Joint Venture's Dynamic Stability with Application to the Renault-Nissan Alliance

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Abstract The cooperative dynamic stochastic multistage game of joint venture is considered. We suggest a payoff distribution procedure (PDP), which defines a time consistent imputation. Based on the results obtained, we conduct a retrospective analysis of dynamic stability of the Renault-Nissan alliance. It is shown that partners within the alliance have divided their cooperative payoffs according to the suggested PDP.
Keywords:strategic alliance, joint venture, dynamic stochastic cooperative games, dynamic stability, normalized share.

1. Introduction

In the recent decades economic globalization continuously increases at a rapid pace. There are constant and strong changes in competitive environment and markets structure. Moreover, customers become more and more informed and seek better quality of products and services. Under such conditions companies are confronted with the increasing challenges of providing themselves with the resources, technologies, competences, skills and information, necessary for achieving competitive advantage. Thus, strategic alliances, and, in particular, joint ventures (JV), are considered to become a necessary condition for company to survive in a violent competitive world. For this reason during the recent decades a number of strategic alliances and JVs shows steadily growth (Meschi and Wassmer, 2013). Indeed, strategic alliances allow companies expanding their geography, entering new markets, getting access to new knowledge, information, technologies, skills and competencies rather quickly (Barringer and Harrison, 2000; Bucklin and Segupta, 1993; Inkpen and Beamish, 1997). Hence, it is not surprising that numerous companies across the world view strategic alliances and JVs as a source of competitive advantage that allows them managing challenges that arise under conditions of markets globalization (Kumar, 2011; Smith et al., 1995).

Strategic alliances have attracted much academic attention in the recent decades. In particular, due to strategic alliances high failure rates (according statistics, more than 50% of strategic alliance and JV agreements dissolve (Kale and Singh, 2009), researchers are especially interested in the issues of strategic alliances and JVs stability (Das and Teng, 2000; Inkpen and Beamish, 1997; De Rond and Buchikhi, 2004).

However, despite considerable interest in the academic community to the issue of strategic alliance and JV stability, common view on this topic has not yet been reached. Moreover, there are several major unresolved issues that require solutions, among which are:

1. Problem of measuring stability of strategic alliances. The question of how to measure the degree of stability of alliance remains unanswered. In general, studies are focusing on identifying factors that may affect stability or instability of strategic alliance (Deitz et al., 2010; Gill and Butler, 2003; Jiang et al., 2008).

2. Strategic alliance stability evaluation. Currently, existing research examining the stability of the strategic alliance has not offered a method of assessing the strategic alliance stability. This can be explained by the existence of various factors of different nature that can influence overall alliance stability in numerous ways. Hence, it becomes a challenge to assess all the components of alliance stability. For instance, there are external factors that affect stability, such as institutional and competitive environment, but there are internal factors as well - trust, opportunistic behaviour, distribution of cooperative benefits, etc. It is clear, that methods of stability evaluation of stability components (e.g. external and internal), probably, should differ due to the different nature of factors, that determine stability.

The important problems associated with the concept of a strategic alliance and its' stability warrant further theoretical and methodological research in this area. In this paper, we attempt to address this gap by implementing and testing game theory methodology for evaluating alliance and JV stability component, that is determined by cooperative benefits allocation factor.

Despite the existence of different factors that affect alliance and JV stability, the factor of allocation of cooperative benefits between the partners during the whole period of alliance realization can be considered as one of the most important (Dyer et al., 2008). It is obvious that when one or several alliance participants do not agree on the distribution of cooperative benefits their motivation for participation decreases which affects stability. Hence, it would be highly useful for alliance partners to know in what way they should design the part of their cooperative agreement concerning benefits allocation for alliance to be stable and to have some instrument that will allow them assessing alliance stability during its realization phase.

In this paper we make an attempt develop an approach for solving these tasks. The approach is based on the concept of dynamic stability in dynamic cooperative games (Petrosjan, 2006).

The paper organized as follows: the first section presents the model of joint venture and suggests a way for cooperative benefits allocation among partners; in the second section the model is applied to a case of Renault-Nissan JV to analyze it's stability; in the conclusions we summarize the main results of the article.

