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ECONOMIC CONSORTIA IN THE MILITARY INDUSTRY

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Summary:

According to the latest media reports, military consortia are more and more frequently formed. They unite Polish arms companies around the implementation of projects of key importance for the Polish Armed Forces' armaments. In December 2012 the Ministry of National Defense (MON) announced that over the coming 10 years the military intends to have further projects performed, that is new combat vehicles, both wheeled and tracked, developed. A consortium aims to prepare plans and submit a bid on the execution of research and development works in order to draw up a joint project and then introduce it to series production. The problem may arise on the grounds of the distribution of a profit and other goods, which are generated in the process of cooperation, and not covered by the consortium agreement. The article attempts to address the question of what tool may be useful when determining fair rules for functioning of consortia in the arms industry so as to reflect the factual distribution of consortium members.

Keywords:

consortium, tools for management support, fair share, military industry

INTRODUCTION

1. BALANCE IN MARKET NEGOTIATIONS

It seems that the factor of cooperative and competitive nature (*Eng. Cooperative-Competitive Value – "COCO-value"* [6]) is applicable (hence its calculation is reasonable) in many everyday situation. It is crucial to strike a kind of balance in market negotiations, which will reflect the factual contribution of business entities concluding various agreements among themselves. Economic consortia, where the need to determine the value is seen, are its classic example.

A consortium, as a body bringing together several entities only temporarily (for a specific period) for achieving a particular goal, is usually created for investments, is characterized by a relatively high degree of risk, is often conducted on a large scale and requires a sizeable financial contribution. A consortium is established with the objective of participating in a common activity (and thus cooperation) in the implementation of a specific business venture, which, due to the need to involve a large financial potential, often prevents "acting alone" (this applies to projects such as: motorway construction, price negotiations between coal mines and power plants, as well as the realization of military projects). Having reached a specific goal, a consortium is most often dissolved, but it can be formed again if the activity is cyclical. Such a solution is "convenient" from the legal point of view in Poland, since it does not require registration, a seat or even a separate name. Furthermore, entities forming a consortium retain their independence when it comes to their own operation activity. Besides, everything is rather determined a priori within a consortium, and supported by an appropriate agreement (legal consortium agreement). Joint property is not an option here and, therefore, possibly only the generated income can be divided. As for the liabilities incurred by a whole consortium the situation is clear - all members of the consortium held joint responsibility for them. Thus, it comes as no surprise that this form of cooperation is often and willingly established, however individual entities are not always keen to share profit equitably, depending on the contribution that was already made by them (when undertaking cooperation) – irrespective of the type of the contribution - financial or informative.

The operation of such an organization can be treated in two stages; at the first one (cooperative, with non-zero sum) both parties should choose the optimal action to maximize aggregate gains so as to reach their fully accepted division (fair in relation to the consortium members' contribution) only at the second stage (that is the stage of benefits achieved, non-cooperative, of zero sum). Therefore, the important element that will be evident in the discussion is information and strategic asymmetries, which can more or less encourage opportunism in activities of either party. Not without significance are also all the activities of entities aiming to improve their situation, which may also take place despite previous arrangements between the parties.

2. CONSORTIA IN THE ARMS INDUSTRY

According to the latest media reports, military consortia are more and more frequently formed. They unite Polish arms companies around the implementation of projects of key importance for the Polish Armed Forces' armaments. In December 2012 the Ministry of National Defense (MON) announced that over the coming 10 years the military intends to have further projects performed, that is new combat vehicles, both wheeled and tracked, developed. This is particularly significant when the main directions of the Armed Forces' development determined by the President of the Republic of Poland are reflected as strategic ones in the plans of technical modernization of the Polish Army implemented by the Ministry of Defense. Delegating as many tasks as possible in these areas to Polish companies and enterprises will be of great importance for the present,

and especially future, security, a sense of sovereignty and independence of Poland in the existing geopolitical system.

