ALLOCATING SAVINGS IN PURCHASING CONSORTIA; ANALYSING SOLUTIONS FROM A GAME THEORETIC PERSPECTIVE

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Abstract

While economies of scale are an obvious advantage for a purchasing consortium as a whole, the benefits for one member is not always clear. He may fear that other members benefit parasitically from his leverage causing lack of commitment and hesitance to join a consortium. This paper presents an instrument that provides clarity in the allocation of cost savings by modelling a purchasing consortium as a cooperative game. With this model we analyse how common approaches to this allocation problem fit with game theoretic concepts. As it turns out, all members paying the same price per item is not a good policy in general. This policy may allocate the largest share of consortium savings to members with the least leverage. Instead game theoretic concepts like the compromise value should be preferred, as they always give reasonable solutions to this problem.

Key words

purchasing consortium, cooperative game theory, decision making

Purchasing consortia: common practice, a forgotten research topic?

Joining a purchasing consortium (also known as Group Purchasing Organisation or GPO) has obvious advantages. By purchasing goods together lower prices can be obtained from suppliers (economies of scale). In addition, transaction costs can be lowered by bundling orders. Ideally, these cost savings have to outweigh the expenses of setting up and maintaining the consortium for all parties involved (Pye, 1996).

Doucette (1997) showed that for a purchasing consortium to be successful commitment of its members is very important. He showed this commitment (apart from financial benefits) is mainly influenced by: the perceived commitment of other members, degree of information exchange and trust. Hence, if from a financial point of view it is worthwhile to join a consortium, there may still be hesitation to join. Reasons for this hesitation mentioned by Hendrick (1997) are: anti-trust (legal) issues, disclosure of sensitive information, supplier resistance and the "fear of parasites". The last reason means that a firm does not see the advantage of joining a consortium as it believes it already has a good leverage. Therefore, the (perceived) result of joining would be that the rest of the consortium would benefit parasitically on its leverage. Clarity is the key issue here.

Bearing in mind the pros and cons, what is the occurrence of purchasing consortia in practice? In the public sector such as health care and education purchasing consortia are well-established (Doucette, 1997). This is also true for for instance the retail sector in Europe (Zentes and Swoboda, 2000), but not for the private sector in general though. A recent study of CAPS (Hendrick, 1997) shows that only about one fifth of US companies is a member of a purchasing consortium. However, Hendrick's research and other sources (Macie, 1995; Sickinger, 1996; Major 1997) indicate that this percentage is increasing.

Last decades purchasing consortia have received only minor attention in purchasing management research. Analysing many sources Essig (1998,2000) concludes that compared to the interest in vertical (buyer-supplier) relationships the interest in horizontal relationships (cooperation) between buyers has been neglected. This lack of attention seems unjustified with purchasing consortia being well-established in the public sector and gaining popularity in the private sector. Also, Essig (1998,2000) introduces the concept of "consortium sourcing" as an important part of supply strategy and as a framework for further research. He sees the development of instruments that help establish purchasing consortia as a next step.

This paper presents such an instrument. It has been developed by modelling the allocation of cost savings in a purchasing consortium as a cooperative game. With this cooperative game model we analyse how common approaches to this allocation problem fit with game theoretic concepts. These common approaches include a.o.: fixed price per item, proportional to the quantity ordered, equal split. The other way around, we also analyse the implications of known allocation methods from game theory within the purchasing consortia setting. The model can be used as an instrument with which allocation methods can be chosen based on underlying properties like: purchasing power and added value of participants, coalition stability, etc. The purpose of developing this instrument has been (1) to contribute to the (theoretical) development of purchasing consortia research and (2) to provide clarity in practice for participants, hence increasing commitment and decreasing reluctance of joining a purchasing consortium.

The setup of the rest of the paper looks as follows. In the next section a brief introduction to cooperative game theory is given. Section three describes the problem of allocating cost savings in purchasing consortia by modelling it as a cooperative game. In section four we analyse possible solutions (allocation methods) to the model and their properties. Also, for practical application an example will be given in this section. Applicability issues are discussed in section five. Finally, together with the conclusions we will give some suggestions for further research.