2. Model of Joint Venture

In order to model a JV, a cooperative stochastic multistage dynamic game is considered (Petrosjan, 2006). In particular, a multistage game with the infinite duration and random time closure is used due to the fact that most of the agreements on strategic cooperation between the companies do not have a predetermined end date of the alliance. Dependent on the circumstances in which alliance partners are, they can only make assumptions on when strategic partnership will come to an end. Multistage principle of the game means that players make decisions at certain discrete points of time which correspond to the steps of the game. The stochastic multistage game with random duration $G(x_{t_0}) = (N; V(S, x_{t_0}))$ is considered:

1. players together take a decision on their cooperative strategy in order to obtain the highest overall benefits;

2. players agree on the allocation mechanism of jointly received benefits between partners.

The game $G(x_{t_0})$ that we are considering is described as follows:

$N = 1, ..., n$ – is a number of players (members of JV).

$Z = 0, ..., \infty$ – is a set of steps in the game $G(x_{t_0})$.

$t_m, m = \overline{0, z-1}$ – is time, during which the game evolves.

X – is a set of all possible states in the game, such that:

$$\bigcup_{m=0}^{\infty} X_{t_m} = X \ , \qquad X_{t_k} \cap X_{t_l} = \emptyset \ , \qquad k \neq l \ , \qquad t_0 < t_1 < ... < t_l <, \cdots, < t_\infty \ .$$

In other words, for any point in time t_m in the game $G(x_{t_0})$ corresponds definite step m in the game, on which a set of possible states X_{t_m} of a strategic alliance is given.

F – is a multivalued mapping, that:

$$F_{t_m} : X_{t_m} \to X_{t_{m+1}} \ , \qquad m = \overline{0, z-1} \qquad \text{for} x \in X_{t_z} \ .$$

Mapping F defines a set of possible states of the game at each step.

$U^i_{t_m} = \{u^i_{t_m}\}$ – is a set of possible controls for the player i at the game moment t_m (step m).

$$U_{t_m} = \prod_{i \in N} U^i_{t_m} \ , \qquad U = \prod_{m=\overline{0,z-1}} U_{t_m} \ ,$$

where $i = \overline{1, n}, m = \overline{0, z-1}$, $u^i_{t_m}$ – control of player i in the game moment t_m.

Vector $u^i = (u^i_{t_0}, ..., u^i_{t_m}, ..., u^i_{t_{z-1}})$ is called a strategy of the player i in the game $G(t_{t_0})$:

$$u_i \in U_i \ , \qquad i \in N \ .$$

Vector $u = (u^1, \cdots, u^n)$ – is a situation in the game.

Vector $u_{t_m} = u^1_{t_m}, ..., u^i_{t_m}, ..., u^n_{t_m}$, $i = \overline{1, n}, m = \overline{0, z-1}$ – is a control vector at the time t_m. u_{t_m} is such that:

$u_{t_m} : \forall x_{t_m} \in X_{t_m} \to x_{t_{m+1}} \in X_{t_{m+1}}$.

It is assumed that being in the state $x_{t_m} \in X_{t_m}$ players do not know for sure what state in $x_{t_{m+1}} \in F_{t_m}(x) \subset \underline{X_{t_{m+1}}}$ they will reach using control vector u_{t_m}. But in each state $x_{t_m} \in X_{t_m}$, $m = \overline{0, z-1}$ probabilities of reaching states at the next step of the game, that are dependent on the control vector u_{t_m} are given: $x_{t_{m+1}} \in F_{t_m}(x) \subset X_{t_{m+1}}$:

$$p(x_{t_m}, x_{t_{m+1}}; u^1_{t_m}, \cdots, u^n_{t_m}) = p(x_{t_m}, x_{t_{m+1}}; u_{t_m}) \geqslant 0 \ ,$$
$$\sum_{x_{t_{m+1}} \in F_{t_m}(x)} p(x_{t_m}, x_{t_{m+1}}; u_{t_m}) = 1 \ ,$$

where $p(x_{t_m}, x_{t_{m+1}}; u_{t_m})$ is the probability that at the step $m+1$ the $x_{t_{m+1}}$ state is realized , provided that at the step m was implemented control u_{t_m}. In each possible state $x \in X$ is given a probability q_m, $0 < q_m \leqslant 1$, $m = \overline{0, z-1}$, that the game will end at step m.

