A Judgment Approach to Estimating Parameter in Group Model-Building : A Case Study of Social Welfare Reform at Dutchess County

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Abstract

Building models directly with client groups has become increasingly common in the field of system dynamics (Vennix et al., 1992; Vennix, 1996). For the past ten years, the modeling group at the University at Albany has been experimenting with techniques for handling the complex modeling and facilitation processes involved in group work. This article extends the previous work of scripted techniques by discussing parameter estimation techniques in group model building. The discussion of the paper is divided into four sections : The first section states the purpose of the study and reviews the literature of the past efforts on estimating parameter in group model building. The second section is an overview of the approach for group parameter estimation designed by the Albany modeling team. This overview section includes the problems addressed by each elicitation step and the solutions for solving them. The third section is the case study describing the data calibration conference at Department of Social Service, Dutchess County. This case study presents how the Albany modeling team applied the designed scripts supporting parameterization in a conference. Strengths and weaknesses of the application are discussed. The last section of this article contains suggestions for future work on estimating parameters in group model building. Due to page limitation, this paper only presents the script of parameter estimation.

I. Background of Dutchess County Group Model Building

Department of Social Services of Dutchess county and Albany modeling team have been through several conferences for group model building regarding social welfare reform issue. The purpose of the social welfare reform model building is for policy analysis and policy suggestion. Several products of the project so far show its contributions on welfare policy analysis and the field of group model building (Center for Policy Research, University at Albany, 1997s, 1998; Rogers, et al, 1997; Allers, et al, 1998). This project at this point includes two models, one focusing on TANF (Temporary Assistance for Needed Families) and the other on the Safety-Net (families ineligible for federal TANF). Two models are planned to be jointed together eventually. This Dutchess County data calibration exercise focused on the Safety-Net model.

The Dutchess County data calibration conference is considered as a part of continuous line of social welfare reform group model building at Albany. Although the modeling team wants to get as much useful information as possible from one conference, eliciting all the parameters of the model at one conference is usually not feasible. Therefore, an upcoming concern is the efficiency of this conference. Generally, there are three sources of the numerical value of parameters: firsthand data, computed value from firsthand data, and expert judgment. By now, some firsthand data have been gathered from past conferences and through it some numerical values of parameters have been directly or indirectly obtained. Thus, this conference will concentrate on those unknown

parameters. After parameters are elicited, they can be fed back to the model for testing model sensitivity and tailoring the model more completely.

Ninety percent of the participants of the calibration conference have been going through several prior Dutchess welfare group model building conferences with Albany modeling team. In other words, most of the participants are familiar with the social welfare reform model under development. The following section will briefly describe the Safety-net model.

II. The Nature of the Model

Figure 1 shows the major structure of Safety-net model. In this model, people who receive safety-net public assistance come from either economic mainstream due to overall economic situation or loss of TANF eligibility due to TANF maximum five year time limit. Safety-net assistance recipients could leave the system because of job finding, being sanctioned or exiting with non-work reasons. For those people being sanctioned, there are chances for them to return to the safety-net system. Part of those people who are employed after safety-net assistance may stay employed and finally go into economic mainstream. However, part of those post safety-net employed people may lose their jobs and recidivate the safety-net system. In this model, several resources have impacts on the flows. Basic services have an impact on flows of "from mainstream", "departing" and "sanctioned leaving". Child Support Enforcement influences the flows of "from mainstream", "departing", "sanctioning" and "into mainstream". Monitoring affect the flow of "departing", "sanctioning" and "job finding". Employment services influence the flow of "job finding". Job Maintenance services have an impact on the flows of "recidivism" and "into mainstream". The overall economic situation (represented by unemployment rate) affect all of the inflows and outflows of the safety-net system. The data elicitation technology is designed based on this model.