Introduction to cooperative game theory

Game theory is a mathematical research field that deals with multilateral decision making. Each decision maker (player) has his own interests and has a number of possible actions. By his actions each player affects the interests of the other players. The foundation of this theory and its application to economic behaviour can be found in the book by Von Neumann and Morgenstern (1944). Other areas of application include social sciences (Shubik, 1982), politics (Ordeshook, 1986) and operations research (Curiel, 1997). Game theory can be divided into two fields: non-cooperative (conflicts) and cooperative game theory.

We will restrict ourselves to cooperative game theory (for theoretical background see e.g. Driessen, 1988; Shubik,1992). In cooperative game theory it is assumed that cost savings / profit can be made when all players cooperate. The main problem that is addressed in this theory is how to divide these savings in a "fair" way among all players.

Now for some more mathematical details. Let us assume a game v with a player set N, consisting of n players. Each subset S that can be formed out of N is called a coalition. We will restrict ourselves to TU (transferable utility) games. In a TU game to each coalition S a real value $v(S)$ is assigned with $v(\emptyset) = 0$ (the empty coalition). This value only depends on the players in S. This value of the coalition $v(S)$ can be interpreted as the savings that can be achieved when only the players in S cooperate. So $v(N)$ are the savings for the grand coalition N.

An example: consider three players each having one painting of Rembrandt in their possession with different value. They want to sell their paintings. These three paintings belong to the same series and it is therefore more profitable to sell them together as a set. For each coalition S the value $v(S)$ can be seen in Table 1. The question arises how to divide the 50 Million Dollars (= $v(N)$) in a fair way among the three players?

Selling coalition *S*	***v*(*S*)**
{1}	5
{2}	10
{3}	15
{1,2}	20
{1,3}	25
{2,3}	30
{1,2,3} = N	50

Table 1: Example of a 3-person cooperative game.

Let x_i be the amount allocated to player i. Then x is the allocation vector. Now we introduce the notion of a solution concept f. A solution concept f prescribes for each game just one allocation vector $f(v)$. Which solution concept to use depends on the agreement the players can reach on what they consider to be "fair". This involves the values of the subcoalitions S. A number of properties that f can have, is given below:

- EFF: efficiency. All savings are allocated back to the players: $\sum_{i \in N} f_i(v) = v(N)$
- SYM: symmetry. If for two players i and j can be interchanged without changing any $v(S)$ then $f_i(v) = f_j(v)$.
- DUM: dummy: If $v(S \cup \{i\}) - v(S) = v(\{i\})$ for all $S \subset N \setminus \{i\}$ then $f_i(v) = v(\{i\})$.
- INV: invariance. For a game w with $w = k \cdot v + a$ (with k a real value and a a real vector) it holds that $f(w) = k \cdot f(v) + a$.

- ADD: additivity. For two games v and w with solutions $f(v)$ and $f(w)$ it holds that $f(v+w) = f(v) + f(w)$.
- IND: individual rationality. EFF is satisfied and for all players i it holds that $f_i(v) \geq v(\{i\})$. It means that for each player the pay-off of cooperation is higher than the pay-off of working alone.
- STA: stability. EFF is satisfied and for all coalitions S it holds that $\sum_{i \in S} f_i(v) \geq v(S)$. It means that for each player the pay-off of cooperation in the grand coalition is higher than the pay-off of working alone or in any other coalition.

Three common solution concepts from cooperative game theory are the Shapley value $\Phi(v)$, the compromise value $\tau(v)$ and the nucleolus $n(v)$. Below we will briefly discuss the definitions and interpretations of these three concepts, as we will make use of them later.

