The analysis of dyadic relationships in the negotiation process

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Abstract

In the paper we analyze the negotiation process as the model of dyadic relationships between negotiator and their counterpart. By using modified Actor-Partner Interdependence Model (APIM: [5], [7]) we show how to investigate interdependence between the parties in the consecutive rounds of negotiation process, which may help to find if the offers the parties submit are the negotiation-process-dependent and depend on the counterparts behaviour and moves. For estimating those relationships we use the structural equation modelling technique. We also focus on the diagnostic of data-related assumptions, in particular the multivariate normality. In the case study, the data from ENS Inspire database describing the past bilateral negotiation experiments are used.

Keywords*: APIM, SEM, dyadic negotiation analysis, negotiation offers exchange mode*

JEL Classification: C51, C44, C81

AMS Classification: 62M20, 62C05

1. Introduction

APIM and some other models have already been investigated as tools for negotiation analysis [12]. However, they were used for analyzing usually the post negotiation data, such us negotiators' satisfaction, system use and usefulness, etc. In our paper the parties' negotiation offers are investigated, that are described by the series of ratings that result from these offers. We try to find if the path the offers comprise can be perceived as an independent negotiation strategy, that is purposely chosen and individually shaped by the party in the prenegotiation phase to realize their goals in the best possible way [14], or it is rather influenced by the counterparts behaviour and moves within the actual negotiation phase (i.e. the counterpart's path). Thus we examine, whether the offers sent by the negotiator and their counterpart influence the future offers they propose later in the negotiation process. We divide the negotiation process into rounds. Within each round one of the parties submits an offer. If accepted, the negotiation ends, if not the next round of the negotiation beginning, in which another offer is proposed by their counterpart (partner). In this work we examine two rounds of negotiations only, trying to measure interdependence between the offer ratings the pair

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(i.e., the negotiator and their counterpart as the dyad) obtains. The ratings (scores) may be determined in very many ways [10, 11, 13]. In this paper we assume that the ratings are calculated by means of simple additive weighting model [6], as it is applied in the Inspire electronic negotiation system [8], the dataset of which we use in our analysis.

2. Measurement of interdependence – dyadic data

The analysis of the negotiation process we conduct here in the context of the dyadic data. This analysis is generally designed to measure interdependence taking into account the interpersonal relationships between dyad members. Two individuals (here: the negotiator and their counterpart) affects each other and the one party's score influence somehow the score obtained by the other party. This correlation of scores implies that the independent observations assumption is violated. That is why the standard statistical data-analytics approaches like ANOVA or multiple regressions give inaccurate results and estimates. Therefore linked scores data are structured in the dyadic design [7]. In further considerations we treat the pair: the negotiator and their counterpart as the dyad - one observation in a sample. Moreover we assume that dyad members are distinguishable. This distinguishablility is critical in quantitative methods of the dyad data analysis.

The example of dyadic data analysis is the aactor-partner interdependence model (APIM). The APIM model allows to find interdependencies among within-dyad variables describing the problem under consideration. The standard path diagram for APIM model with observed variables is presented in figure 1.

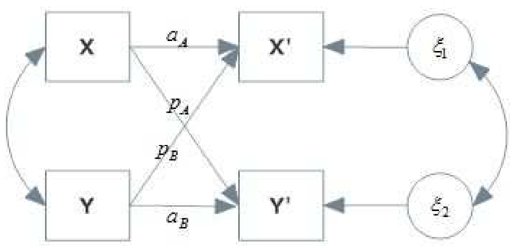

Fig. 1. Actor-partner interdependence model [2].