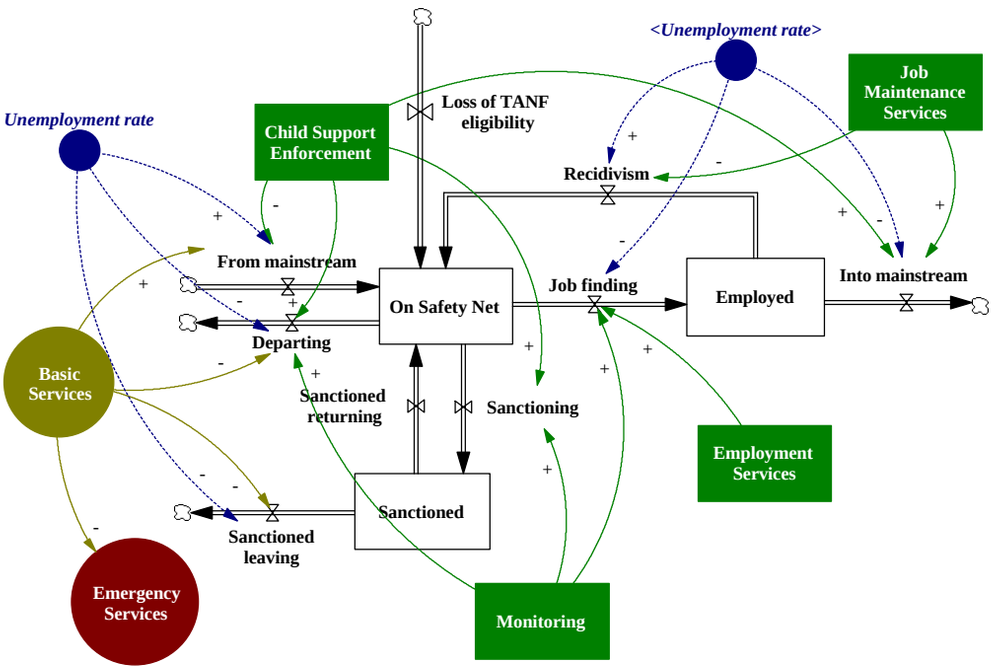

Figure 1. Safety-net Client Stock-and-flow Diagram With Resource Impacts and Unemployment Scenario

III. Data Calibration Conferencing : An Overview of the approach designed by Albany modeling team

A data calibration conference is one in a series of group model building sessions. Typically it occurs after an earlier conference designed to elicit model structure. As with other group model building sessions, a calibration conference is supported by a team of at least three professionals who fill specific roles during the meeting: the process facilitator, whose function is to ensure that all group members are able to participate fully in the process and that the group session is not dominated by a minority of group members (Keltner, 1989), modeler/reflector who takes care of all the computer support and information feedback tasks (Andersen & Richardson, 1997), and a correspondent who monitors the process and electronically records the important details of the group's discussion for good documentation and a printed report to client group (Reagan-Cirincione & Rohrbaugh, 1992). A typical room layout for a data calibration conference is similar to the one for group model building workshop. It should include large white boards, flip charts, swivel chairs and an overhead projector with projection pad (or beam projector) linked to a computer in the background (Andersen and Richardson, 1997). Extensive discussion of the room layout and the roles in the room are contained in Richardson and Andersen (1995) and Andersen and Richardson (1997). Since the conference is on a continuous line of group model building, those people who attended previous group model building meeting are expected and preferred for data calibration.

A Script for Calibrating A Complete Stock and Flow Chain

This calibration script is based on a completely structured model – safety-net model. The purpose of this script is to elicit parameters and table functions after the structure of the model has settle down. Some potential problems could hinder group communication during the data calibration session as well as the accuracy of the calibration results from individual or group judgment exercises. Such problems include participants' different recognitions or definitions of a specific variable in the model, the presence of dominant individuals, participants' unfamiliarity of the model structure due to memory limitation, individual human judgment inconsistency, high disagreement among group members, to name but a few. The following section will discuss the problems addressed by each elicitation step and the Albany team's approach designed to mitigate these potential problems.

1. Learning major structure of the model

The conference should be opened by reviewing the model to help participants refresh their memories of the model's major structure. This presentation should not too detailed. A high level view of system structure including major feedback loops, stocks and flows should be shown. Computer support using a beam projection of model output are recommended here to show runs that are designed to raise attention and make participants better understand linkages between system structure and behavior.

2. Clarify the definition of important variables

Richardson and Pugh (1981) pointed out that care must be taken that the data gathered have the same meaning as the model parameters. Participants' different definitions of a specific variable can be a source of disagreements on the numerical value

of a related parameter. Skewed understanding of a variable will induce skewed parameter elicitation. Therefore, for those variables that may have been ambiguous during discussion in the group model building sessions, it is important to clarify their definitions before parameterization. Definition should be drawn from past meeting minutes or report in order to ground participants in the groups' prior understanding of what a specific parameter meant.

3. Elicitation of key parameters

Based on a complete stock-and-flow structure, the task of eliciting key parameter here is specifically for equilibrating the stock-and-flow chain. Therefore, this is not a global way of parameter elicitation.

