vartheta_1^{*^2} - 6\vartheta_2\vartheta_1^* - \vartheta_2(1-2\vartheta_2)$$

$$B\vartheta_1^* = 9\vartheta_1{}^3(\vartheta_2) - 6\vartheta_2\vartheta_1^{*^2} - \vartheta_2(1-2\vartheta_2)\vartheta_1^* \tag{24}$$

Again refer to (19). After expressing $\vartheta_2(1-2\vartheta_2)\vartheta_1^*$ and replacing the bolded part of (24) the following is obtained, where it becomes obvious that $B\vartheta_1^*$ is positive:

$$B\vartheta_1^* = 3\vartheta_1^{*^2}(2\vartheta_1^* - \vartheta_2) + \vartheta_2{}^2 > 0 \tag{25}$$

By dividing $A\vartheta_1^*$ and $B\vartheta_1^*$ the following result is obtained:

$$\frac{d\vartheta_1^*}{d\vartheta_2} = \frac{A\vartheta_1^*}{B\vartheta_1^*} = \frac{A}{B} > 0 \tag{26}$$

This finding proves the observation 1a) in a general case, stating that the Principal optimal reward for the Agent increases as the Agent's profit share in the competitive company rises, keeping in mind that the rewarded share should be greater than the Agent's share in competitive company (expression 17).

Observations 2 and 3 can partially be proven using the following analysis: by rearranging the values of quantities (12), price (13) and profits (14) in the following way:

$$\begin{aligned}
\boldsymbol{y}_1^{\boldsymbol{C}} &= \frac{\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2}{3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2} = \frac{\mathbf{1}}{\mathbf{3}} - \frac{2\boldsymbol{\vartheta}_2}{3(3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2)} < \frac{\mathbf{1}}{\mathbf{3}} \\
\boldsymbol{y}_2^{\boldsymbol{C}} &= \frac{\boldsymbol{\vartheta}_1}{3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2} = \frac{\mathbf{1}}{\mathbf{3}} + \frac{\boldsymbol{\vartheta}_2}{3(3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2)} > \frac{\mathbf{1}}{\mathbf{3}} \\
\boldsymbol{Y} &= \frac{2\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2}{3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2} = \frac{\mathbf{2}}{\mathbf{3}} - \frac{\boldsymbol{\vartheta}_2}{3(3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2)} < \frac{\mathbf{2}}{\mathbf{3}} \\
\boldsymbol{p} &= \frac{\boldsymbol{\vartheta}_1}{3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2} = \frac{\mathbf{1}}{\mathbf{3}} + \frac{\boldsymbol{\vartheta}_2}{3(3\boldsymbol{\vartheta}_1 - \boldsymbol{\vartheta}_2)} > \frac{\mathbf{1}}{\mathbf{3}} \\
\pi_1 &= \frac{1}{9} - \frac{\vartheta_2(3\vartheta_1 + \vartheta_2)}{9(3\vartheta_1 - \vartheta_2)^2} < \frac{1}{9} \\
\pi_2 &= \left[\frac{1}{3} + \frac{\vartheta_2}{3(3\vartheta_1 - \vartheta_2)}\right]^2 > \frac{1}{9} \\
\pi &= \frac{2}{9} + \frac{\vartheta_2(3\vartheta_1 - 2\vartheta_2)}{9(3\vartheta_1 - \vartheta_2)^2} > \frac{2}{9}
\end{aligned} \tag{27}$$

It is proven that in this model Principal's company 1 produces less and earns less when Agent has the conflict of interests; competitive company, where the Agent has the share, produces more and earns more; prices soar above the basic Cournot level of prices and the overall profit on the market is also above the overall Cournot profit without conflict of interest, showing a negative effect of the conflict on consumers and competition. The tendencies, however, should be tested in the same way as the observation 1a) was tested, which is beyond the scope of this paper.

