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MODELING DISSOLUTION OF COMPLEX ORGANIZATIONS

Slobodan KRČEVINAC, Jovan PETRIĆ

Faculty of Organizational Sciences, University of Belgrade
Jove Ilića 154, 11000 Belgrade, Yugoslavia

Abstract: Modeling dissolution of complex organization has been rarely studied in the literature. Starting on the premises that one of the processes of dissolution is allocation of assets of dissolving organization to dissolution units, and the fact that asset valuation presents an interval of values, a nonlinear programming model is formulated which solution could help the selected dissolution unit with arguments in defining its economic position relative to the rest of dissolution units. An illustrative example is given solved by using GAMS/MINOS solver.

Keywords: Organization, modeling, valuation, privatization.

1. INTRODUCTION

A process of dissolution of large, complex organization that is, generally, geographically dispersed, into separate parts, poses a number of difficult problems, (Nutty,1989) . Amongst the others, the problem how to share, on a fair basis, its assets and liabilities is a premier one. So far, this problem attracted insufficient attention in the literature.

After an inventory of all assets and liabilities of the parent organization has been established, it is needed to valuate each inventory item belonging to the specified asset class. State-of-the-art valuation practice uses several different methods yielding different values in an interval between the lower and upper bound, (Copeland et al,1990). For most part all of these techniques and formulae can be categorized into three distinct and general approaches: the market, income and cost approaches. The objective of using more than one method is to develop mutually supporting evidence as to the valuation conclusion. The methods selected for use in valuation engagement will depend upon the appraiser's judgment and experience with similar valuations and upon quantity and quality of available financial, operational and industry data.

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In the market approach methods , the value of the business entity is determined by comparing it to (1) comparable firms (guideline companies) whose shares are publicly traded on organized capital markets and/or (2) guideline companies that have been bought or sold during a reasonable period of time. In either case, an appropriate sample of guideline companies is selected based on comparability criteria. Adjustments are then applied to these observed values to compensate for differences in location, time of sale, and physical characteristics between subject assets and comparable assets, so as to indicate a fair market value for the subject assets.

The income approach is based on the premise that the value of the business entity is the present value of the future economic income to be derived by the owner of the business. The discounted future returns takes into account: (1) the stream of benefits the owner of the asset expects to receive in the future; (2) the timing of the receipt of these benefits; and (3) the risk borne by the owner of the asset. That requires the following analysis: revenue, expense, investment, capital structure and residual value analysis.

The cost approach considers the concept of replacement cost as an indication of value. A prudent investor would pay no more for an asset than the amount for which could replace the asset new. Thus the first step under this approach is to determine the replacement cost, new. This cost represents the amount of money in terms of current labor and materials to construct or acquire new property of similar utility to the subject property. Similar utility refers to similar economic satisfaction and production capacity. Once the appropriate replacement cost, new is determined, adjustments are made to represent losses in value resulting from physical deterioration and from functional, technical and economic obsolescence.

Each valuation methodology has its own merits and proponents advocating its usability. The span of values derived by different valuation methods can be attributed to each inventory item, and all of them being reasonable on the grounds of corresponding valuation methodology, allow for searching an optimal value mix yielding an advantageous position of a selected part and/or parts of complex organization. Namely, the specified dissolution unit could consider economically advantageous to search for a policy to minimize the value of its share of assets and/or it would try to argue that the rest of dissolution units or certain selected ones, are getting maximum values.

Here, one possible approach to modeling of this problem is discussed, using single nonlinear objective, a set of upper and lower bounds constraints on unknowns and constraints combining the total value of several classes of assets. An illustrative example is given, that has been solved using GAMS/MINOS solver, (Brooke et al,1988)

2. MODEL

In the process of dissolution of large, complex organization each dissolution unit is aspiring to get an advantageous economic position. Often, it is reflected to the economic value of assets assigned to it. Depending on the objectives the unit wants either to minimize or maximize its economic value. For example, from the standpoint of the subject unit it would be advantageous to minimize its worth, proving that the value of its assets obtained in dissolution process is minimal and, therefore, asking the minimal participation in covering liabilities of the parent organization and/or asking for a greater share of assets. Simultaneously, it would aspire to show that the value of the rest of dissolution units is getting the maximal value. In other words it would like to have the value of its proportionate part of assets minimal relative to the value of total assets of parent organization.