The Ministry, therefore, strongly supports consortia created by domestic companies, developing projects corresponding to the concept of development of the Armed Forces. Recently there have been established several new consortia to work on, among others, a new armored platform, future armored personal carriers and the modernization of Leopard tanks. The agreement of eight companies from the military industry, which are to jointly design a new combat infantry vehicle, was greatly echoed. The leader of this consortium is Huta Stalowa Wola. The company legal representatives taking the opportunity of the conclusion of the agreement determined the conditions of its operation – *"the consortium brings together Polish military enterprises on fair and viable principles around the implementation of key projects for the armament of our Army"* [13]. In addition, it was emphasized, that "*the consortium has a closed character, and its members provide for the possibility of exclusion from among them a company that improperly performs the obligations specified in the signed contract*" [13].

Thus, the question arises: what tools can assist military consortia in dividing generated profits in a just way? All this really means: can every situation during the implementation of a particular project be predicted in the consortium agreement? What to do in the case of contentious situations – e.g. generating additional income by the consortium as a result of increasing orders and deliveries? How to share goods when their division is not clearly defined in the agreement concluded upon the establishment of a military consortium? It seems that in the future the cooperative - competitive solution proposed by Kalai may prove a helpful tool [6].

3. THE USE OF COOPERATIVE - COMPETITIVE SOLUTIONS IN A MILITARY CONSORTIUM

As can be easily noticed, this type of arrangement can be treated as a typical bilateral monopoly (in the relation: a consortium and a project contracting entity, or in special cases - within a military consortium), where the cooperative - competitive solution is applicable without doubt, (assumptions and the definition of the solution are discussed further in the work). So it is applicable when it is important to find a kind of balance, where negotiations between parties are only decisive. This balance should reflect the actual input and output strategic positions of economic entities forming the consortium. The distribution of the joint maximum profit system using the cooperative - competitive factor makes it possible to change the individual payments and may be one of the methods of calculating the so-called secondary (transfer) payment due to information asymmetry of both entities. It seems obvious, therefore, that in this situation, much depends on the initial position of 'players', bargaining power and, in general, skills to negotiate. A bilateral monopoly is usually met in the situation when a production factor occurs rarely, with the simultaneous high demand for the product. Such a situation leaves a wide field when it comes to negotiating and profit distribution among players involved in a certain relation. Other examples of a bilateral monopoly include: a supplier of parts required for assembly and the final assembly (e.g. for the production of military equipment), a provider of a good and its user, a service provider and a customer (roles with reference to numerous tenders). The reasons for the

occurrence of such a monopoly can be different - often in the case of military consortia the quasi-monopolistic relationship arises from the expectations of safety. The existing techniques for determining the distribution of profits (and thus involving a non-price transfer) can be based on a number of contract mechanisms. This paper proposes the use of the concept of the Kalai's cooperative - competitive solution [6], the so-called solution of the COCO type. The subject of the negotiations is, therefore, not the price of a good or service between the participants of consortia, but the share in profits and, more specifically, their final distribution between cooperating entities. The disclosure of own costs and their mutual control are essential if a consortium is to function correctly indicating the optimal production volume and ensuring that the previously approved profit sharing is maintained.

4. THEORETICAL PRINCIPLES OF THE COOPERATIVE – COMPETITIVE SOLUTION

Assuming that the two units (players) forming the consortium:

- are highly rational;
- each of them can assess its preferences towards different objects $A, B, \ldots \epsilon S$;
- have a similar ability to bargain (negotiate);
- have full knowledge of tastes and preferences of the other party.

By introducing (von Neumann, Morgenstern, 1944) the utility function $u: S \rightarrow R$ for a single player, it is expected (with an accuracy of a linear combination: $au + b, a > 0$) that the following conditions are met:

- A unit (person) can always decide which outcome is to be chosen, or that both are equally desirable. Moreover, if $0 \leq p \leq 1$ and A and B are possible results, $pA + (1 - p)B$ is also a possible result;
- The order relation is transitive;
- Any probabilistic combination of equally preferred states is preferred as much as them;
- If A, B and C satisfy the transitivity condition, the probabilistic combination A and C occurs, which is preferred to the same extent as C;
- If $0 \leq \mathrm{p} \leq 1$ and A and B are equally preferred, then $\mathrm{pA} + \mathrm{(1\text{-}p)C}$ and $\mathrm{pA} + \mathrm{(1\text{-}p)C}$ are equally preferred as well. Also, if A and B are equally preferred, A can replace B in any order relation fulfilled by B.