Now, let us consider only those states in the game, that have positive probability of being reached by implementation of control vectors u_{t_m}, $m = \overline{0, z-1}$:

$CX = \{x_{t_m} : p(x_{t_m}, x_{t_{m+1}}; u_{t_m} > 0, \forall x_{t_m} \in X, m = \overline{0, \infty}\}$. $CX \subset X$.

Value function of the game $G(N; V(S, x_{t_0}))$ is defined as a lower value of a zero-sum game between two players – coalition S and coalition $N \setminus S$, assuming that the players use only pure strategies. Details on the value function of a cooperative game can be found in (Zenkevich et al. 2009). Let us define it.

Coalition N acts as one decision making center and will try to maximize their total benefits in the game. Suppose, that a sequence of control vectors $u_{t_0}, u_{t_1}, \cdots, u_{t_m}, \cdots, u_{t_{z-1}}$ was implemented.

Then the payoff of player i will be determined by the formula:

$$K_i(x_{t_0}; u_{t_0}, u_{t_1}, \cdots, u_{t_m}, \cdots, u_{t_{z-1}}) = K_i(x_{t_0}) =$$
$$= \sum_{j=0}^{\infty} q_m \left(\prod_{m<j, j \geqslant 0} (1 - q_m) \right) \left(\sum_{k=0}^{j} K_i^{t_m}(u_{t_m} \right) .$$

Due to the fact that the game has a random nature, it is reasonable to consider the expected payoff of the alliance, that players try to maximize in the game $G(x_{t_0}))$:

$$V(N, x_{t_0}) = \max\nolimits_{u_{t_m}} \left[\sum_{i \in N} E_i(x_{t_0}; u_{t_m}, \cdots, u_{t_{z-1}}) \right] . \tag{1}$$

Vector $\bar{u} = (\bar{u}_1, \cdots, \bar{u}_n)$ is called a cooperative solution.

Maximum of (1) is found by solving the corresponding Bellman equation

$$V(N, x_{t_0}) = \max\nolimits_{u^i(x_{t_0}) \in U_i(x_{t_0}),\ i \in N} \left[\sum_{i \in N} K_i^{t_0}(u_{t_0}) + \right.$$
$$\left. (1 - q_0) \sum_{x_{t_1} \in F(x_{t_0})} p(x_{t_0}, x_{t_1}; u_{t_0} V(N, x_{t_1}) \right] =$$
$$= \sum_{i \in N} K_i^{t_0}(\bar{u}_{t_0}) + (1 - q_0) \sum_{x_{t_1} \in F(x_{t_0})} p(x_{t_0}, x_{t_1}; \bar{u}_{t_0}) V(N, x_{t_1}) \tag{2}$$

with the boundary condition

$$V(N, x_{t_m}) = \max\nolimits_{u^i(x_{t_m}) \in U_i(x_{t_m}), i \in N} \sum_{i \in N} K_i^{t_m}(u_{t_m}) , \qquad x \in \{x : F(x) = \emptyset\} . \tag{3}$$

In the case when coalition $S \neq N$ and $S \neq \emptyset$, value function is described by the following equation

$$V(S, x_{t_m}) = \max_{u^S(x_{t_m}) \in U_S(x_{t_m})} \min_{u^{N\setminus S}(x_{t_m}) \in U_{N\setminus S}(x_{t_m})} \left[\sum_{i\in S} K_i^{t_m}(u^S(x_{t_m}), u^{N\setminus S}(x_{t_m})) + (1-q_m) \sum_{x_{t_{m+1}} \in F(x_{t_m})} p\left(x_{t_m}, x_{t_{m+1}}; u^S(x_{t_m}), u^{N\setminus S}(x_{t_m})\right) V(S, x_{t_{m+1}}) \right] \quad (4)$$

with the boundary condition

$$V(S, x_{t_m}) = \max_{u^S(x_{t_m}) \in U_S(x_{t_m})} \min_{u^{N\setminus S}(x_{t_m}) \in U_{N\setminus S}(x_{t_m})} \sum_{i\in S} K_i^{t_m}(u^S(x_{t_m}), u^{N\setminus S}(x_{t_m})), \quad x \in \{x : F(x) = \emptyset\} , \quad (5)$$

where $i_1, \cdots, i_k \in S$, $i_{k+1}, \cdots, i_n \in N\setminus S$ and

$$u^S(x_{t_m}) = (u_{t_m}^{i_1}, \cdots, u_{t_m}^{i_k}); \qquad u^{N\setminus S}(x_{t_m}) = (u_{t_m}^{i_{k+1}}, \cdots, u_{t_m}^{i_n}) .$$