The Shapley value $\Phi(v)$ is the unique solution concept that satisfies EFF, SYM, DUM and ADD (Shapley, 1953). The Shapley value is defined as:

$$\Phi(v) = \frac{1}{|N|!} \sum_{\sigma \in \Pi(N)} m^{\sigma}(v) \qquad (1)$$

Here $m^{\sigma}(v)$ is called the marginal vector of a game v and it is defined as:

$$m^{\sigma}_{\sigma(k)} = v(\{\sigma(1), \ldots, \sigma(k)\}) - v(\{\sigma(1), \ldots, \sigma(k-1)\}) \text{ with} \qquad (2)$$

$$\sigma \in \Pi(N),\ \Pi(N) = \{\sigma : \{1, \ldots, |N|\} \to N \mid \sigma \quad bijective\}$$

Note that for a game there are $|N|!$ marginal vectors. The marginal vector can be interpreted as follows: assume the players enter the game one by one in the order $\sigma(1)$, $\sigma(2)$, etc and assign each player the marginal contribution (added value) he creates by joining the group of players already present. The Shapley value is simply the weighted average of all possible marginal vectors.

The compromise value $\tau(v)$ is based on the maximum $M_i(v)$ and minimum $m_i(v)$ amount that each player i can reasonably claim (Driessen, 1985). This maximum amount $M_i(v)$ equals the total value of the game minus the value the other players can establish without him:

$$M_i(v) = v(N) - v(N \setminus \{i\}) \qquad (3)$$

The minimum amount $m_i(v)$ can be determined by looking at each coalition that player i belongs to. In each of these coalitions he will give to the other players in that coalition their maximum claims and see what is left for him. Then the maximum leftover is the minimum claim:

$$m_i(v) = \max_{S:i\in S}\left\{v(S) - \sum_{j\in S, i\neq j} M_j(v)\right\}$$
(4)

As indicated in its name the compromise value lies in between the maximum and minimum claims in such a way that the allocation is efficient:

$$\tau(v) = \alpha M(v) + (1-\alpha) m(v)$$
(5)

with $\alpha \in [0,1]$ unique such that $\sum_{i\in N} \tau_i(v) = v(N)$

The nucleolus $n(v)$ is a concept in which minimises the maximum dissatisfaction level of all coalitions. As a measure for the dissatisfaction level the excess $E(S,x)$ of coalition S with respect to allocation x is introduced:

$$E(S,x) = v(S) - \sum_{i\in S} x_i$$
(6)

Furthermore $\theta(x)$ is the excess vector consisting of the excesses of all coalitions in a decreasing order. The nucleolus n(v) is defined as the unique solution that satisfies IND and:

$$\theta(n(v)) \leq_L \theta(x) \text{ for all x satisfying IND}$$
(7)

The general properties of the three solution concepts are listed in Table 2. For the example above (Table 1) the actual values of these solutions are given in Table 3. Note that in this case the Shapley value and nucleolus are equal, but in general this need not be true.

	EFF	**SYM**	**DUM**	**INV**	**ADD**	**IND***	**STA***
Shapley value	Y	Y	Y	Y	Y	-	-
Compromise value*	Y	Y	Y	Y	-	Y	-
Nucleolus*	Y	Y	Y	Y	-	Y	Y

*Table 2: Properties of solution concepts (Y = satisfied, - = not satisfied in general, * = if existent).*

	Player 1	**Player 2**	**Player 3**
Shapley value	11.67	16.67	21.67
Compromise value	14.05	16.67	19.29
Nucleolus	11.67	16.67	21.67

Table 3: Values of solution concepts for the example in Table 1.

Modelling a purchasing consortium as a cooperative game

Managaging purchasing consortia can be a complex task (see e.g. Laing and Cotton, 1997). To model purchasing consortia as a cooperative game we only consider take into account two aspects: price reduction due to economies of scale and costs for setting up / maintaining a consortium. First we will focus on the price reduction, the costs will be added later (so assuming negligible costs).

For the price per item $p(q)$ we assume a decreasing discount is given, when more items are purchased. However, there is a minimum price p_0. So $p(q)$ is a convex function as in Figure 1. In addition, we assume the total price $q \cdot p(q)$ always to be increasing with the number of items (see Figure 2). These assumptions hold for most practical situations (for more about quantity discounts see e.g. Dolan, 1987).