Market saturation in the Cournot oligopoly model can also be analysed by the number of companies in the oligopolistic market. Fundamental microeconomic theory provides the information that the overall produced quantity on the Cournot oligopoly market (Y^C) with *n* companies is equal to $Y^C = \frac{n}{n+1} Y^{PC}$, where Y^{PC} is perfectly competitive quantity. In the example presented in (1), Y^{PC} turns out to be equal to 1. Therefore, each total quantity of production in Table 1 could provide an equivalent of the market participants:

$$Y = \frac{n}{n+1} \Longrightarrow n = \frac{Y}{1-Y} \tag{28}$$

It provides the background for the Table 2:

Table 2: Conflict of interests and the equivalent number of market players

ϑ2	**0**	**0,05**	**0,25**	**0,5**	**0,75**
Y	0,666667	0,63006	0,590343	0,558471	0,529765
n	2	1,70314	1,44107	1,26486	1,12660

Table 2 shows that, the larger the company share of the Agent in company 2, the lower is the equivalent number of participants, corroborating the previous statements saying that the rise in the conflict of interests discourages competition.

Conclusion

In this paper a basic Cournot duopoly model with standardized prices and zero costs is analysed. A novelty was introduced by assuming that the manager of the company 1 (Agent), is rewarded with a share of profit by the owner (Principal). The Agent also has a share in the other company, but without executive power. The goal was to show was happens as the Agent's share in the other company increases, thus increasing the conflict of interests. It was found out that the Principal's profit function is positive only when he rewards the Agent with the share which is higher than the Agent's share in the other company, but depletes as that share increases. Algebraic analysis has provided that these two shares are positively correlated.

Numerical examples have shown that when the conflict of interests rises, then production and the profit level of the other company and its co-owners increase too, while production and the payoff of the owner the company 1 falls due to both fall in that company's profit and rise of the share of the Agent. Prices also tend to go up, market profits too, while market coverage falls. It shows that the more intense is the conflict of interest, the lower is the consumer's welfare and the lower is the level of competitiveness on the market.

This paper has also provided a novelty in the competitiveness measuring, relating the market coverage with the equivalent number of companies in oligopoly, showing that the conflict of interests has the effect as if the number of companies is not integer. Future studies will focus on the generalization of the analysis to n participants. Also, the tendencies of the ownership share increase should be provided not only by numerical example, but also using comparative statics.

References

Arrow, K. J. (1984). *The economics of agency*. Stanford univ ca inst for mathematical studies in the social sciences. Retrieved from https://apps.dtic.mil/sti/pdfs/ADA151436.pdf)

Barnard, C. (1938). *The functions of the executive*. Cambridge/Mass: Harvard University Press

Berle, A., & Means, G. (1932). The modern corporate and private property. New York: McMillian.

Bonazzi, L., & Islam, S. M. (2007). Agency theory and corporate governance: A study of the effectiveness of board in their monitoring of the CEO. *Journal of modelling in management*. *2*(1), 7-23

Cohen, J. R., & Holder-Webb, L., Sharp, D. J., & Pant, L. W. (2007). The effects of perceived fairness on opportunistic behavior. *Contemporary Accounting Research*, *24*(4), 1119-1138.

Cooper, W. W. (1949). Social accounting: An invitation to the accounting profession. *The Accounting Review*, *24*(3), 233-239.

Cooper, W. W. (1951). A Proposal for Extending the Theory of the Firm. *The Quarterly Journal of Economics*, 87-109.

Crutchley, C. E., & Hansen, R. S. (1989). A test of the agency theory of managerial ownership, corporate leverage, and corporate dividends. *Financial Management,* 36-46.

Daily, C. M., Dalton, D. R., & Rajagopalan, N. (2003). Governance through ownership: Centuries of practice, decades of research. *Academy of Management Journal*, *46*(2), 151–158

Davidson III, W. N., Jiraporn, P., Kim, Y. S., & Nemec, C. (2004). Earnings management following duality-creating successions: Ethnostatistics, impression management, and agency theory. *Academy of management journal*, *47*(2), 267-275.

Demski, J., & Feltham, G. (1978) Economic incentives in bud- getary control systems. *Accounting Review*, *53*, 336-359

Donaldson, L., & Davis, J. H. (1991). Stewardship theory or agency theory: CEO governance and shareholder returns. *Australian Journal of management*, *16*(1), 49-64.

Donaldson, L., & Davis, J. H. (1991). Stewardship theory or agency theory: CEO governance and shareholder returns. *Australian Journal of management*, *16*(1), 49-64.

Eccles, R. (1985). *Transfer pricing as a problem of agency*. In J. Pratt & R. Zeckhauser (Eds.), Principals and agents: The structure of business (pp. 151-186). Boston: Harvard Busi- ness School Press.