For the case when $S = \emptyset$ it is assumed that its' payoff is 0 :

$$V(\emptyset, x_{t_m}) = 0 . \quad (6)$$

Thus, the game $G(x_{t_0})$ is defined by the pair $(N; V(S, x_0))$, where

1. Value function $V(S, x_{t_0})$ is determined by the formula (2) with the boundary condition (3) for $S = N$;
2. Value function $V(S, x_{t_0})$ is determined by the formula (4) with the boundary condition (5) with $S \neq \emptyset$;
3. Value function $V(S, x_{t_0})$ is determined by the formula (6) with $S = \emptyset$.

The main objective of alliance members is a division of the benefits derived by joint efforts. In the game theory terminology, payoffs of players at the end of the game are called imputation.

Definition 1 (Petrosjan et al., 2004). Vector $\xi(x_{t_0}) = (\xi_1(x_{t_0}), \cdots, \xi_n(x_{t_0}))$ is called imputation in a cooperative stochastic game with the random duration $G(x_{t_0})$, if :

1. $\sum_{i\in N} \xi_i(x_{t_0}) = V(N, x_{t_0})$;
2. $\xi_i(x_{t_0}) \geqslant V(\{i\}, x_{t_0})$, for all $i \in N$,

where $V(\{i\}, x_{t_0})$ is a winning coalition S in a zero-sum game against the coalition $V(\{i\}, x_{t_0})$ when coalition S consists of only one player i.

The set of all possible imputations in the cooperative stochastic game $G(x_{t_0})$ is denoted as $I(x_{t_0})$.

Definition 2 (Petrosjan et al., 2004). Solution of a cooperative stochastic game is any fixed subset of $C(x_{t_0}) \subset I(x_{t_0})$.

Value function definition and definitions 1-2 are also valid for any subgame $G(x_{t_m})$ of the original game $G(x_{t_0})$, that starts at time t_m from the state x_{t_m}.

Thus, having introduced the cooperative stochastic game $G(x_{t_0})$ and having defined the concept of sharing the benefits of cooperation, we defined the stochastic model of strategic alliance.

The main issue of cooperative game theory is the study of the dynamic stability of the division of benefits from cooperation. So let us move to the results obtained in the game theory in the area of the stability of cooperative behaviour.

Definition 3 (Petrosjan et al., 2004). Vector function $\beta(x_{t_m}) = (\beta_1(x_{t_m}), \cdots, \beta_n(x_{t_m}))$, where $x_{t_m} \in CX$, is called payoff distribution procedure (PDP) at a vertex x_{t_m}, if

$$\sum_{i\in N} \beta_i(x_{t_m}) = \sum_{i\in N} K_i^{t_m}(\bar{u}^1_{t_m}, \cdots, \bar{u}^n_{t_m}) = \sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m}) \ ,$$

where $\bar{u}_{t_m} = (\bar{u}_1^{t_m}, \cdots, \bar{u}_n^{t_m})$ is the situation at the time t_m in the game element $G(x_{t_m})$ that was realized under cooperative solution $\bar{u} = (\bar{u}^1, \cdots, \bar{u}^n)$ in the game $G(x_{t_0})$.

Definition 4 (Zenkevich et al. 2009). Imputation $\xi(x_{t_0}) \in C(x_{t_0})$ is called time consistent in a cooperative stochastic game $G(x_{t_0})$, if for each vertex $x_{t_m} \in CX \cap (F(x_{t_0}))^k$ there exists a nonnegative PDP $\beta(x_{t_m}) = (\beta_1(x_{t_m}), \cdots, \beta_n(x_{t_m}))$ such that

$$\xi_i(x_{t_m}) = \beta_i(x_{t_m}) + (1 - q_m) \sum_{x_{t_{m+1}} \in F(x_{t_m})} p(x_{t_m}, x_{t_{m+1}}, \bar{u}_{t_m} \xi_i(x_{t_{m+1}}) \qquad (7)$$

and

$$\xi_i(x_{t_m}) = \beta_i(x_{t_m}), \ x_{t_m} \in \{x_{t_m} : F(x_{t_m}) = \emptyset\} \ ,$$

where $x_{t_m} \in (F(x_{t_m}))^k$, $\xi(x_{t_{m+1}}) = (\xi_1(x_{t_{m+1}}), \cdots, \xi_n(x_{t_{m+1}}))$ is some imputation, that belongs to a solution $C(x_{t_{m+1}})$ of cooperative subgame $G(x_{t_{m+1}})$.

