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RETURN TO WORK BEHAVIOR OF PEOPLE WITH DISABILITIES: A MULTI-METHOD APPROACH

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ABSTRACT

This paper discusses the development of a simulation model to mimic a return to work phenomenon of Social Security Disability Insurance (SSDI) enrollees in the United States. Agent Based and Bayesian Network methods are used within a multi-method simulation model to capture system conditions and enrollee behavior. Bayesian Network is used within an agent to represent enrollee's decision to work. A developed simulation model can be used to investigate many aspects of the return to work phenomenon. The model is used to answer a sample research query that examines how the perception of an enrollee on work incentives related to health improvements, money, and vocational assistance can affect the return to work phenomenon for 18 to 39 year old SSDI enrollees (at enrollment). This is measured as the total percentage of population with benefits terminated for work.

1 INTRODUCTION

1.1 Introduction to SSDI

Social Security Disability Insurance (SSDI) is a benefit available in the U.S. to people with disabilities. It can often be combined with Supplemental Security Income (SSI), Medicaid and Medicare (Kennedy, Gimm, and Blodgett 2013). Statistical data from 2010 indicates 64.9% of SSDI recipients aged 21 – 44 years, 50% of SSDI recipients, aged 45 – 54 years, and 31.4% aged 55 – 64 years, were also Medicaid/Medicare beneficiaries, translating into significant spending (Kennedy, Gimm, and Blodgett 2013). In 2008, estimated federal expenses on workers with disabilities were approximate at $357 billion while state spending estimated $71 billion (90% of which on Medicaid) (Livermore, Stapleton, and O'Toole 2011). The cost of SSDI benefits for workers with disabilities and their dependents was $127.9 billion (Livermore, Stapleton, and O'Toole 2011). Difficult economic situations can increase the rate of application for disability benefits. By the end of 2001, 5.3 million disability benefits were provided by Social Security Administration (SSA) with an average of 57,600 new recipients per month. This number increased to 7.1 million by the end of 2007 with an average of 68,900 new recipients per month, and to 8.8 million in mid-2012 with an average of 82,400 new recipients each month (Sherk 2013). A typical SSDI enrollee stays in the program for many years. Three major paths to exiting the program are as follows: 1) death; 2) reaching full retirement age; and 3) no longer meeting medical disability standards. Data shows that in 2004, 12% of beneficiaries left the program for the above reasons (Duggan 2006). The 10-year follow-up study of SSDI enrollees provides information that benefits were terminated for 3.7% of recipients after they found work (Liu and Stapleton 2010). Moreover, data indicates that a majority of SSDI enrollees who found work while using work incentives do so in the first five years from being awarded (Liu and Stapleton 2010).

Upon award of SSDI benefits, a disabled person becomes eligible for federal and state programs that include vocational rehabilitation and employment assistance. There are four major work incentive programs: 1) Work Incentive Planning and Assistance Program (WIPA); 2) Protection and Advocacy for

Beneficiaries of Social Security Program (PABSS); 3) Ticket to Work Program; and 4) Social Security / Vocational Rehabilitation Program. Kregel (2012) provided an overview of outcomes from current research related to these programs. Livermore, Prenovitz, and Schimmel (2011) found a consistent and significant relationship between the receipt of WIPA services and an increased likelihood that a beneficiary will be employed and experience a reduction in benefits in the future. Once SSDI is awarded, there is a 24-month waiting period for Medicare entitlement.

Development of a coordinated and comprehensive system of incentives is challenging because it must be tailored to many different groups with specific needs and characteristics, but may bring profits for recipients and providers, assuring that the money is spent wisely, bringing savings for the budget and at the same time giving the best possible care and options for the disabled population. As pointed out by Kennedy, Gimm, and Blodgett (2013) evidence from outside of the U.S. suggests that an introduction of vocational rehabilitation and return-to-work goals at the beginning of an SSDI determination process can encourage successful workforce reintegration. Because the amount of outpatient services used for Medicare enrollees is negatively associated with employment, one should expect savings of government money (Thomas and Ellis 2013). Moreover, findings support efforts to encourage work because of associations between employment with better health, healthy behaviors, and lower costs (Hall, Kurth, and Hunt 2013).

1.2 Problem of Representation of SSDI Enrollee Behavior

Liu and Stapleton (2010) discussed the problem of short term evaluations based on "cross-sectional" statistics, and highlighted the need for a more detailed view of beneficiaries leaving SSDI for a work phenomenon through longitudinal studies. They discussed the complexity of capturing dynamic changes in possible multiple transitions from significant gainful activity (SGA), non- SGA, and an unemployed status. These transitions depend on the amount of enrollee earnings each month. Kennedy, Gimm, and Blodgett (2013) point out the need to measure enrollee employment in terms of earnings, which would require merging (e.g. unemployment and Medicare) data.