An "Estimate-Feedback-Talk" group process intervention is applied to elicit key parameters. The process facilitator first helps group members to understand parameter definitions and how they are used in the model. This discussion is followed by individual anonymous judgment. After that, information feedback is provided by a equilibrium stock-and-flow spreadsheet in which various individual estimates can be entered. The structure of this stock-and-flow spreadsheet is exactly the same as the structure of safety-net model except the spreadsheet is in a equilibrium status. When various individual estimates are entered into the spreadsheet, some related numbers will change accordingly. Group members then discuss these estimates and their effects on the whole system. The detailed of the elicitation process is as following.

a. Clarifying parameter definition and location

As mentioned above, different definitions of a parameter being elicited may cause difficulties reaching agreement among group members or even meaningless value estimation. Thus, by presenting a major stock and flow diagram with clear parameter explanations of how parameters are used in the model, the process facilitator helps participants to understand the definition of the parameters and the effect of the parameters on flows.

b. Estimating parameters by individual judgment

In order to collect estimates from all members present, the data estimation process starts from individual anonymous judgment without group discussion. In group judgment, research has revealed that groups have been found to perform under the level of their best member, i.e. the member with the most accurate judgment (Miner, 1984). However, when the group is unsure about who their "best member" is, research indicates that judgment is best done in interacting groups provided that individuals first make their own individual estimates before a discussion and subsequent group decision (Miner, 1984; Sniezek and Henry, 1989)

Here, for individual judgment, a well-designed, typed-up list of key parameters being elicited will be handed out to each participant. Based on individual judgment, each participant is asked to put a numerical value for each parameter on the handout.

c. Tuning numerical value of parameters by group judgment

This is a judgment aggregation step combining behavior approach and computer facilitation. It allows full interaction among group members. Unstructured discussion could cause process losses during this phase of calibration. Therefore, a device that helps

to direct the whole discussion to be more structured is used. A stock-and-flow spreadsheet (figure 2) is built to connect participants' judgments on real world data to model structure and help people to simply pay attention on the influence of value change of each parameter on the value change of other variables. In figure 2, the cells with black shading are used to input numerical value estimated by participants. Changing specific parameter input will influence multiple other values of the overall stock and flow chain. From the exercise, participants can learn more about the impact of specific parameters on the overall stock and flow equilibrium. In addition, using the flow spreadsheet could help to identify some contradictory numerical values.

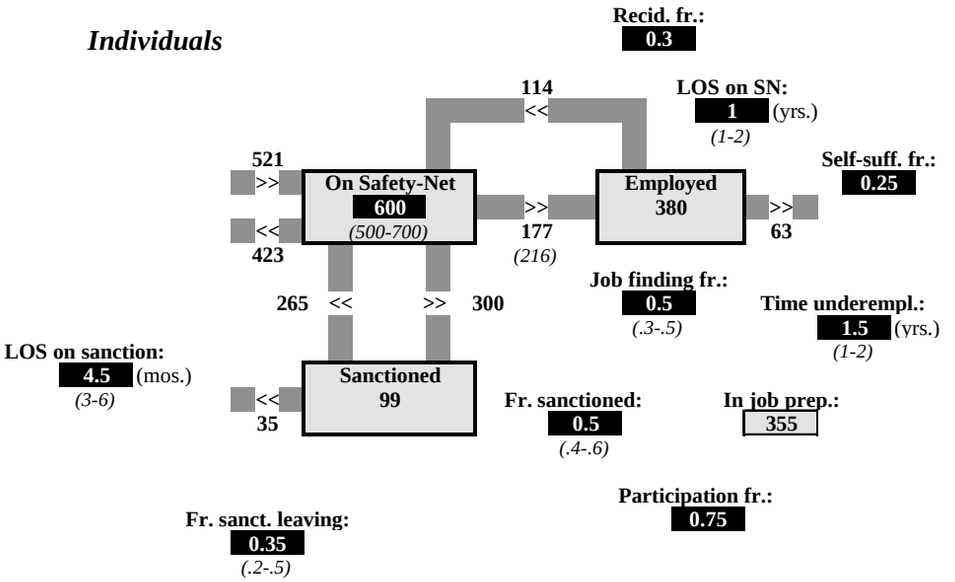

Figure 2: Spreadsheet Used to Calibrate a Linked Stock & Flow Chain

4. A Script for Eliciting Multiple Linked Table Functions Associate With Stock-and-Flow Chain

One of the important natures of the safety-net model is that a given flow is usually affected by multiple resources. For example, all of child support enforcement, basic services and monitoring influence departing flow (please see figure 1). Based on the safety-net model, the script for table function elicitation here is specifically for multiple elasticities impacting on a given flow point.