Definition 5 (Zenkevich et al. 2009). Cooperative stochastic game with random duration $G(x_{t_0})$ is a time consistent solution $C(x_{t_0})$, if all imputations $\xi(x_{t_0}) \in C(x_{t_0})$ are time consistent.

Now, based on definitions 1-5, we introduce a normalized share.

Consider normalized shares for imputation $\xi(x_{t_m})$ in the subgame $G(x_{t_m})$, where

$$\theta_i(x_{t_m}) = \frac{\xi_i(x_{t_m})}{V(N, x_{t_m})}, \quad i \in N \ . \qquad (8)$$

According to equation (7)

$$\theta_i(x_{t_m}) = a_i(x_{t_m}) + (1 - q_m) \sum_{x_{t_{m+1}} \in F(x_{t_m})} p(x_{t_m}, x_{t_{m+1}}, \bar{u}_{t_m}) \frac{\theta_i(x_{t_{m+1}}) V(N, x_{t_{m+1}})}{V(N, x_{t_m})} \ , \qquad (9)$$

where

$$a_i(x_{t_m}) \equiv \frac{\beta_i(x_{t_m})}{V(N, x_{t_m})}, \qquad (10)$$

$$\sum_{i\in N} a_i(x_{t_m}) = \frac{\sum_{i\in N}\beta_i(x_{t_m})}{V(N,x_{t_m})} = \frac{\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})}{V(N,x_{t_m})} < 1 \, .$$

Let us verify the normalization condition:

$$\sum_{i\in N}\theta_i(x_{t_m}) = \frac{\sum_{i\in N}\beta_i(x_{t_m})}{V(N,x_{t_m})} + (1-q_m)\sum_{x_{t_{m+1}}\in F(x_{t_m})} p(x_{t_m},x_{t_{m+1}},\bar{u}_{t_m})\frac{V(N,x_{t_{m+1}})}{V(N,x_{t_m})} \, .$$

that is

$$1 = \frac{\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})}{V(N,x_{t_m})} + (1-q_m)\sum_{x_{t_{m+1}}\in F(x_{t_m})} p(x_{t_m},x_{t_{m+1}},\bar{u}_{t_m})\frac{V(N,x_{t_{m+1}})}{V(N,x_{t_m})}$$

or

$$V(N,x_{t_m}) = \sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m}) + (1-q_m)\sum_{x_{t_{m+1}}\in F(x_{t_m})} p(x_{t_m},x_{t_{m+1}},\bar{u}_{t_m})V(N,x_{t_m}) \, ,$$

Thus we came up to the equation (2).

Let us consider constant normalized share:

$$\theta_i(x_{t_m}) = \theta_i(x_{t_{m+1}}) = \theta_i = \text{const} \, . \tag{11}$$

Proposition. *If normalized shares θ_i, $i \in N$ (8) are constant (11) for any subgame $G(x_{t_m}), m = \overline{0, z-1}$, then the imputation $\xi(x_{t_0})$ is time consistent in the game $G(x_{t_0})$.*

Proof. From (9) it follows that

$$\theta_i\left(1-(1-q_m)\sum_{x_{t_{m+1}}\in F(x_{t_m})} p(x_{t_m},x_{t_{m+1}},\bar{u}_{t_m})\frac{V(N,x_{t_{m+1}})}{V(N,x_{t_m})}\right) = a_i(x_{t_m}) \, . \tag{12}$$

Taking into account equation (2), it is easy to obtain

$$\theta_i\left(1-\frac{V(N,x_{t_m})-\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})}{V(N,x_{t_m})}\right) = a_i(x_{t_m}) \, .$$

Simplifying equation (12) we derive

$$a_i(x_{t_m}) = \theta_i\frac{\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})}{V(N,x_{t_m})}$$

or, what is the same,

$$\theta_i = a_i(x_{t_m})\frac{V(N,x_{t_m})}{\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})} \, .$$