The utility function *u* has the following properties:

a) $u(A) > u(B) \Leftrightarrow A$ is preferred over B;

b) If $0 \leq p \leq 1$ then $u[pA + (1 - pB] = pu(A) + (1 - p)u(B)$.

A two - player result is defined as a combination of two one - player results.

a) If $[A, B]$ is a two - player result and $0 \leq \mathrm{p} \leq 1$, then $p[A, B] + (1 - p)[C, D] = [pA + (1 - p)C, pB + (1 - p)D]$.

b) The pair (a, S) is assigned to each two – player game where a is the point of the plane;

c) S is a subset thereof. Let $a = (a_{1,} a_2)$ where a_i is the level of utility achieved by the I[th] player if both players do not cooperate with each other and $x = (x_1, x_2) \in S$ shows the level of utility of the attainable payout in a game in which players cooperate[1].

Let U denote the set of pairs (a, S). Each element of U is a bargaining pair. Thus, the task arbitration is to find a payment in S accepted by both players. The solution to the bargaining problem is the function $f: U \to R^2$, $f(a, S) \in S$.

Nash (1950) was the first to give the solution to this problem by formulating four axioms that are necessary and sufficient for the existence of the solution:

- Axiom 1 - Pareto optimality. For each pair $(a, S) \in U$ there is not any $y \in S$, where $y \geq f(a, S)$ and $y \neq f(a, S)$;
- Axiom 2 - Symmetry. Let $T: R \to R^2$ be the function $T((x_1, x_2) = (x_1, x_2)$. For each pair $(a, S) \in U$, $f\big(T(a), T(S)\big) = T(f(a, S)$.
- Axiom 3 - Constancy due to the affine transformation of utility;
- Axiom 4 - Independence of irrelevant alternatives. If (a, S) and (a, T) are the bargaining pairs such that $s \subset T$ and $f(a, T) \in S$, then $f(a, T) = f(a, S)$.

The key axiom here is the one of independence of irrelevant alternatives. Satisfying it is often called in question. Kalai and Smorodinsky (1975) replaced it with the monotonicity axiom, formulating the appropriate theorem on the existence and unambiguity of the solution to the bargaining problem. The previously presented possible solutions to the bargaining problem are characterized by the so-called full information. It is assumed that each player has full knowledge of own and the competitor's collections of payments, i.e. about the set of variants and functions of utility. The search for a solution means that in this case an extra "arbitrator" exists, who – having obtained full knowledge - are able to determine the solution (the equilibrium point). However, many practical issues are associated with specific difficulties in access to information possessed by the parties. There are also strategic behaviors either related to the selection of a variant which is not the best at a given moment, but the choice of which provides winning or behaviors related to the fact that the real problem is a multistage problem, in which a solution is obtained by multiple alternating movements of two players (reference can be found, for example, in the work by Rusinowska [11]). Certain assumptions obviously change solutions to the problem of tendering. In the literature there are many examples of such assumptions (e.g. to mention just some of the latest work: Akin and Platt [1] – a tender with initial transfers of utility, Kibris and Sertel [12,8] – a tender with finite number of alternatives, Roszkowska [10] - the use of the

[1] It must be assumed that cooperation improves the results (and at least does not get them worse) achieved by players, that is $a = (a_1, a_2) \times x = (x_1, x_2), a, x \in S$. In some works the authors (e.g. Sertel, 1992) assume $x = (0,0)$ This point is called a point of contention. Such an assumption does not exclude the existence of individual functions of utility with the accuracy of multiplication by any positive real number.

complex of rules, Driesen et al. [3] - a tender with risk averse, Bozbay et al. [2] – a tender with endogenous non-conformity, et al. In cases of a bilateral monopoly with the disturbed information exchange, it seems that two conflicting processes are dealt with at the same time: cooperation and competition. For such situations Kalai [5] introduced the cooperative – competitive value hereinafter referred to as the COCO-value [6]. The cooperative – competitive value (COCO) is appropriate for each of the two players with matrices of payments, respectively X and Y:

$$coco - value(X,Y) \equiv \left(max_{i,j}\frac{x_{ij}=y_{ij}}{2}, max_{i,j}\frac{x_{ij}=y_{ij}}{2}\right) + \min\max\left(\frac{X-Y}{2}, \frac{Y-X}{2}\right) \quad (1)$$

The COCO-value is the only solution that meets the following axioms:

- Pareto efficiency;
- Invariance due to the shift of all payments by a constant value (in this case, the COCO-value is also shifted by the constant value);
- Monotonicity;
- Dominance, i.e. that dominated strategies are not selected;
- Invariance by virtue of the strategy multiplication;
- Monotonicity of information; this means that a less-informed player should not expect payout of higher value.