Eisenhardt, K. (1985). Control: Organizational and economic approaches. *Management Science*, *31*, 134- 149.

Eisenhardt, K. (1988). Agency and institutional explanations of compensation in retail sales. *Academy of Management Journal*, *31*, 488-511.

Eisenhardt, K. M. (1989). Agency theory: An assessment and review. *Academy of management review*, *14*(1), 57-74.

Fama, E. (1980). Agency problems and the theory of the firm. *Journal of Political Economy*, *88*, 288-307.

Fama, E., & Jensen, M. (1983). Separation of ownership and control. *Journal of Law and Economics*, *26*, 301-325.

Hammond, T., & Knott, J. (1996). Who controls the bureaucracy? Presidential power, congressional dominance, legal constraints, and bureaucratic autonomy in a model of multi-institutional policy-making. Journal of Law, Economics, and Organization, 12(1), 119–166

Hill, C. W., & Jones, T. M. (1992). Stakeholder-agency theory. *Journal of management studies*, *29*(2), 131-154.

Holmstrom, B. (1979). Moral hazard and observability. *Bell Journal of Economics*, *10*, 74-91.

Jensen, M. C. (1994). Self-interest, altruism, incentives, and agency theory. *Journal of applied corporate finance*, *7*(2), 40-45.

Jensen, M. C., & Smith, C. W. (2000). Stockholder, manager, and creditor interests: Applications of agency theory. *Theory of the Firm*, *1*(1). Retrieved from https://www.researchgate.net/profile/Clifford-Smith-7/publication/228138310_Stockholder_Manager_and_Creditor_Interests_Applications_of_Agency_Theory/links/5b507c66a6fdcc8dae2cf9e9/Stockholder-Manager-and-Creditor-Interests-Applications-of-Agency-Theory.pdf

Jensen, M.C, & Meckling, W.H. (1976). Theory of the Firm: Managerial Behavior, Agency Cost and Ownership Structure, *Journal of Financial Economics* 4, 305-360

Kiser, E., & Tong, X. (1992). Determinants of the amount and type of corruption in state fiscal bureaucracies: An analysis of late imperial China. *Comparative Political Studies, 25*(3), 300–331.

Kosnik, R. (1987). Greenmail: A study in board performance in corporate governance. *Administrative Science Quarterly, 32*, 163-185.

Kosnik, R. D., & Bettenhausen, K. L. (1992). Agency theory and the motivational effect of management compensation: An experimental contingency study. *Group & Organization Management*, *17*(3), 309-330.

Laffont, J. J., & Martimort, D. (2009). The theory of incentives. In *The Theory of Incentives*. Princeton university press.

Lafontaine, F. (1992). Agency theory and franchising: some empirical results. *The rand journal of economics*, 263-283.

Mitnick, B. M. (1982). REGULATION AND THE THEORY OF AGENCY1. *Review of Policy Research, 1*(3), 442-453.
Mitnick, B. M. (1990). The Two-Part Problem of Regulatory Compliance: Compliance Reform and Strip Mining. *Government Regulation and Business Response: Research Issues and Empirical Studies*, 85.
Noreen, E. (1988). The economics of ethics: A new perspective on agency theory. *Accounting, Organizations and society*, *13*(4), 359-369.
Panda, B., & Leepsa, N. M. (2017). Agency theory: Review of theory and evidence on problems and perspectives. *Indian Journal of Corporate Governance*, *10*(1), 74-95.
Perrow, C. (1986). *Complex organizations*. New York: Random House.
Ross, S. A. (1973). The economic theory of agency: The principal's problem. *The American Economic Review, 63*(2), 134-139.
Shapiro, S. P. (1987). The social control of impersonal trust. *American journal of Sociology*, 623-658.
Shapiro, S. P. (2005). Agency theory. *Annu. Rev. Sociol.*, *31*, 263-284.
Tosi Jr, H. L., & Gomez-Mejia, L. R. (1989). The decoupling of CEO pay and performance: An agency theory perspective. *Administrative Science Quarterly*, 169-189.
White, H. (1985). *Agency as control*. In J. Pratt & R. Zeck- hauser (Eds.), Principals and agents: The structure of business (pp. 187-214). Boston: Harvard Business School Press.
Williamson, O. E. (1975). *Markets and hierarchies: analysis and antitrust implications: a study in the economics of internal organization*. University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.