Finally, with the use of (10)

$$\theta_i = \frac{\beta_i(x_{t_m})}{V(N,x_{t_m})}\cdot\frac{V(N,x_{t_m})}{\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})} = \frac{\beta_i(x_{t_m})}{\sum_{i\in N} K_i^{t_m}(\bar{u}_{t_m})} \, ,$$

that is

$$\beta_i(x_{t_m}) = \theta_i \sum_{i \in N} K_i^{t_m}(\bar{u}_{t_m}) \ .$$

Thus, it is shown that when normalized share is constant in the sense of (11), it means that $\xi(x_{t_0})$ is time consistent in a game $G(x_{t_0})$.

3. Analysis of Renault-Nissan JV

In this section, the Renault-Nissan JV is analysed. This alliance is considered to be one of the most successful and stable alliances in the world. Renault and Nissan companies started their informal collaboration in 1999. At that time Nissan had strong engineering experience, car design that did not attract much customers and serious financial problems. Renault had good design and administration practices but was not strong in engineering. It was seen that companies had complementary resources and could improve each others positions. Hence, companies decided to start to cooperate. Renault bought 36.8% shares of Nissan company and increased the amount up to 44.4% in 2001, and Nissan bought 15% of Renault company shares the same year. At that time there was no formal agreement on cooperative activity of the Renault and Nissan companies, however both of them were interested in developing of the partners' company due to the ownership of partners equity shares. Finally, companies formed a strategic alliance in a form of JV in 2003. This step was the initiation of formal cooperative activity.

Fig. 1 shows the strategic alliance's structure (Renault official website).

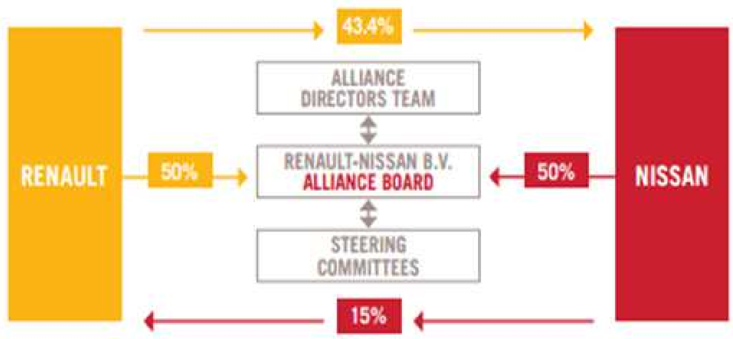

Fig. 1: Renault-Nissan strategic alliance structure

Within JV companies cooperate in a broad range of areas. First of all, Renault and Nissan use the same distribution channels for both companies, which allowed Nissan gaining positions on European market and made possible for Renault enter Japan and South American markets. Secondly, most of the Renault and Nissan cars have the same production platforms. This means that Renault can produce its cars at Nissan plants and vice versa. That leads to significant cost reductions. Thirdly, companies cooperate in innovations and technology areas. They jointly provide research and development activities and jointly produce engines, accumulators and other car components. For instance, partners concentrate on development of engines with zero gas emission rate to the atmosphere. Finally, companies have unified supply chain of components. In 2010 companies announced that collaborative initiatives led to 1.5 billion Euro of cost reduction that year. In 2012 the sales of Renault-Nissan alliance reached the level of 8.1 million units across the world. That showed a 1% increase in sales comparing to the previous period and continuing growth. In order to analyse whether the one of the long lasting alliance is dynamically stable, we calculated their payoffs for the realization period of the alliance.

The analysis starts from 2004, because 2003 is considered as a period of alliance formation phase in accordance with strategic management theory. At this phase alliance coordinates it's operations and companies adapt to new conditions (De Rond and Buchikhi, 2004; Styles and Hersch, 2005).

The goal of the analysis is to check whether Renault and Nissan companies use such PDP, that their imputations are time consistent. Therefore, we are going to check whether normalized shares during the alliance realization phase remain constant or not.

First, it is necessary to calculate companies' payoffs, taking into account the complicated structure of their relationship. Hence we consider companies' financial data. Because Nissan is a Japanese company, Nissan's reports provide the numbers in Japanese Yens. Hence, the convertion from Japanese Yens to Euros was necessary. Table 1 shows financial data of Nissan company in Japanese Yens (Nissan official website) and exchange rates, that were used to make the conversion (Renault official website).