In their analysis, Liu and Stapleton (2010) identified five stages: SSDI awarded, first time employed, trial work period (TWP) completed, benefits suspended after finding work, and benefits terminated after finding work. Percentages of SSDI awardees for each stage from 1996 to 2006 were traced, giving also a cumulative percent at the 10-year mark. Liu and Stapleton (2010) focused mostly on reporting what has happened using data analysis, which provided initial clues about how the system behaves. Ben-Shalom and Mamun (2013) focused on four milestones: service enrollment, start of TWP, TWP completion month, and the first suspension month. They used only "complete" cohort data for 60 months after the first SSDI award, taking the research one-step further and providing estimated probabilities of service enrollment at considered stages, as a function of age and type of disability. However, this more informative approach still lacks the answer to the question "why" enrollees would consider returning to work.

In order to get insight into the "why" question, a common approach involves qualitative analysis of issues related to disability to provide further hypotheses for quantitative analysis (Kennedy, Gimm, and Blodgett 2013). Alternative to this could be a simulation based study in which generated pseudo qualitative data can be processed at a higher level, providing a more holistic view of the system. With current state-of-the-art, simulation at multiple levels of analysis could combine aspects of both qualitative and quantitative empirical worldviews. The use of multiple modeling and simulation (M&S) methods within a single simulation model (Balaban and Hester 2013) can be helpful to represent and gain insight for the system at different levels of abstraction.

1.3 Research methods

Eldabi, Paul, and Young (2006) analyzed current uses and future prospects of M&S in the healthcare domain. The growth of healthcare related simulation studies after 2000 clearly indicate fast increase of this approach. The application of M&S can be used for medical, administrative, and operational context. Katsaliaki and Mustafee (2011) reviewed about 250 high-quality journal papers related to healthcare simulation with view on application and methods used. The following is a brief presentation and discussion of M&S methods used in this paper.

1.3.1 Agent Based Modeling (ABM)

ABM is a bottom-up method that aims at capturing interactions by using computer created entities called "agents". These individual agents are assigned attributes, states, rules of behaviors, and interactions. Agent Based Model (ABM) is more suitable in representing complexity arising from individual behavior and interactions (Macal and North 2005). ABM in healthcare is often used to simulate epidemiological phenomena (Kasaie, Dowdy, and Kelton 2013, Patlolla et al. 2006), but also can be used to more operational setting, for instance, to test medical innovations or interventions (Djanatliev and German 2013).

1.3.2 Bayesian Network

Bayesian modeling, based on the principles of Bayes' Theorem by Thomas Bayes (1702-1761), where a probability is represented as the likelihood that a statement is true, given the prior information (Bayes and Price 1763). Bayesian method is extensively used in the healthcare setting for design and inference of clinical trials (Berry et al. 2010), and healthcare evaluations (Spiegelhalter, Abrams, and Myles 2004). Bayesian method can be useful in drawing inferences with a quantified degree of confidence, based on some prior known evidence. This method has evolved significantly, providing easy-to-use tools with graphical interfaces allowing to quickly developing Bayesian Networks (BN), which are widely used within many scientific, business and government communities.

1.3.3 Multi-method M&S approach

Different M&S methods can contribute their advantages, forms of expressiveness, and different perspectives on capturing complexity of healthcare related phenomena. Balaban and Hester (2012) and Balaban and Hester (2011) explored the use of computer simulations in unraveling Research and Development (R&D) and innovation problems. The use of multi-method models can be supported with the similar purposes as in an empirical mixed method approach (Balaban and Hester 2013), and methods can be arranged depending on type of problems or questions.

Multiple layers of methods could be constructed, allowing for desirable structure and communication between layers. The research questions within a healthcare system can vary from clinical to social context of daily activities (Creswell et al. 2011), and usually involve high complexity. Chahal (2010) proposed the reasoning for the use of multi-method SD/DES models in the context of phenomena representation applied to the healthcare setting. Djanatliev and German (2013) used three methods: SD, DES, and ABM to develop a framework for health technology assessment. The following section will guide through the employed M&S research process.

2 M&S RESEARCH PROCESS

This section discusses the details of the adopted M&S process. The M&S research process was iterative, but Figure 1 shows the main phases in a simplified, linear manner.