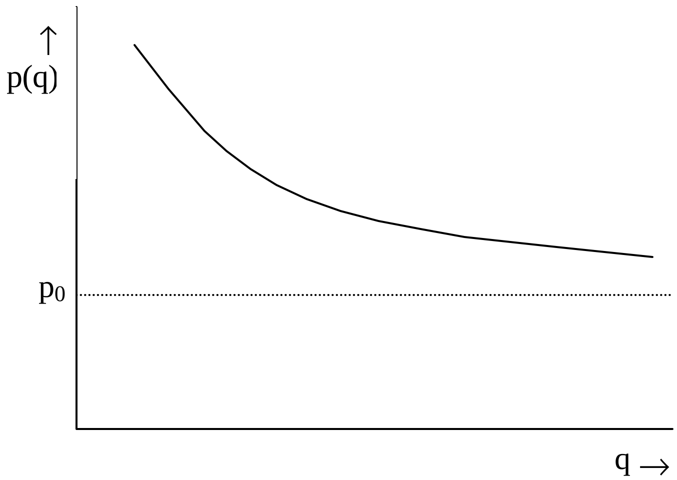


Figure 1: Price per item as a function of the quantity of the items to be purchased.

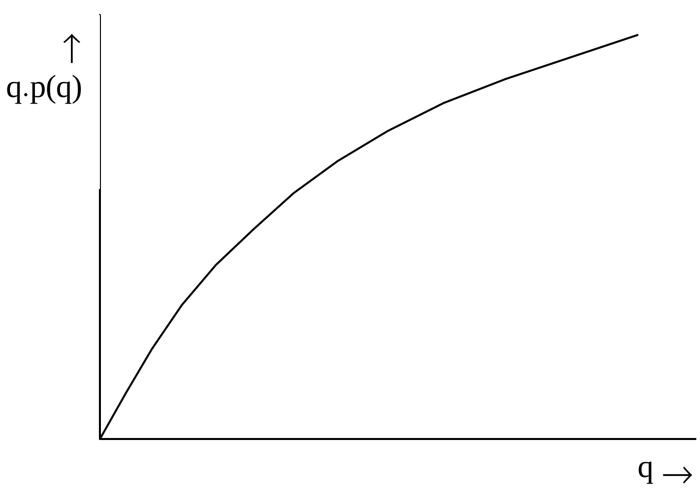


Figure 2: The total price for buying a quantity of q items.

We will for the rest of this article refer to the game model for a purchasing consortium as a cooperative purchasing game or CP-game (N,q,p). N is the number of players, q the number of items each player wants to purchase and p the price per item (as a function of the quantity) completely define the CP-game together with the price function $p(q)$ and the following definition of the reward function $v(S)$. The value $v(S)$ of each coalition S is defined as defined as the savings that it generates by buying items together compared to the situation where each of the player in the coalition has to buy the items on his own. Thus:

$$v(S) = \sum_{i \in S} (q_i \cdot p(q_i)) - \sum_{i \in S} q_i \cdot p\left(\sum_{i \in S} q_i\right) \tag{8}$$

With this definition all coalitions $\{i\}$ (consisting of just one player) have value 0:

$$v(\{i\}) = 0 \tag{9}$$

For all other coalitions $v(S)$ will always be positive.

A CP-game is a convex game (proof can be obtained from the author). This is relevant as for convex games the following statements hold:

- The game is superadditive. This means $v(S)$ increases as the coalition consists of more players:

  $$v(S \cup T) \geq v(S) + v(T) \text{ for all } S, T \in 2^N \text{ with } S \cap T = \emptyset \tag{10}$$

- There always exist allocations satisfying IND and STA, which implies the compromise value $\boldsymbol{t}(v)$ and the nucleolus $n(v)$ always exist.
- For all players the minimum claim $m_i(v)$ equals zero, reducing the formula for the compromise value to:

  $$\boldsymbol{t}(v) = \frac{v(N)}{\sum_{i \in N} M_i(v)} M(v) \tag{11}$$

The costs of setting up and maintaining a consortium can not be neglected. Hendrick (1997) reported that for the consortia he investigated the average annual costs were $ 300,000. For modelling we assume a cost function C(S) with fixed costs C_0 and variable costs c depending on the number of players in the consortium |S| (only for a coalition of at least two players):

$$C(S) = \begin{cases} C_0 + c \cdot |S| & |S| \geq 2 \\ 0 & |S| = 1 \end{cases} \tag{12}$$