Table functions (graphical functions) are used to express non-linear relations between two variables. Again, clarifying the variables related to table functions being elicited should be focused before starting elicitation process. Then, table function elicitation starts from an individual anonymous rank-ordering of comparative strength of competing table functions. The judgment from individuals are aggregated statistically to obtain an overall rank. The overall rank will help us to focus on those table functions with higher strength. The ranking task is followed by a more complete discussion of those table functions of comparative higher strength being estimated first.

a. Rank-Ordering the effect by individual judgment

Individual human judgment inconsistency is a problem not only in the field of group decision making but also in the field of group model building. In order to overcome the possible human judgment inconsistency, we design a column-by-column total effect analysis and a row-by-row marginal effect analysis sheets (figure 3 and 4) for each participant to rank order. In column-by-column form, each column represents the effect of several services on a single flow. A blank cell indicates the existence of a relationship between the service and the flow while the shaded cells implies no relations. For each column, participants rank-order the services from most to least powerful in terms of individual beliefs concerning the total effect on the flow. That is for the rate associated with a given column which resource could have the greatest overall impact on the flow. The most powerful variable will be ranked as 1, the next less powerful one will be ranked as 2, and so forth. No discussion is allowed at this phase.

In the row-by-row form, each row indicates the effect of the service on several flows. A blank cell indicates the existence of relationship between the service and the flow while a shaded cell implies no relations. For each row, each participant is asked to rank-order the flows from most to least influenced in terms of the marginal effect of the service. That is for the rate associated with a given row which flow could be marginally affected by the service. Marginal effect means the effect of one unit change of the service on the flow. The flow being influenced most will be ranked as 1, the next less powerful effect will be ranked as 2, and so forth. After integrating the two sheets, the existence of any judgment inconsistency could be raised for further discussion.

1. Column-By-Column Analysis:
Rank-Order of Magnitude of The "Total Effect" of Several Services Upon A Single Flow Rate.

Per Case	Service v. Flow Rates	From mainstream	TANF families losing eligib.	Departing	Sanctioning	Sanctioned leaving	Sanctioned returning	Job finding	Recidivism	Into mainstream	Total cost of emergency services
	Basic SN Services	S		O		O		O			O
	Emergency Services										S
	Child Support Services	O		S	S			S	O	S	
	Assessment & Monitorin			S	S			S			
	Employment Services			O				S			
	Job Maintenance								O	S	
	If "Unempl. rate"	S	S	O		O		O	S	O	

Figure 3: Column-By-Column Total Effect Sheet

2. Row-By-Row Analysis:
Rank-Order of the Magnitude of The "Marginal Effect" of A Single Service Upon Several Flow

	Service v. Flow Rates	From mainstream	TANF families losing eligib.	Departing	Sanctioning	Sanctioned leaving	Sanctioned returning	Job finding	Recidivism	Into mainstream	Total cost of emergency services
Cost	Basic SN Services	S		O		O		O			O
Unit	Emergency Services										S
Per Case	Child Support Services	O		S	S			S	O	S	
	Assessment & Monitorin			S	S			S			
	Employment Services			O				S			
	Job Maintenance								O	S	
	If "Unempl. rate"	S	S	O		O		O	S	O	

Figure 4: Row-By-Row Marginal Effect Sheet

b. Selecting most important effect for estimation

Due to limited time, it is not possible to elicit all the table functions at one data calibration conference. At the conference, we simply want to elicit those table functions that are considered most important by the client group. The way to choose these elicitation-worthy table functions is to sum up the total ranking score for each cell and concentrate limited time on those with the highest ranks.

c. Estimating table function by group judgment

We used a “marker pen and cling sheet” way with full discussion among group members. Participants were asked to sketch the curve relation of two variables of a table. This would be considered the hardest part of data elicitation exercise because this exercise is asking people to sketch their professional knowledge into a non-linear curve. Thus, the process facilitator will help participants start from an anchor point which is drawn directly or indirectly from observed data. From this anchor point, participants are asked to think about the relationship between the two variables while one of the two variables (typically on the X-axis) is two times as much as the anchor value and zero. Then, process facilitator sketches the curve according to participants’ discussion of the shape of the curve between anchor point and the other two points. The shape of the curve will be finished when the group reach consensus.

IV. Further Work

This article attempted to report a script specifically for data calibration conference in Dutchess County. The overall issue of evaluation of these group data calibration techniques is worthy to be studied in the future. For instances, table function elicitation could be done by either “marker pen and cling sheet” method or “pencil and paper”

method or even a method with computer drawing facilitation. Some experiment could be conducted to find out which way is better under what circumstances. Another interesting issue is what and how people learned during the data calibration session.

Since group data calibration is time consuming, it is important to clarify the purpose of the model and have good preparation before group data calibration exercise. If the purpose of the model is policy analysis and, its policy implications do not change when parameters are varied plus or minus some percent, then the parameters do not need to be elicited any more accurately (Richardson and Pugh, 1981). Therefore, we suggest that a complete parameter sensitivity analysis should be done before a group data calibration exercise.

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