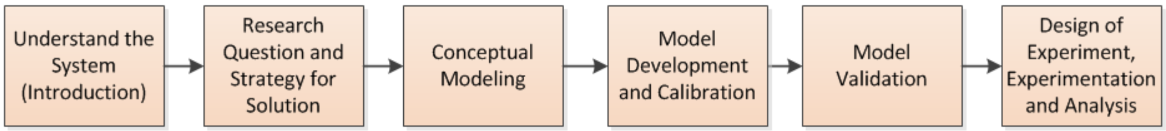

Figure 1: M&S Process adopted for this research.

2.1 Research Question and Strategy for Solution

Evidence indicates that younger beneficiaries who have received benefits for a shorter period are more likely to become employed (Kregel 2012). Work incentive programs focus on different aspects (e.g. health improvement, money incentives, and vocational assistance) that can contribute to a return-to-work. The research question examines how much perception on the above incentives affects the return to work phenomenon. This will be measured for the younger population (18 to 39 year old) of SSDI enrollees' as the difference in percentage that remained "on the rolls". A multi-method simulation model comprised of ABM and BN methods will be developed. It will detail system phases and enrollee behavioral factors leading to the creation of agent behavior. A developed simulation model will be used to conduct experimentations to create insight into the research question.

2.2 Conceptual Modeling

Figure 2 presents an SSDI enrollee (agent) passing through different stages related to the return-to-work phenomenon. *SSDI behavior* and *Work Status* are two main parts (state charts) visible within the enclosed blue dashed lines. The goal of the model is to represent SSDI systemic conditions related to the return-to-work phenomenon and corresponding behavior of enrollees.

An SSDI awarded enrollee enters the initial composite state: *SSDI awardee,* where they may consider working, represented as *Transition 1* from *Awarded* state to *Decided To Work* state. This transition triggers *Condition 1* for moving the enrollee from *awarded* state to *Look For Job* state, both located within composite state *Not Working*. If the enrollee finds a job (*Transition 2),* they enter the composite *Working* state Significant Gainful Activity (*SGA*) or Not Significant Gainful Activity (*NSGA*) at the same time triggering *Condition 2*. If the enrollee makes more than TWP income limit, they move to *TWP Start* state. This counts as the first month of TWP (Ben-Shalom and Mamun 2013). During this time, the enrollee can make as much as they want-without financial reductions of SSDI payments (SSA 2011). Internal *Condition 3* counts the TWP months in which the enrollee made more than the TWP income limit. The enrollee stays in *TWP Start* state until a total of 9 months has accumulated. The amount of monthly income and its consistency determines length of stay in *TWP Start* state. Upon accumulating 9 months (*Condition 4),* the enrollee enters *Extended Period of Eligibility* (EPE) state, and the internal *Condition 5* starts adding time. During this time if enrollee makes more than $980 per month, which is considered SGA for non-blinded enrollee (Ben-Shalom and Mamun 2013), the financial benefits are withheld for this month. This is shown as transitions between *SGA* and *NSGA* states within *Working* state based on monthly income of enrollee. After the 36-month mark has been reached, the enrollee's financial benefits will be terminated for work after the first *SGA* month (*Condition 6* - completion of EPE and *SGA* state). Otherwise, the enrollee stays in EPE state indefinitely. If the enrollee is terminated for work, *Condition 7* checks the enrollee's job status and if other than *SGA* (e.g. *NSGA*, *Look for job*), the benefits will be reinstated. In addition, the enrollee enters *Medical Reason* state if SSDI is terminated for medical reasons (*Condition 8)*, enters *Retired* state after becoming 64 years old (*Condition 9*), or enters *Died* state (*Condition 10*) when deceased. The *conditions* 1 to 10 represent the system process. Hall, Kurth, and Hunt (2013) reported that enrollees are being discouraged from working by medical professionals and federal disability policies. Transitions 1 to 3 define enrollee behavior and job related factors. Prediction of the system behavior and subsequent experimentation of alternative solutions (interventions and/or programs) could only be accomplished based on the gained understanding of transitions as prerequisite.