Costs and benefits can be dealt with separately with a different allocation method for both of them. This cost function can also simply be included in the expression for $v(S)$. We assume $v(S)$ can not become negative though. If the costs of cooperating would be larger than the benefits for a coalition S, cooperation would simply not occur and therefore in that case $v(S) = 0$, so:

$$v(S) = \max\left(\sum_{i \in S} (q_i \cdot p(q_i)) - \sum_{i \in S} q_i \cdot p\left(\sum_{i \in S} q_i\right) - C(S), 0\right) \tag{13}$$

Furthermore, in general this CP-game is not convex anymore. This is caused by the marginal costs c, as the added value of a player could become negative. However, if we require that only players are allowed in the game such that superadditivity (see above) holds then convexity is satisfied. This basically means the marginal contribution (added value) of a player to any coalition because of the price reduction must be larger than the marginal costs *c*. In this paper we will restrict ourselves to this requirement.

Assuming the *n* players in the CP-game want to cooperate, the question remains how the total savings of the purchasing consortium *v*(*N*) can be allocated to the players in a "fair" way.

Solutions to cooperative purchasing games

Before going into detail about the solution concepts we will first introduce another property that these solutions could have: the purchasing power property (POW). Satisfying this property means that a player with a larger quantity of items to be purchased through the consortium (higher leverage) should receive a larger share of the savings. More formal: if for two players *i* and *j* $q_i \geq q_j$ then $f_i(v) \geq f_j(v)$. Note that POW implies SYM.

In practice often simple rules are used when dividing the savings among the members of a consortium like: equal, proportional, same price per item, etc. Sometimes costs and cost savings are dealt with in a different way, each with their separate allocation method. Four of these common allocation methods will be considered and compared to the three solution concepts from game theory. These four methods are:

- *eq*(*v*). All players are considered equal, hence they obtain the same amount:

  $$eq_i(v) = \frac{v(N)}{n} \tag{14}$$

- *pr*(*v*). The amount allocated to a player is proportional to the number of items he purchased:

  $$pr_i(v) = \frac{q_i}{\sum_{i \in N} q_i} v(N) \tag{15}$$

  As can be easily verified, with *pr*(*v*) the savings are allocated on equal (absolute) savings per item.
- *ep*(*v*). The amount allocated to a player is based on an equal savings percentage per item:

  $$ep_i(v) = \frac{q_i \cdot p_i}{\sum_{i \in N} (q_i \cdot p_i)} v(N) \tag{16}$$

- *sp*(*v*). All players pay the same price per item (the price that can be obtained with the volume of the grand coalition *N*) and share costs equally:

$$sp_i(v) = q_i \cdot \left(p(q_i) - p\left(\sum_{i \in N} q_i \right) \right) - \frac{C(N)}{n} \qquad (17)$$

With these solutions we can have a look which solutions satisfy which properties. An overview is given in Table 4 (proven statements, but proofs have been omitted here). The first three practical solutions satisfy the POW property, but they do not satisfy STA in general. So it may be worthwhile not to cooperate in the grand coalition *N*. As for paying the same price per item it is the other way around. STA is satisfied, but in general the player who is purchasing the most items does not always get the largest share of the savings. For the solutions from game theory both properties are satisfied. ADD is only satisfied for the equal split and the Shapley value.

Properties® ¯Solutions	**EFF/SYM/ DUM/IND**	**STA**	**POW**	**ADD**
eq	Y/Y/N/Y	-	Y	Y
pr	Y	-	Y	-
ep	Y	-	Y	-
sp	Y	Y	-	-
Shapley	Y	Y	Y	Y
Compromise	Y	Y	Y	-
Nucleolus	Y	Y	Y	-

Table 4: Properties of solution concepts for CP-games (Y = satisfied, - = not satisfied in general)

To illustrate the CP-game model and its solutions, we will give an example. We assume a situation in which three companies want to purchase laptops. Each company needs a different quantity: 20 for company 1, 40 for company 2 and 50 for company 3. Furthermore, the price p for the laptops as a function of the quantity q that will be ordered, is known (in Euro):

$$p(q) = 2000 \cdot \left(1 + \frac{1}{\sqrt{q}} \right) \qquad (18)$$

The companies want to buy the laptops together, but they still have to decide how to allocate the savings. We assume no costs. This situation can be modelled into a CP-game as has been done in Table 5. When the three companies cooperate 14,720 Euro can be saved.