Two factors labelled by a_A, a_B indicate the potential actor's effect, while two factors denoted by p_A, p_B indicate the partner effect of the parties. The idea of APIM model is to estimate model's effects which measure interdependencies between dyads (depicted by the arrows). It is possible to apply three approaches to estimate actor's and partner's effects: ordinary least squared regression (OLR), structural equation modelling (SEM) and multilevel analysis (HLM). In this paper we focus on SEM technique. Consider the structural model defined according to [4]:

$$\mathbf{y}=\mathbf{B}\mathbf{y}+\mathbf{\Gamma}\mathbf{x}+\xi, \tag{1}$$

where **y**(p x 1) is the vector of endogenous variables, **x**(q x 1) is the vector of exogenous variables and ξ(p x 1) is the vector of residuals in regression's equations. Two matrixes **B**(p x q) and **Γ**(p x p) denote: the matrix of structural parameters (effects) **y** terms **y** and matrix of structural parameters (effects) **y** terms **x**. The following assumptions are necessary in model discussed: (i) $E(\mathbf{x}\xi^T) = 0$, (ii) $E(\xi) = 0$, (iii) $\det(\mathbf{I}\text{-}\mathbf{B})^{-1} \neq 0$.

Let **Φ, Ψ** be the covariance matrices of exogenous **x** and residuals ξ respectively. Than it follows, from the assumptions (i)-(iii), that the covariance matrix **Σ**[(p+q)x(p+q)] of (**x**,**y**) is:

$$\mathbf{\Sigma}=\left[\frac{(\mathrm{I-B})^{-1}(\Gamma\Phi\Gamma^T+\Psi)(\mathrm{I-B})^{-1}}{\Phi\Gamma^T(\mathrm{I-B})^{-1}}\,\Big|\,\frac{(\mathrm{I-B})^{-1}\Gamma\Phi^T}{\Phi}\right]. \tag{2}$$

The goal of SEM modelling is to estimate the matrix **Σ** which is equivalent to estimate all structural parameters in the matrices. In the terminology presented above, the considered APIM path diagram (Fig. 1) has a following structural model:

$$\begin{bmatrix} Y' \\ X' \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}\begin{bmatrix} X' \\ Y' \end{bmatrix} + \begin{bmatrix} a_A & p_A \\ a_B & p_B \end{bmatrix}\begin{bmatrix} X \\ Y \end{bmatrix} + \begin{bmatrix} \xi_A \\ \xi_B \end{bmatrix}, \tag{3}$$

where $\mathbf{B} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix}$ and $\mathbf{\Gamma} = \begin{bmatrix} a_A & p_A \\ a_B & p_B \end{bmatrix}$. The problem of estimation of such a model is quite complex and is not the subject of our researches, see in [1]. We simply analyze the considered models using SPSS AMOS – the specialist software for structural equation modeling. In the case study we focus on the estimation of structural parameters from matrices **B** and **Γ**.

3. Measurement of interdependences in negotiation process

The negotiation process can be analyzed for many different aspects. In this work we focus on the interdependencies between and within the dyads, i.e. two parties in bilateral negotiation. In our SEM model, scores of offers (obtained by SAW [6]) in every round of negotiations are taken as the variables.

Let X_t^N and X_t^C be the score for the negotiator and their counterpart in t-th round of negotiations respectively. All variables taken into consideration are observed and continuous. First we examine the interdependence within the dyad in one round of negotiations. The simple path diagram for SEM model is:

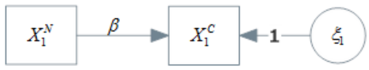

Fig. 2. The interdependence in one round of negotiation.

The structural equation is of form:

$$X_1^C = \beta X_1^N + \xi_1 \tag{4}$$

with matrices of parameters as follows: **B** = **0**, **Γ** = $[\beta]$, **Φ** = $[\mathrm{var}(X_1^N)]$, **Ψ** = $[\mathrm{var}(\xi_1)]$.

The extension of this model is 2-round SEM with observed variables, in which we investigate the interdependence: between the dyad in each two rounds of negotiation and within the dyad in every round of negotiations. There are few possibilities to verify the potential interdependencies. First approach is to apply the standard APIM model. In this case, the 2-round negotiation process is represented as the path diagram presented in Fig. 1.