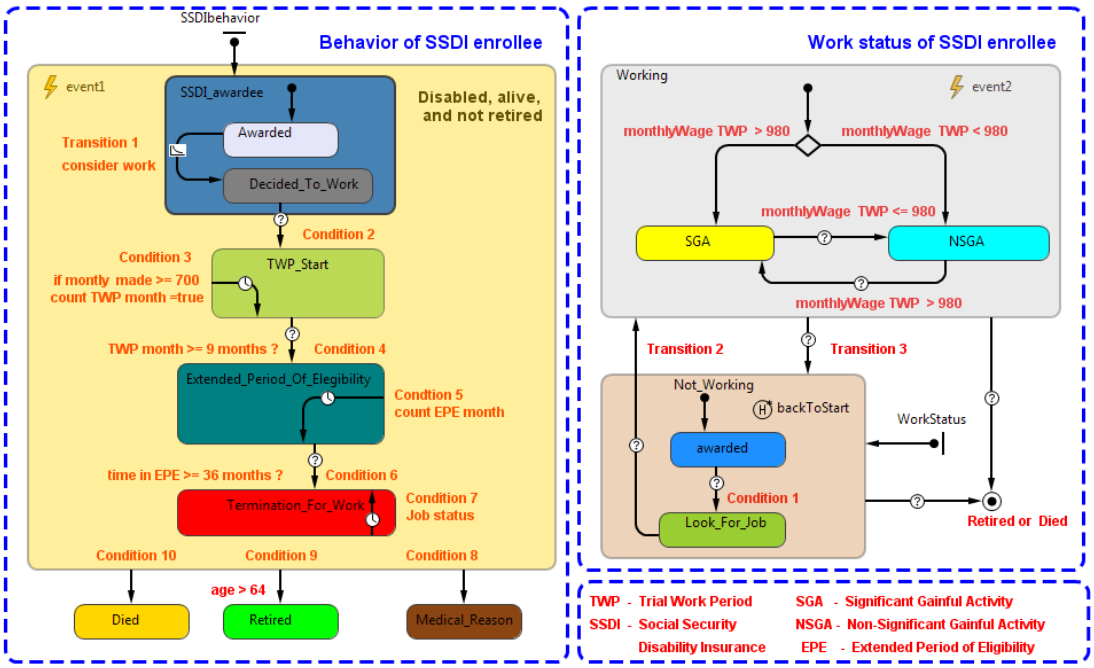

Figure 2: SSDI enrollee.

Both medical condition and internal perception about the system are determinants for a decision to work. In the system, the monthly income of enrollee determines SGA or NSGA state, which in turn determines transitions to TWP, EPE, and termination of benefits because of work. Understanding the relationship between enrollees' perception about level of income that is sufficient to encourage working behavior, and minimizing adoption of the patient role can provide insight into a possible design of return-to-work programs.

The systemic conditions presented above provide a high-level view that needs to be expanded to uncover hidden aspects related to transitions controlled by human behavior. Statistical cross-sectional and longitudinal aggregated data can prove useful in relation to the proposed above transitions, but tracing transitions to variables at a lower qualitative level as pointed by Thomas and Ellis (2013) is needed to uncover causal factors related to return-to-work behavior. Unfortunately, the integration of analytic and interpretative parts as qualitative and quantitative methods has limitations (Creswell et al. 2011).

Modeling and simulation, especially a multi-method M&S approach, may provide in the future the missing link between qualitative and quantitative methods. Different M&S methods allow capturing quantitative and qualitative views. Qualitatively viewed transitions as BNs can be calibrated to provide lower level causal inputs to the higher-level structures (state charts). Please refer to Figure 3 during the discussion that explains the concept model of the lower level factors.

The factors are represented using BN (Genie ® software) derived based on work of Hall, Kurth, and Hunt (2013), Kennedy, Gimm, and Blodgett (2013) and Thomas and Ellis (2013). This BN model aims at capturing financial and health factors on the probability of an enrollee to consider work, and subsequently be able to work. *Possible incentives* can encourage working behavior, but *Fear of losing current benefits* create a detrimental effect to *looking for work* factor, especially because of a high effort to obtain benefits in the first place (Kennedy, Gimm, and Blodgett 2013). The scope and availability of *current health benefits*, significance of *current financial benefits*, and *confidence to prove disability* (which should at least in principle be proportional to actual *disability level*) influence *fear of losing benefits*. This fear may be offset by providing *possible incentive,* for instance *vocational assistance* (such as vocational rehabilitation, personal assistance, and adaptive technologies and transportation), *money incentives,* and *health improvement programs* at a sufficient level as seen by the enrollee (sufficient, insufficient, or a degree sufficiency).