Table 6 gives an overview of possible allocations for this example based on each of seven solutions, that were introduced earlier. These solutions have been plotted in Figure 3, in which a triangular plane of all allocations satisfying IND and EFF is shown (for more than three companies / players this picture becomes more-dimensional). In this case all seven solutions satisfy STA and all except the allocation based on the same price per item satisfy POW. For this allocation we see company 1 receives the largest share of the savings, while only purchasing the least laptops. Of course, because of the same price per item, the savings per item are the highest for company 1, but in this case even the total allocated savings are the highest.

Buying party S	**Number of laptops**	**Price per laptop**	**Total**	***v*(*S*)**
{1}	20	2,447	48,940	0
{2}	40	2,316	92,640	0
{3}	50	2,283	114,150	0
{1,2}	60	2,258	135,480	6,100
{1,3}	70	2,239	156,730	6,360
{2,3}	90	2,211	198,990	7,800
{1,2,3} = N	110	2,191	241,010	14,720

Table 5: A CP-game for buying laptops by three companies

Allocation method	*Company 1*	**Company 2**	**Company 3**
1 eq	4,907	4,907	4,907
2 pr	2,676	5,353	6,691
3 ep	2,817	5,332	6,571
4 sp	5,120	5,000	4,600
5 shapley	4,383	5,103	5,233
6 compromise	4,262	5,149	5,309
7 nucleolus	3,860	5,300	5,560

Table 6: Allocation of the savings for each solution of the example in Table 5.

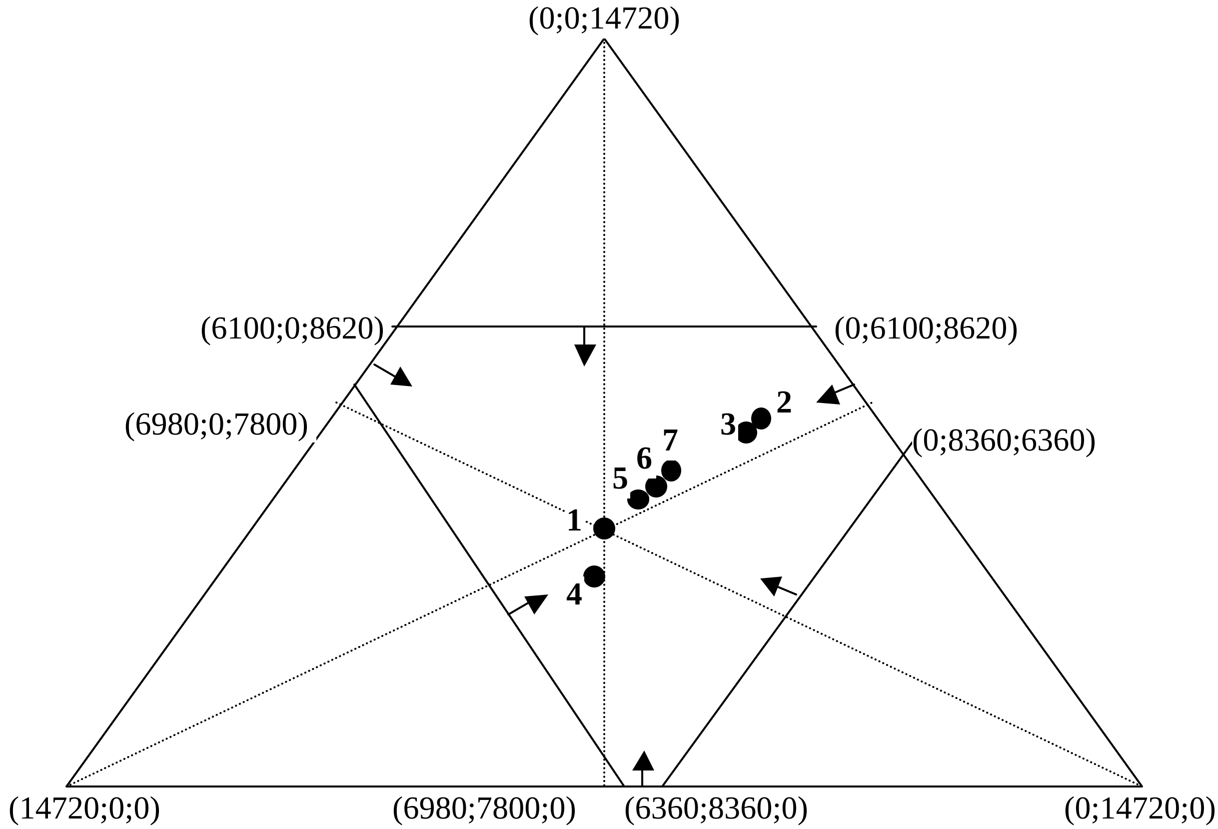
Except for paying the same price per item all solutions seem reasonable, as they all satisfy POW and STA for this example. Looking at these solutions one can see that the three game-theoretic solutions are less "extreme" than the other three. As for the costs, they can be included easily, as mentioned in section three. This will lead to a similar results, with less total savings naturally.