Table 1: Financial data of Nissan company, ¥ million

Year	Nissan shareholders' equity	Nissan dividends	Exchange rate €/ ¥
2004	2465.75	94.24	134.00
2005	3087.99	105.66	136.80
2006	3586.62	131.06	146.10
2007	3868.14	151.73	161.20
2008	3556.48	126.30	152.30
2009	3598.97	0.00	129.40
2010	3981.51	20.92	116.50
2011	4269.83	62.75	111.00

The financial data necessary to make the calculations is presented in Table 2 and is obtained from the official sources (Renault official website; Nissan official website). Columns with the Renault and Nissan net incomes report only the income received by the companies from the Renault-Nissan JV.

Table 2 represents the data in unified form in Euro currency.

Table 2: Financial data of Renault and Nissan companies, € million

Year	Renault net income	Nissan net income	Renault shareholders' equity	Nissan shareholders' equity	Renault dividends	Nissan dividends
2004	1.35	3.90	15.86	18.40	1.80	0.70
2005	1.18	5.19	19.49	22.57	2.40	0.77
2006	1.07	4.26	21.07	24.55	3.10	0.90
2007	1.45	2.95	22.07	24.00	3.80	0.94
2008	0.25	1.00	19.42	23.35	0.00	0.83
2009	-2.17	-1.91	16.47	27.81	0.00	0.00
2010	2.41	2.61	22.76	34.18	0.30	0.18
2011	0.88	3.29	24.57	38.47	1.16	0.57

In order to explain how we calculated companies payoffs, let us introduce the following notation: $Payoff_R$ – Renault's payoff; $Payoff_N$ – Nissan's payoff; $Income_R$ – Renault net income from participating in JV; $Income_N$ – Nissan net income from participating in JV; $ShEq_R$ – Renault shareholders' equity; $ShEq_N$ – Nissan shareholders' equity; Div_R – dividends paid by Renault company; Div_N – dividends paid by Nissan company.

To get payoffs it is not enough to consider only the net income the companies earned from JV. As was mentioned earlier, companies exchanged shares with each other. During the whole period of alliance realization Nissan owned 15% shares of Renault and this percentage remained constant. However, the percentage of Nissan's shares owned by Renault differed during the alliance period and amounted to $43.4\%, 44.3\%$ and 44.4%. Possibly, the differences were caused by different methods used by company to evaluate its' share. For this reason we decided to consider the average percent of three numbers listed above, which is equal to 44.03%.

The logic for companies' payoff calculation is the following: if Renault company owns 44.03% shares of Nissan company, than we should add the value of 44.03% shares in Nissan company to Renault payoff. Also, we should not forget to incorporate the value of Renault company, which has the value of 85% shares. Moreover, the payoff should include 44.03% of all the dividends that were distributed by Nissan company, as well as dividends that were distributed in Renault company. The same logic applies to Nissan company payoff calculation.

Thus, the formula for Renault company payoff calculation is:

$$Payoff_R = Income_R + 0,85ShEq_R + 0.4403ShEq_N + 0.85Div_R + 0.4403Div_N.$$

Let us show how it works by analysing Renault payoff for 2004. In this case $Income_R = 1.35, ShEq_R = 15.86, ShEq_N = 18.40, Div_R = 1.80, Div_N = 0.70$.

Renault company owns only 85% of its' shares. Hence, it has $0,85ShEq_R$ and $0.85Div_R$, but also it owns 44.4% of Nissan shares, that yields $0.444ShEq_N$ and $0.444Div_N$. Finally, we should sum up all the components with $Income_R$.

We got that $Payoff_R = 24,77$.

Following the same methodology, equation for Nissan company is

$Payoff_N = Income_N + 0.55977 ShEq_N + 0.15 ShEq_R + 0.5597 Div_N + 0.15 Div_R$. To calculate Nissan payoff in 2004 we should take the following numbers: $Income_N = 3.90, ShEq_R = 15.86, ShEq_N = 18.40, Div_R = 1.80, Div_N = 0.70$.

Hence, $Payoff_N = 17.24$.

Payoffs for years 2005-2011 are calculated using the same formulas.