Let us assume that the assets of parent organization are classified into m classes $(i = 1, \dots ,m)$ and that the parent organization is dissolving into n units $(j = 1, \dots ,n)$. Each dissolution unit j is obtaining a_{ij} units of assets of class i. Therefore, if it is assumed that the dissolution unit j wants to minimize its proportionate share of asset value, the corresponding nonlinear objective function is:

$$\min \frac{\sum_{i=1}^{m} a_{ij} x_i}{\sum_{j=1}^{n}\sum_{i=1}^{m} a_{ij} x_i} \tag{1}$$

where: x_i denotes the unit value of the asset class i.

The total number of units of assets of class i of the parent organization, that is to be distributed among dissolution units, is:

$$C_i = \sum_{j=1}^{n} a_{ij}$$

thus the objective function (1) can be rewritten as:

$$\min \frac{\sum_{i=1}^{m} a_{ij} x_i}{\sum_{i=1}^{m} C_i x_i} \tag{2}$$

By using a selected set of valuation methods, one obtains, for each asset class, corresponding minimum unit value V_i^{min} and maximum unit value V_i^{max} that represent lower and upper bound for the x_i :

$$V_i^{min} \le x_i \le V_i^{max} \tag{3}$$

Furthermore, an additional constraint could be put, expressing the need of a dissolution unit j to keep the total value of selected classes of assets k between presupposed limits A_j^{min} and A_j^{max} , i.e.:

$$A_j^{min} \le \sum_{k\in\{i\}} a_{kj}\, x_k \le A_j^{max} \tag{4}$$

where, the summation is carried over the indices k that are the subset of indices i. The constraint (4) can be modified to reflect a wish to keep the proportion of total value of selected classes of assets k to the total value of all assets allocated to the dissolution unit j , between presupposed limits B_j^{min} and B_j^{max} :

$$B_j^{min} \le \frac{\sum_{k\in(i)} a_{kj} x_k}{\sum_{i=1}^{m} a_{ij} x_i} \le B_j^{max} \tag{5}$$

Obviously, besides the constraints (3), (4) or (5), it might be necessary to introduce additional linear or nonlinear ones, depending on the type of the problem and specific needs of dissolution units. Anyhow, further extensions of the model are pretty straightforward.

The objective function (1) and/or (2) could be modified by introducing additional criteria, thus obtaining a multicriteria problem. This could better describe various conflicting objectives of dissolution units. The multicriteria approach would yield to the considerable solution intricacy not guaranteeing significant improvements in the results obtained. However, further research is needed for the full evaluation of multicriteria approach.

3. AN ILLUSTRATIVE EXAMPLE

As an illustration consider a parent organization that is going to dissolve into 6 dissolution units. Its assets have been classified into 7 classes and corresponding data are given in Table 1.

Table 1.

Asset Class	c_{ij}	C_i	V_i^{min}	V_i^{max}
1	1600	5800	50	70
2	1000	3000	4	5
3	533	1600	1000	1200
4	200	600	600	800
5	400	1200	250	300
6	200	400	800	900
7	100	650	350	400

The column c_{ij} presents the number of units of the asset class i, $(i = 1, \dots, 7)$ that are allocated to the dissolution unit j in the process of dissolution of the parent organization. The column C_i denotes the total number of units of asset class i, $(i = 1, \dots, 7)$ in parent organization that is to be allocated to the dissolution units. The columns V_i^{min} and V_i^{max} give the minimum and maximum value of the asset class i, respectively, as obtained in the valuation process.

Firstly, the solution of the model (2) and (3) that is constraining unknowns with their lower and upper bounds only and without any additional constraint of type (4), has been sought. The solution is performed by using Generalized Algebraic Modeling System - GAMS Version 2.05 on PC 386 , 33MHz, 4MB RAM computer. Specifically, MINOS 5.02 solver is used, that for linearly constrained nonlinear problems uses reduced-gradient algorithm combined with a quasi-Newton algorithm that generally leads to super linear convergence. If any of the constraints are nonlinear, a projected Lagrangian algorithm is employed.

The listing of the corresponding GAMS program is given in Listing 1.

LISTING 1

```
GAMS 2.05 PC AT/XT 93/09/05 12:11:53 PAGE 1

G E N E R A L A L G E B R A I C M O D E L I N G S Y S T E M
C O M P I L A T I O N

SETS
        I /1,2,3,4,5,6,7/;
PARAMETERS
        AMIN(I) /1 50, 2 4, 3 1000, 4 600, 5 250, 6 800, 7 350/
        AMAX(I) /1 70, 2 5, 3 1200, 4 800, 5 300, 6 900, 7 400/
        C1(I) /1 1600, 2 1000, 3 533, 4 200, 5 400, 6 200, 7 100/
        C(I) /1 5800, 2 3000, 3 1600, 4 600, 5 1200, 6 500, 7 650/;
VARIABLES
        X(I) OPTIMAL VALUES
        Z MINIMUM PARTICIPATION OF DISSOLUTION UNIT J ;
EQUATIONS
        PARTICIPATION defines objective function;
*
*
*
PARTICIPATION ..   Z =E= (SUM(I, C1(I)*X(I)))/(SUM(I, (I)*X(I)));
X.LO(I) = AMIN(I);
X.UP(I) = AMAX(I);
MODEL DISSOLUTION /ALL/;
MODEL DISSOLUTION /ALL/;
SOLVE DISSOLUTION USING NLP MINIMIZING Z;
```

```
32 DISPLAY X.LO, X.L, X.UP, X.M;
```

The excerpt of the results obtained is presented in Listing 2.