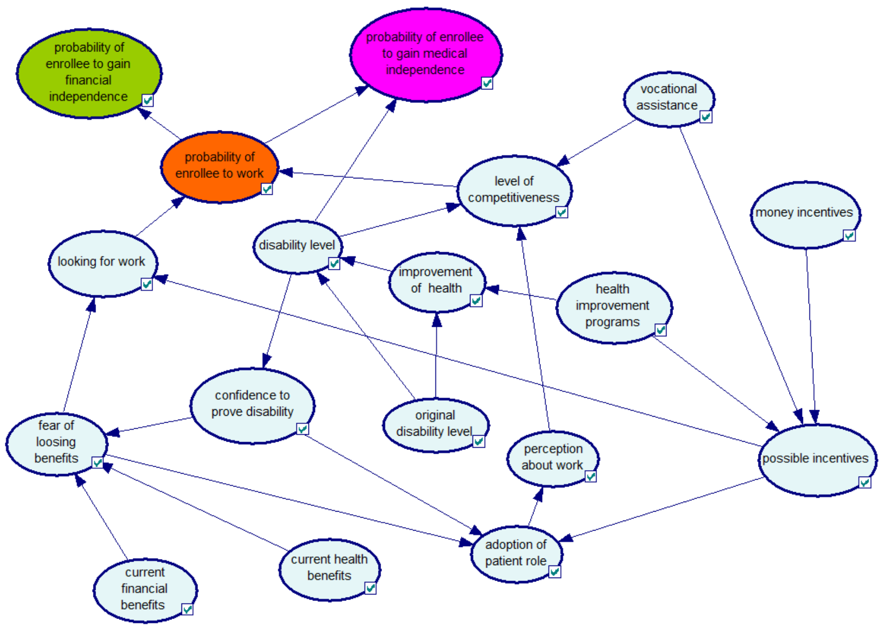

Figure 3: Factors affecting enrollee-working behavior.

A*doption of patient role* can change an enrollee's *perception about work* and influences *level of competitiveness* (Thomas and Ellis 2013). *Level of competitiveness* is also influenced by *vocational assistance* and *disability level*, while *disability level* may be improved by *health improvement programs.* Finally, both the *level of competitiveness* and *looking for work* factors influence *probability of enrollee to work*, which in turn influences medical and financial independence of enrollee. The sample values of conditional probability tables (CPT) are proposed and available on request, but due to space limitation, are not included in the paper. Empirical derivations of CPTs based on qualitative interview data are desirable, but this was not possible for this study. Useful guidelines and examples for using interviews to build CPT values can be found in literature (Cain 2001, Nadkarni and Shenoy 2004, Sun and Müller 2012).

C*urrent financial benefits* and *current health benefits* can work as a mental inhibitor to work, while incentives can offset this attitude. Assuming that for some enrollees their health condition permits work, the question is how to establish the system of benefits and incentives to prevent *adoption of patient role*, which can prohibit enrollees to better their lives through work and subsequent financial and medical independence. Improvement of their health through *health improvement programs* can improve *level of competitiveness*, at the same time decreasing *confidence to prove disability,* hence increasing *fear of losing benefits*. This can be especially true when *current health benefits* are already provided (2 year waiting period).

2.3 Model Development and Calibration

A simulation model was developed using AnyLogic® modeling software. A custom distribution of the population ages 18 to 39 was created based on the Annual Statistical Report by the Social Security Disability Insurance Program SSA (2011, 58) for the 1996 population. State charts developed during conceptual modeling were used as a blueprint for a sample population of SSDI awardees. The model was calibrated using historical data of return to work phases for the population ages 18 to 39 (Stapleton et al. 2011). In the first phase *Transition 1* was represented as rate. The rate is determined by a scaled *looking for work* factor of BN. The time-series probability tables of *vocational assistance*, *money incentives,* and *health improvement programs* factors within BN are assumed zero in the base case scenario and will serve as an input variable during experimentation. Six CPT values (other six are equal to 1- probability of the first one) of *looking for work* factor representing a person decision to work are derived through a calibration experiment that minimized error between enrolees that entered *TWP Start* state and historical data for completed TWP phase (Stapleton et al. 2011). The meaning of the calibration curves shown in the bottom-right part of Figure 4 is as follows: "standard" is the historical data, "current" is the last run, and "Best feasible" means the curve with the overall lowest error.