5. THE EXAMPLE OF THE USE OF THE COOPERATIVE - COMPETITIVE SOLUTION FOR A BILATERAL MONOPOLY

The work [4] shows 7 possible variants of situations associated with different techniques serving for output of coal using the open-pit method and their implications for possible border values of the coal price for another example of a bilateral monopoly: a coal mine – a power plant:

Table 1. Profits of the coal mine and the power plant at different levels of border prices of coal

No.	Amount of coal (mass units)	Amount of overburden (mass units)	Ratio of overburden to coal amount	Border price of coal	Coalmine's profit (monetary units)	Power plant's profit (monetary units)	Total profit (monetary units)
1.	0	1	-	-	-10,00	-	-10,00
2.	1	3	3,00	80,00	0,00	22,05	22,05
3.	2	7	3,50	83,33	1,69	44,83	46,52
4.	3	13	4,33	100,00	20,09	43,30	63,39
5.	4	21	5,25	112,50	42,63	30,05	72,68
6.	5	31	6,20	122,22	67,88	6,50	74,37
7.	6	43	7,17	130,00	95,23	-26,75	68,48

Source: [4]

Table 1 shows successively the values associated with particular options (1-7): the amount of recoverable coal (in mass units), the amount of overburden necessary to be removed in order to allow the coal mining (an open-pit mine is considered), the ratio of overburden to the coal mining (its value reflects the difficulties associated with coal mining in a given scenario), the border price of coal, i.e. the lowest price of coal at which a given excavation has a maximum value among other excavations, the profit of the coal mine in contractual monetary units, the profit of the power plant in the same units and the total profit. It can be easily noticed that the total profit of the coal mine and the power plant reaches its maximum in option No. 6, and the coal mine obtains the maximum profit also in the option No. 6, while the power plant in the option No. 3. What is important is that the profit of the coal mine for the option No. 3 is one of the lowest.

Therefore, a consortium - in this and in any other case - requires far-reaching and close cooperation, in particular, that in such agreements, unfortunately, there is a noticeable asymmetry of information – here, the advantage of the coal mine resulting from the knowledge of the deposit. In fact, for each level of prices, the coal mine may choose the dominant strategy (maximizing its payment) consisting in exploiting an excavation that is optimal for that price. Usually, this pit will be less than optimal for the entire system, which, in result, will reduce the profit of the power plant, limit the time of the deposit exploitation and reduce the degree of its use. Therefore, it seems that in this particular case, as well as for other consortia set up in the arms industry, one of the ways to resolve the conflict of interests can be the enforcement of secondary payments e.g. through the use of the cooperative – competitive factor. Therefore, it is assumed that any bilateral relation agrees to maximize the total profit and made secondary payments compensating any dissatisfaction with this result. It is clear that after the decision on the cooperation in the conditions provided under the consortium contract it is not possible to increase the joint profit, but its fair division (using the cooperative - competitive factor) enables the change of individual payments. The aforementioned transfer of payments is of particular interest, and such is the answer to the question how to compensate the worse individual choice concerning e.g. the extraction or production of certain goods in the case of a player who could get a much higher individual payment if he / she individually selected a different location, but for the sake of a bilateral monopoly he / she chooses the excavation maximizing the joint profit. The payment matrix for the said example of the bilateral monopoly of the coal mine and the power plant (the first payment refers to the coal mine, the second one to the power plant) includes the choice of all the excavations. Choosing the best excavation from the point of view of the relation is at the same time the worst choice for the power plant individually (the lower individual profit, the worse result only when choosing the excavation No. 7 - then the loss appears), which may be the reason for the more skeptical power plant's attitude to establishment of the cooperation. Therefore, special attention was paid to the possibility of improving the strategic position of the power plant, which initially was weaker than the second player (the coal mine had the advantage of information relating to deposits). Obviously, it should be done without detriment to the relation (the profit of the relation remains unchanged), and the

smallest possible change of the coal mine's position (still favorable individual payment). The COCO-value calculated as a result of decomposition to the respective excavations is presented in Table 2:

Table 2. The payments for players calculated based on the data from Table 1, assuming that a given excavation has been selected

Max averaged profit				min max	
Excavation number	Coal mine's profit X	Power plant's profit Y	Averaged profit	$\frac{X-Y}{2}$	$\frac{X-Y}{2}$
2	0	22,05	11,025	-11,025	11,025
3	1,69	44,83	22,26	-21,57	21,57
4	20,09	43,30	31,695	-11,605	11,605
5	42,63	30,05	36,34	6,29	-6,29
6	67,88	6,50	37,19	30,69	-30,69
7	95,23	-26,75	34,24	60,99	-60,99

Source: own study

Based on the data from Table 2 the decomposition may be performed and the COCO-value counted, which in this case for the coal mine and the power plant amounts to respectively:

(25.6; 48.8).

After the decomposition of the payment matrix, when selecting various excavations it turned out again that the choice of the excavation No. 6 was the solution that maximizes the profit of the relation. The calculated COCO-value allows to determine the payment transfer between the players:

(67.88 ; 6.5) + (-42.3 ; 42.3) = *(25.6; 48.8)*.

which means that the power plant should receive compensation (the secondary payment) of 42.3 monetary units from the coal mine. Owing to this, the solution is much more favorable for the power plant, as it improves its payment up to seven times, while still high payment for the coal mine. The arithmetic mean of payments of individual entities is better than in the case of all other possible solutions. Thus, the observed information asymmetry is aligned between the parties of the consortium - the coal mine and the power plant.

Solutions of this kind can be successfully applied also in the military consortia that recently have been eagerly and in large numbers established on the market. The only problem remains the extension of the solution up to n>2 entities forming the relation, which could be a subject for further research.

CONCLUSION

The use of the cooperative - competitive factor in a bilateral monopoly seems to be a solution that meets expectations of players in this kind of market relations. After making simple decomposition of this factor, two main objectives are achieved: the maximum possible joint payment (it is not worse than the standard solution proposed in the work [4], with the simultaneous compensation (transfer) designed to leveling strategic or information asymmetries. Therefore, even a solution that seems to be optimal from the point of view of the relation is not necessarily worse for either party, because the COCO-value enables the calculation of transfer payments, compensating the worse strategic position or the information disproportion. This aspect also encourages the application of the said solution, since it focuses not only on the material dimension of the allocation of goods and the distribution of profit, but (as a dynamic solution) pays special attention to the conduct of negotiations, which is often encountered in economic reality, also in the military industry. This article may also be a starting point when it comes to the use of the cooperative – competitive solution in the oligopoly system, as well as specific systems in which players can gain additional benefits from the cooperation. Finally, what may be most interesting - it would be useful to propose a solution for a number of two-player games (not only for a bilateral monopoly) and identify which theoretical axioms are often "violated" in the real world.

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BIOGRAPHICAL NOTE

Anna LAMEK – PhD, a graduate of the Faculty of Computer Science and Management of the University of Technology in Wrocław, specialization: Information Technologies in Management. In 2010 her master's thesis "Analysis of the development trends of the ERP systems on the example of selected companies" won the first place in the I edition of the competition for the best thesis on the ERP systems, organized by SENTE Information Systems. A participant in projects co-financed from the Operational Program Innovative Economy, including "Business analysis for Pol Miedź Trans Sp.z o.o" and "Platform of optimization of business processes in integrated information systems". A winner of a scientific grant for Young Scholars on 'Cooperation and competition in economic consortia' funded by the Ministry of Science and Higher Education. Her professional experience spans work at several universities - including the Universities of Technology in Wroclaw and Opole, as well as the General Tadeusz Kosciuszko Military Academy of Land Forces in Wroclaw. Currently works as Assistant Professor in the Department of Business Information Systems, at the Poznan University of Economics and Business. A member of the Scientific Society of Business Informatics. She conducts research on the application of econometrics and computer science in organizations of different type. She also specializes in modeling, analysis and optimization of business processes. She teaches, among others,: Analysis of information systems, Business process management, IT in administration, Information systems in management.

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