LISTING 2

```
GAMS 2.05 PC AT/XT 93/09/05 12:11:53 PAGE 2
G E N E R A L A L G E B R A I C M O D E L I N G S Y S T E M
SYMBOL LISTING

COMPILATION TIME = 0.007 MINUTES

GENERATION TIME = 0.009 MINUTES

          S O L V E   S U M M A R Y

     MODEL DISSOLUTION  OBJECTIVE Z
     TYPE NLP           DIRECTION MINIMIZE
     SOLVER MINOS5.2    FROM LINE 30

**** SOLVER STATUS   1 NORMAL COMPLETION
**** MODEL STATUS    2 LOCALLY OPTIMAL

**** OBJECTIVE VALUE        0.3203


---- VAR X      OPTIMAL VALUES
```

	LOWER	LEVEL	UPPER	MARGINAL
1	50.000	70.000	70.000	-7.713E-5
2	4.000	4.000	5.000	1.1757E-5
3	1000.000	1000.000	1200.000	6.1706E-6
4	600.000	600.000	800.000	2.3514E-6
5	250.000	250.000	300.000	4.7028E-6
6	800.000	800.000	900.000	1.1946E-5
7	350.000	400.000	400.000	-3.240E-5
Z	-INF	0.320	+INF	

```
Z      MINIMUM PARTICIPATION OF DISSOLUTION UNIT J
```

**** REPORT SUMMARY :	0	NONOPT
	0	INFEASIBLE
	0	UNBOUNDED
	0	ERRORS

EXECUTION TIME = 0.016 MINUTES

The results obtained show that the minimal participation of 32% in total value of all assets allocated to the dissolution unit j is obtained, if the values of asset class 5 and 7 are on their upper bound and the rest of the asset classes are taking values at their corresponding lower bounds.

Further, it is assumed that besides constraints of type (3) are present constraints of type (4), i.e. that the combined value of asset class 2 and 4 must be greater than or equal to 140 000, and combined value of asset class 5 and 6 must be less than or equal to 28 500, and combined value of asset class 1, 4 and 6 must be greater than or equal to 390 000 :

$$1000x_1 + 200x_2 \geq 140000$$
$$400x_5 + 200x_6 \leq 28500$$
$$1600x_1 + 200x_4 + 200x_6 \geq 390000$$

The results obtained for this case are shown in Listing 3.

LISTING 3

VAR X OPTIMAL VALUES

	LOWER	LEVEL	UPPER	MARGINAL
1	50.000	70.000	70.000	-7.635E-5
2	4.000	5.000	5.000	EPS
3	1000.000	1000.000	1200.000	5.9955E-6
4	600.000	675.000	800.000	.
5	250.000	250.000	300.000	4.5704E-6
6	800.000	800.000	900.000	1.1749E-5
7	350.000	400.000	400.000	-3.198E-5
Z	-INF	0.320	+INF	.

Now, besides variables 1 and 7, the variable 2 is taking its upper bound and variable 4 is taking value inside its allowed interval of values. The objective function is keeping its minimal value of 32%.

Therefore, the results obtained show that the model developed allows for determination of optimal values of asset classes that yield the minimal participation of selected dissolution unit in the overall value of dissolving organization assets. This can be used as an argument advantageous for the economic position of this dissolution unit in bargaining process in the course of dissolution of parent organization. This example illustrates the basic ideas behind modeling approach only and by no means is a complete representation of the real situation.

4. CONCLUSION

The process of dissolution of large, complex organizations poses a number of difficult problems barely studied in the literature. This is of specific interest in the process of privatization and economic transition of Eastern European countries. The approach presented is only an initial step towards a more thorough study of this phenomena. The results obtained are encouraging and appear to be useful in formulation of economic policies of dissolution units and/or parent organization.

The game theoretic approach is also under consideration being better suited for some other aspects of privatization and economic transition problems. Anyhow, the vital importance of these problems for the survival and faster recovery of Eastern European economies, asks for greater attention of O.R. community.

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