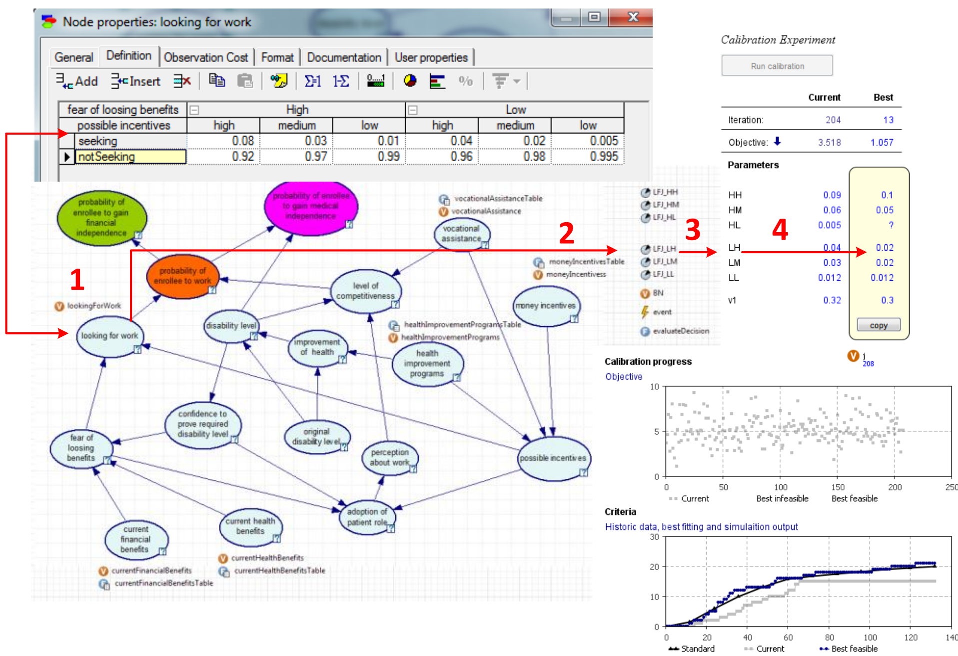

Figure 4: Calibration of CPT of *looking for work* factor.

The top left of Figure 4 displays an extract of CPT for the *looking for work* factor, while symbols HH, HM, HL… are its parameters used during calibration. For instance, HH is its conditional probability value that person is seeking job given that both the *fear of losing benefits* and the *possible incentives* are high (see CPT table). Support arrays (1) store values of input and output variables for each agent's BN, which are connected (2) to experimentation framework through a set of parameters (3 and 4) as depicted in Figure 4.

Transitions 2 and *3,* and internal transitions between *SGA* and *NSGA* states within *Working* state depends on the amount of money made by an enrollee. The money made varies with the amount, and with the frequency of changes represented as a dynamic event setting different probability distribution functions (PDF) for each enrollee's phase. The monthly amounts of money made are represented using Beta PDFs, which were also derived through calibrating the experiment against historical data for percentage of enrollees that completed EPE phase (Stapleton et al. 2011). Different PDFs were tested (e.g. uniform, triangular, truncated normal, exponential, and beta). None of them was an exact fit, but the closest matches were obtained using Beta PDFs (see Figure 5). Two Beta PDFs were used within the EPE phase. The triggering point to switch between first and second Beta PDFs in this phase was developed in an effort to represent approaching the end of EPE phase and possibility of losing benefits.

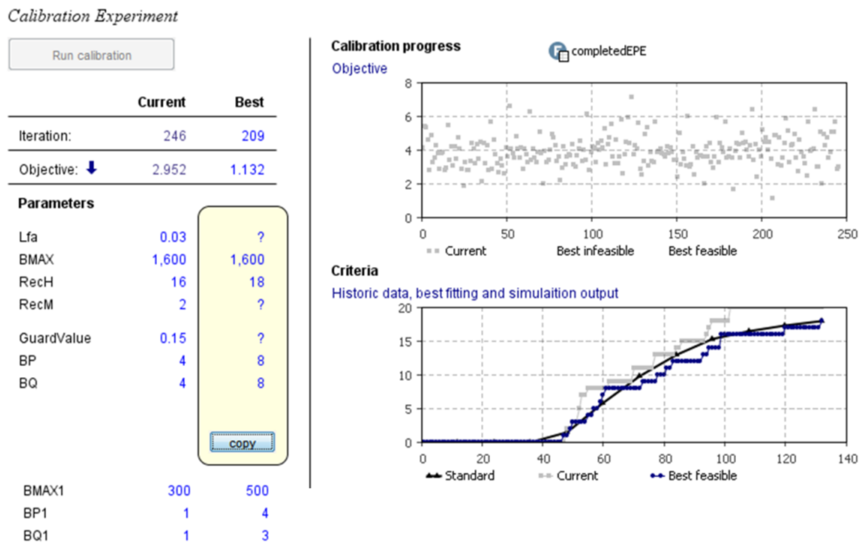

Figure 5: Calibration of Beta PDF for transition to EPE phase.