Which solution will be chosen, depends on which allocation concept companies can agree after negotiations. However, reaching agreement is likely to be easier when the actual figures are not known yet. It is easier to decide on the concept to use, while not having the bias of the actual figures. Knowing these figures will cause companies to prefer the allocation that maximises their share regardless of the concept behind it.

Applicability issues

In the previous two sections the CP-game model and possible solutions were described from a more theoretical point of view. In this section we will focus on issues regarding applicability in practice.

From the possible solutions it seems that the game-theoretic solutions are the best to use, as they satisfy most properties mentioned in Table 4. Calculating these solutions becomes more complex for larger coalitions though. Compared to the Shapley value and the



nucleolus, the compromise

Figure 3: Possible allocations satisfying IND and EFF. The coordinates (1;2;3) refer to the amount given to company 1, 2 and 3. Within the area indicated by the arrows STA is satisfied. The numbers next to the dots correspond to the allocation method in Table 6.

value is the easiest to calculate. Only the values for the grand coalition *N* and the coalitions consisting of n-1 players are used for the compromise value, while for the others all coalition values need to be known and larger number of calculations need to be done with those values (the marginal vectors for the Shapley value, constructing the least excess vector for the nucleolus).

Although the compromise value is easy to calculate, applying it to the combination of different items has one major drawback. A purchasing consortium could of course be used for multiple (types of) items at the same time. Each item could be treated as a separate game with a separate allocation of the savings. The costs savings from all items could also be added up and with this total savings just allocate the savings at once. It seems "fair" that when the same allocation method would be used for each item separately or for all of them together the total amount allocated to each player should be the same. This is just another way of saying that ADD has to hold. This is only true for the equal split and the Shapley value though (Table 4), not for the compromise value (and the other solutions).

Another applicability issue for the CP-game model is the different forms in which purchasing consortia occur. Consortia can consist of members purchasing more or less equal quantities, members purchasing very different quantities or even have one main buyer (who has by far the highest leverage of the members). Another possibility is a third party, that in exchange for a fee is specialised in negotiating leverage and arranging a consortium setting on behalf of other companies. The third party does not purchase items for itself, it uses the purchasing volume of the companies on which behalf it operates.

All these situations can be modelled as a CP-game. Except for the third party option, simply the CP-game model as described above can be used. The model is particularly useful when the quantities of each member differ a lot. When consortium members order (nearly) equal quantities the extensive analysis of solution concepts is not necessary. In this case all solutions discussed converge to an equal split of the savings, a solution to which no member is likely to object.