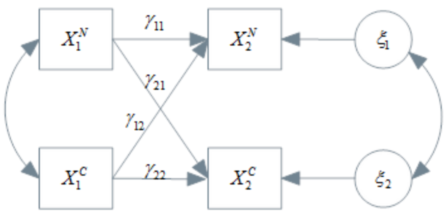

Fig. 3. 2-round negotiation APIM with observed variables.

The corresponding structural model is as follows:

$$\begin{bmatrix} X_2^N \\ X_2^C \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \end{bmatrix} \begin{bmatrix} X_2^N \\ X_2^C \end{bmatrix} + \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix} \begin{bmatrix} X_1^N \\ X_1^C \end{bmatrix} + \begin{bmatrix} \xi_1 \\ \xi_2 \end{bmatrix}. \tag{5}$$

This classic APIM model allows to analyze the relationships between the negotiator and the counterpart in two rounds of negotiations (going from one offer to another), assuming that there is a correlation within a dyad (double-headed arrow in diagram). Such an approach, however, does not reflect properly the negotiation process, as in each round two following situations are possible: the negotiator submits an offer, i.e. affects the counterpart - $X_t^N -> X_t^C$; or quite the contrary, the counterpart submits an offer - $X_t^C -> X_t^N$. It is therefore necessary to introduce a regression model within the dyad (one-headed arrow in diagram). Assuming regular sequence in the negotiation process, in which negotiator submits an offer in round *t* and their counterpart responds in round *t*+1, the modified APIM model has the following path diagram:

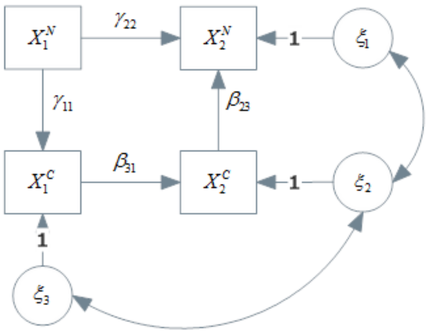

Fig. 4. 2-round negotiation modified APIM model with observed variables for regular offers' exchange.

The above model takes the structural form:

$$\begin{bmatrix} X_1^C \\ X_2^N \\ X_2^C \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & \beta_{23} \\ \beta_{31} & 0 & 0 \end{bmatrix} \begin{bmatrix} X_1^C \\ X_2^N \\ X_2^C \end{bmatrix} + \begin{bmatrix} \gamma_{11} & 0 & 0 \\ 0 & \gamma_{22} & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} X_1^N \\ X_1^N \\ X_1^N \end{bmatrix} + \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{bmatrix}. \quad (6)$$

This SEM model describes the situation which the offers send by the negotiators are directly determined by the offers sent by him and his counterpart in the previous negotiation round. The problem that may appear while building such models is a possible irregularity of the negotiation process. The irregularity appears when the sequence of the alternately exchanged offers is broken. In such a case the negotiator sends two offers in a row. Such a situation may be symmetric, i.e. it may take place both for the negotiator and their counterpart, and should be analyzed by means of a separate SEM, in which we assume the sequence in negotiation process as in path diagram form Fig. 5.

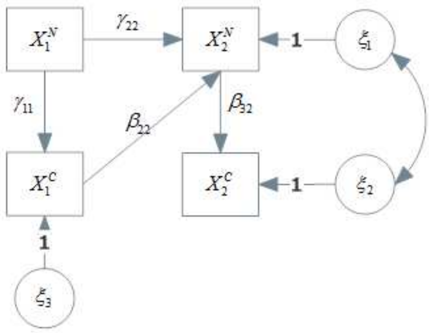

Fig. 5. 2-round negotiation modified APIM model with observed variables for irregular offers' exchange.