Further experimentations were conducted to alter Beta PDF and to create custom distributions to minimize calibration error. Only one of the custom PDFs (for *Decide To Work* and *TWP Start* states) was finally used because it had a smaller error as compared to Beta PDF. Ideally, all transitions should be calibrated at once, but this was not possible only because seven parameters maximum can be optimized using the educational version of AnyLogic. The professional or "university researcher" versions of AnyLogic does not have this limitations.

2.4 Model Validation

A validation process was aimed at the determination of feasibility of the developed model to conduct necessary experimentations to answer the sample research question. It was a challenge to capture phenomenon related to termination of benefits using aggregated PDFs representing money made by enrollees during period of *Extended Period of Eligibility* due to high variability (see Figure 6).

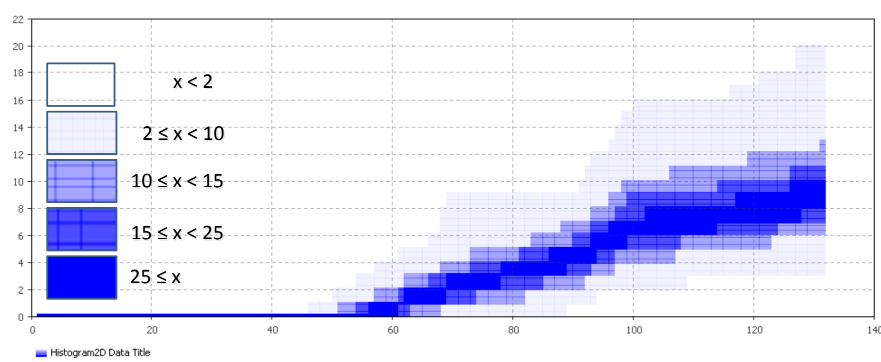

Figure 6: 2D histogram showing variability levels for percentage of benefits terminated based on 200 runs.

This is most likely because of enrollees' awareness of possible imminent termination of benefits (highly variable human behavior). A 2D histogram was built based on 200 runs. It displays variability levels for a percentage of benefits terminated. It ranges from 0 to 132 on the x axis and 0 to 25 on the y axis, with 132 and 125 intervals, respectively. According to the graph, rarely, percentage of benefits terminated could reach 20 percent at the high end and 3 at the low end (less than 10. More likely outcomes (darker color) can range between 6 and 12 percent. The end of EPE phase, similarly to initial decision to start TWP, should be in the future represented in more detail, for instance similarly as *Transition 1* using a BN. The simulation model output was compared to the real historical data (Stapleton et al. 2011). Figure 7 shows percentages for four phases of a sample population of 3000 enrollees within the return-to-work process, generated by the simulation model (purple), in comparison to the historical data (green). The visual inspection indicates correct trend lines of the model. Additional calibrations and refinement related to the EPE phase could improve this model further. A 200-simulation run experiment with 100 enrollees per each run was used for validation.

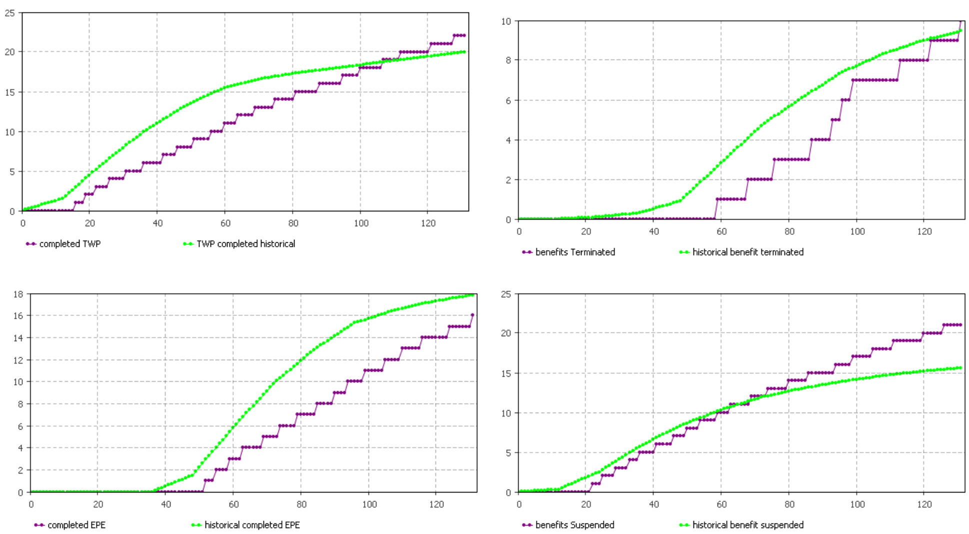

Figure 7: The output from the simulation vs the historical data for return to work phases.