Total alliance benefits are the sum of the partners payoffs:

$$Benefits_{JV} = Payoff_R + Payoff_N.$$

Renault's share and Nissan's share are calculated as follows:

$$Share_R = \frac{Payoff_R}{Benefits_{JV}},$$

$$Share_N = \frac{Payoff_N}{Benefits_{JV}}.$$

The results of the calculations of companies' parameters are represented at Table 3.

Table 3: Renault and Nissan shares of alliance cooperative benefits, € millions

Year	Renault payoff	Nissan payoff	Total alliance benefits	Renault share	Nissan share
2004	24.77	17.24	42.01	0.59	0.41
2005	30.06	21.53	51.59	0.58	0.42
2006	32.82	22.12	54.94	0.60	0.40
2007	34.41	20.78	55.20	0.62	0.38
2008	27.40	17.44	44.84	0.61	0.39
2009	24.08	16.12	40.21	0.60	0.40
2010	37.13	25.29	62.42	0.59	0.41
2011	39.86	28.98	68.84	0.58	0.42

Here columns with Renault and Nissan benefits represent players' payoffs at game stages. Columns with Renault and Nissan shares correspond to considered in the paper normalized shares.

Figure 2 represents the dynamics of Renault and Nissan shares during

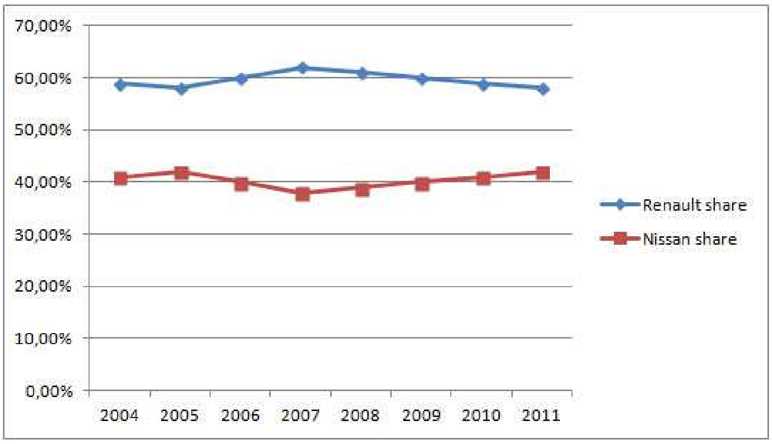

Fig. 2: Shares of Renault and Nissan companies of cooperative benefit

It is seen from the graph that payoff shares of Renault and Nissan companies are approximately stable across the realization stage of the strategic alliance in the form of JV. There are multiple reasons for slight variations of values. The major one refers to the evaluation methodology used for annual report preparation.

To assess these variations, standard deviation $\sigma = 0.01$ was calculated. Thus, companies' shares can be considered to be equal during the whole period of alliance realization.

We showed that one of the most successful and stable alliances in the world has a time consistent imputation. This fact can be considered as a first argument towards adequacy of implementation of dynamic stability concept to the investigation of JV and alliance stability in terms of cooperative benefits distribution among alliance partners.

It is worth mentioning that the reverse problem to those, that usually handle game theory, was solved. The task was not to evaluate future payoffs of the players using the model of dynamically stable behaviour principle, but rather to check whether the dynamic stability took place in terms of implementation of time consistent imputation principle. Thus, it is possible to provide retrospective analysis of JV and alliance stability based on historical data of alliance/JV performance.

4. Conclusion

In this paper we attempted to apply the cooperative game theory methodology in order to evaluate JV stability. We showed, that constant normalized share guarantees imputation to be consistent. This fact allows companies developing a cooperative agreement in a way, when all partners receive constant normalized share during the whole period of alliance realization. Also, it enables retrospective checking of JV stability as it was shown on the case of Renault-Nissan alliance. It appeared that the alliance most known in the world for it's success, durability and stability uses imputation principle with constant normalized shares.Of course, the instrument developed and presented in the paper is applicable to a restricted range of problems in the sense that it allows considering only one type of imputation. However, the paper can be considered as a first step towards developing instrumental apparatus for JV stability evaluation. We believe that game theory methodology has a great potential for solving the problem of strategic alliance and JV stability evaluation. It can serve as a basis for developing instruments of practical assessment of different stability components, which would provide companies across the world with a valuable strategic tool in designing and managing their alliance agreements in a "stable" manner.

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