The corresponding structural model is as follows:

$$\begin{bmatrix} X_1^C \\ X_2^N \\ X_2^C \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & \beta_{22} & 0 \\ 0 & \beta_{32} & 0 \end{bmatrix} \begin{bmatrix} X_1^C \\ X_2^N \\ X_2^C \end{bmatrix} + \begin{bmatrix} \gamma_{11} & 0 & 0 \\ 0 & \gamma_{22} & 0 \\ 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} X_1^N \\ X_1^N \\ X_1^N \end{bmatrix} + \begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \end{bmatrix}. \tag{7}$$

To take this irregularity into account in the data analysis, we propose to classified all dyads according to the form of the sequence of negotiations. So in 2-round model there are two classes: A – model as in Fig. 4 and B - model as in Fig. 5. Of course in the negotiation process with more than 2 rounds, the number of classes will rapidly grow.

4. The case study

In our case study we analysed simulated data dyads based on ENS Inspire initial dataset describing the past bilateral negotiation experiments. The models from Fig. 3, 4 and 5 were estimated using SEM techniques (AMOS software). Either using maximum likelihood (ML) or normal theory generalized least squares (GLS) estimation, two critically important data-related assumptions must be fulfilled: the requirement that the data are of a continuous scale and have a multivariate normal distribution. So in preliminary analysis we tested the assumption about the multivariate normal distribution (the score is of a continuous scale). In the initial phase of testing we investigated the distributions of all variables separately. Histograms clearly showed that the normality assumption is not satisfied even for one variable. In order to handle the presence of multivariate nonnormal data, we use the bootsrap resampling procedure, see in [3], which is available in AMOS software as an option. The results are presented in Table 1.

Model Fig. 3			Estimate	S.E.	P
X_2^N	<--- $\hat{\gamma}_{11}$	X_1^N	.796	.016	***
X_2^C	<--- $\hat{\gamma}_{12}$	X_1^N	.153	.021	***
X_2^N	<--- $\hat{\gamma}_{21}$	X_1^C	.642	.016	***
X_2^C	<--- $\hat{\gamma}_{22}$	X_1^C	.950	.021	***
Model Fig. 4			**Estimate**	**S.E.**	**P**
X_1^C	<--- $\hat{\gamma}_{11}$	X_1^N	-.853	.066	***
X_2^C	<--- $\hat{\beta}_{31}$	X_1^C	.771	.019	***
X_2^N	<--- $\hat{\gamma}_{22}$	X_1^N	.693	.020	***
X_2^N	<--- $\hat{\beta}_{23}$	X_2^C	.676	.024	***
Model Fig. 5			**Estimate**	**S.E.**	**P**
X_1^C	<--- $\hat{\gamma}_{11}$	X_1^N	-.853	.066	***
X_2^N	<--- $\hat{\beta}_{22}$	X_1^C	.106	.077	0.165
X_2^N	<--- $\hat{\gamma}_{22}$	X_1^N	.040	.029	0.165
X_2^C	<--- $\hat{\beta}_{32}$	X_2^N	10.785	8.024	0.179

Table 1 Estimated structural parameters (effects)

As we see the effects estimated by models 3 and 4 are large positive and statistically significant, indicating that there is reliable stability. The classic APIM model confirms that the actor effects ($\hat{\gamma}_{11}, \hat{\gamma}_{22}$) are greater than the partner ones ($\hat{\gamma}_{12}, \hat{\gamma}_{21}$). Models 4 and 5 show however, that there are strong within-dyad interdependencies, namely, the results negotiator obtains influence strongly the counterpart's ones within each round ($\hat{\gamma}_{11}$). Moreover, model 4 confirms, that there offer counterpart formulates in second negotiation round depends strongly on the negotiator's first proposal ($\hat{\beta}_{31}$).

5. Conclusions

In this work we showed how the APIM-based modified approach for dyadic analysis may be used in negotiation analysis to find the interdependence between the successive offers submitted by the parties within their concession paths in 2-round model. In the future work we will try to investigate the dependences in *n*-round negotiation process using multilevel modelling. What should be emphasize here, is that in the dyadic data analysis of the negotiation processes two major problems may appear: the assumption of normality and linearity of data may be violated. If some statistical data transformation methods do not solve these problems, using SEM is not legitimate. Therefore in our future research we will analyze the applicability of the multilevel modelling to negotiation process analysis, as an alternative for SEM.

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