A sample mean of benefits terminated was used for statistical validation of output using the test statistic value $z = \frac{\bar{x} - \mu_0}{\delta/\sqrt{n}}$, where $\bar{x} = 9.36$ is a sample mean of percent of benefits terminated; $\mu_0 = 9.5$ is the historical value of benefits terminated; $\delta = 3.1$ is the sample standard deviation, and $n = 200$ is the sample size. The test conducted is based on a two-tailed $z_{0.25} = 1.96$ at a significance level of 0.05. The resulting $z = 0.62 \leq 1.96$ so the model cannot be proven to produce results different from statistical historical data. Finally, it should be pointed out that except for *looking for work* factor, values of the rest of CPT were not fully calibrated nor derived based interviews or surveys, hence results should be considered with caution.

2.5 Design of Experiment, Experimentation and Analysis

2.5.1 Design of Experiment

In order to answer the research question, enrollee perception about three types of incentives: *vocational assistance, money incentives,* and *health improvement programs* will be varied. The base case will be compared to four scenarios, in which the effects of enrollees' increased perception about incentives will be assessed as the difference in the total percentage that remained "on the rolls" at the end of year 2006. The first three scenarios use a single incentive, while the last one uses all three incentives combined. Prescribed yearly "levels of incentives" are represented as time series prior probabilities of sufficient incentives as seen by enrollee (see Figure 8) and are set with the same values for all incentives to enable their comparison. There is a single output measure captured: percentage of population with benefits terminated for work.

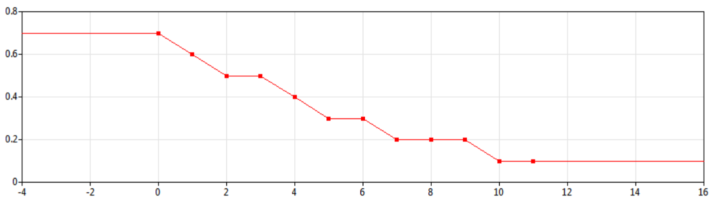

Figure 8: A sample input probabilities for incentives used for analysis.

2.5.2 Experimentation and Results Analysis

Figure 9 shows the results.

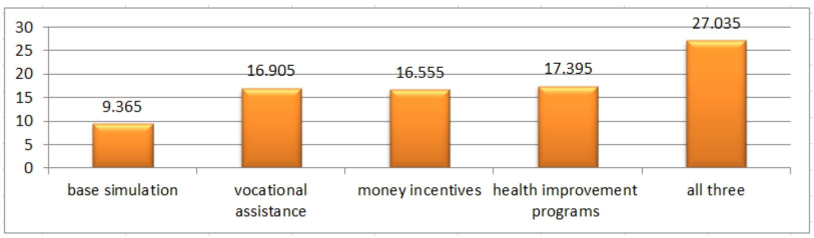

Figure 9: Percentage of population with benefits terminated based on incentives used.

All incentives were statistically significant at 95% as compared to the base simulation. The difference with the base simulation ranges for *vocational assistance* between 6.80 and 8.28, for *money incentives* between 6.52 and 7.86, and for *health improvement* between 7.32 and 8.74. All three incentives resulted in similar values with only *money incentives* and *health improvement* statistically different (1.60; 0.08), but as mentioned in the validation section, these results should be considered with caution. When all incentives were combined, this resulted in a difference between 16.90 and 18.44 as compared to the base scenario.

According to the simulation, output prescribed levels of incentives significantly increased percentage of population with benefits terminated for work as compared to the base case with no incentives. The relationship with the cost for this effect was not considered and should be included in the future research. According to Kregel (2012) annual savings from the WIPA program accounted for about 20 percent of the program cost itself, which although seem modest, can accrue over time. Better understanding of costs related to incentives could provide improved view on financial tradeoffs for decision related to which programs and incentives should be implemented.

3 CONCLUSIONS

This paper discussed the development of a simulation model to mimic a return-to-work phenomenon. A multi-method simulation model that consists of ABM and BN was used in an attempt to capture system conditions and enrollee behavior. The simulation model proposed an approach that connects perception of enrollee on work incentives and percentage of benefits terminated. In order to improve understating of enrollee behavior it is desirable to employ qualitative data collection within simulation studies to provide more valid and credible experimental platform. The growth of the use of a multi-method M&S approach still trails empirical mixed methods in healthcare, but both methodologies are built on similar pragmatic philosophical beliefs, and a combination of both should be the natural next step in the evolution of scientific endeavor.

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