A consortium with one main buyer is an extreme case of unequal quantities of members. The following example gives an interesting insight. Consider a main buyer *m* whose quantity is much larger than the quantities of all *n*-1 small indistinguishable buyers together. Using the leverage of the main buyer m cost savings k can be obtained for one small buyer. We will only calculate the compromise value, hence only the values for the following coalitions are relevant:

$$v(N) = (n-1)\cdot k$$
$$v(N\setminus\{i\}) = (n-2)\cdot k \qquad i \neq m \qquad (19)$$
$$v(N\setminus\{m\}) = 0$$

In this case the compromise value for the main buyer is $\tau_m(v) = 0.5\cdot(n-1)\cdot k$ and for the small buyers $\tau_i(v) = 0.5\cdot k$. So with this allocation each small buyer shares the savings fifty-fifty with the main buyer.

When a third party is responsible for the consortium, the CP-model has to be extended. Basically there will be two cost functions $C(S)$ depending whether or not the third party is involved in coalition *S*. The third party will only have added value if its involvement can lower the costs. But it may be possible that the third party can negotiate a better price, which means also two price functions could be involved. With these functions $v(S)$ can be calculated for all coalitions *S* similar to the basic CP-model. Analysis of the allocation method can also be done similarly. The third party will normally be the decision maker. The allocation method determines the contract arrangements that are offered to possible participants. The extended CP-model can help the third party in providing insights in more and less profitable or "fair" arrangements, which can affect the continuity of the consortium over time, commitment of the participants and persuasion of new participants to join.

Until now we assumed the marginal contribution of a player to a coalition always to be positive. As mentioned in section three, with this marginal contribution can be negative. At first it may seem unlikely that this player would (be allowed to) join the consortium. However, in practice this situation may occur more often than one would think. When companies decide to join together in a consortium the quantities to be purchased may not always be known exactly beforehand. Early indications of the quantities may turn out to be quite different. When the quantity purchased through the consortium turns out to be much less than expected for a company, a negative marginal contribution can occur. The CP-model can incorporate this, but in general it will not be convex anymore. Solutions such as the compromise value and the nucleolus may then no longer exist and certain properties of Table 4 may not hold. If a certain "fair" allocation method was decided upon at the start-up of the consortium, it may turn out not to be so "fair" anymore. To prevent this penalties could be included for not meeting the quantities that were indicated at the start-up. Another way would be to split up costs and cost savings. The CP-model without costs is always convex and different quantities will not change the properties of the solutions discussed. Naturally this still leaves the allocation problem of the costs, but with equal marginal costs for all participants equally splitting the costs may be agreed upon.

Conclusions

Only limited research has been conducted on purchasing consortia. Linking cooperative game theory to purchasing consortia is a new approach. The CP-game model provides new insights into the problem of allocating the costs and cost savings to the consortium members. Several allocation methods have been analysed on their properties. As it turns out, all members paying the same price per item is not a good policy in general. This policy may allocate the largest share of consortium savings to members with the least leverage (POW is not satisfied). Instead game theoretic concepts like the compromise value should be preferred, as they always satisfy POW and STA, therefore giving more "fair" solutions to this problem.

Furthermore, the CP-game model with possible solutions and their properties can be used as an instrument to provide clarity to participants in a purchasing consortium. It can help in negotiations, by reducing fear the fear of other members benefiting parasitically. By enhancing trust commitment to the consortium can improve, which is very important for the purchasing consortium to be successful (Doucette, 1997).

Practical applicability of the CP-game model as an instrument still needs to be verified. Testing it with members of several purchasing consortia on its use an impact on the success of the consortium is necessary to ensure validity. In addition, a good overview of the purchasing consortia especially with regard to allocation methods for cost savings is still lacking, as not much empirical data on purchasing consortia is available at the moment.

Apart from the empirical research, future research can include theoretical development of the model itself. Companies could having slightly different requirements regarding the item to be purchased through the consortium. Some companies would therefore have to change their requirements in order to get obtain the volume discount, for which they could receive compensation. Also, volume discounts could be not known exactly and depend on negotiation efforts. In the CP-game model only volume discounts are taken into account as benefit of cooperation. However, cooperation is also possible on making specifications and searching and selecting suppliers. Incorporating these items into the CP-game model can increase practical relevance and applicability.

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