Using simulation to evaluate policies for the financial imbalance of the National Health Insurance in Taiwan[1]

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Abstract

This study applies system dynamics to explore the long-term influences of multiple policies on handling the financial imbalance of the National Health Insurance (NHI). In order to improve the financial imbalance of the NHI, three policies and three scenarios are proposed. Each policy is evaluated for each scenario. According to the simulation results, the policy of a 20% increase in premium rate, plus a 2% decrease each year in annual rate of change of benefit payments per beneficiary can improve the financial imbalance. However, the benefit payments will be greater than premium revenues from 2008. So, the financial imbalance of the NHI will present again.

Keywords: System Dynamics, Simulation, National Health Insurance

Introduction

The National Health Insurance (NHI) program was officially launched in Taiwan on 1 March 1995. Three objectives are stressed in the program's implementation: (1) universal enrollment and equal-opportunity medical care; (2) balanced finances and long-term operational viability; (3) better quality medical care and better health for

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citizens. The initial balance of revenues and expenditures was stable, but there has been a deficit since 1998.

According to the literature review, the deficit problem is mostly caused by the payment system of fee-for-service. Fee-for-service was a major method of the payment scheme since the NHI program was launched. Under fee-for-service, the contracted medical care institutions (CMCI) increase the volume of care to make the maximum wealth. Due to one dollar per payment point, the more medical services the CMCI provide, the more medical benefits the Bureau of NHI (BNHI) pays, and the more income the CMCI will receive.

In order to prevent the financial status from keeping on worsening, the BNHI carried out some measures such as establishing the Financial Balance Monitoring System, strengthening audits on the insured payroll-related amounts, pursuing the premium payment from interrupted beneficiaries, enhancing investigation into the medical benefit claims, adjusting the co-payment schedule, gradually implementing the global payment system, raising the premium rate, expanding the payroll-related premium base[2], etc.

Under the global payment system, the BNHI negotiates with the CMCI to set a rate of change of benefit payments per beneficiary before a fiscal year. The payment per point is floating and equal to the answer of annual medical benefit budget dividing by total points of medical services. As total points of medical services are over the medical benefit budget, the payment per point will be less than one dollar. On the contrary, as total points of medical services are under the medical benefit budget, the payment per point will be more than one dollar.

Under such circumstances to all of the above, the financial status was improvement, but still deficit (Table 1). What are the long-tem influences of these policies on the financial status?

Up to now, those researches of handling the financial problem of the NHI, focused mostly on those influences of the individual policies, rare studied the long-term whole influences of multiple policies. Moreover, those methods of the researches were mostly questionnaires, data analysis, regression, rare simulated methods. Hence, this study applies system dynamics to explore the long-term influences of multiple policies on handling the financial imbalance of the NHI.

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[2] The BNHI expanded the payroll-related premium base by proposed that the premium of each insured should be calculated according to their full salary scale and that the upper and lower limit of insured amount should be raised 5 times higher.

Table 1. Financial Status of the Bureau of National Health Insurance (Accrual Basis)

Unit：NT$

Year	Revenues	Cost	Surplus or Deficit	Cumulative balance
1995	194500470391	157356886496	37143583895	37143583895
1996	242330951952	223941437002	18389514950	55533098845
1997	251315403719	245289838677	6025565042	61558663887
1998	263787887917	265347329576	-1559441659	59999222228
1999	269127116540	290130315355	-21003198815	38996023413
2000	291403574137	290439343474	964230663	39960254076
2001	291571916229	307214112650	-15642196421	24318057655
2002	311199550250	326854374281	-15654824031	8663233624
2003	338777533524	339160405872	-382872348	8280361276

Source: Bureau of National Health Insurance, 2004, pp. 94-99.

The system dynamics model

The system dynamics model was developed on the basis of the research of Hwang (2002, 2004). The model was constructed using the Vensim software (Ventana Systems Inc, 2004). Figure 1 shows the stock-flow diagram of the model. The Appendix shows the model's complete equations with documentations.

Fee-for-service was a major method of the payment scheme since the NHI program was launched in 1995. In order to improve the financial status, the BNHI was gradually implementing the global payment system from 1998 and had fully implemented it in 2002. Since the payment system of fee-for-service is completely different from the global payment system, the simulation of the model will start from December 2001 to December 2010.

The model has been examined by the author. Structure verification test, parameter verification test, dimensional-consistency test, extreme-conditions test, behavior reproduction test, changed behavior prediction test, and behavior-sensitivity test were used to validate the model (Forrester and Senge 1980; Sterman 2000, pp.843-891; Ventana Systems Inc, 2004).

Policy design and evaluation

In order to improve the financial imbalance of the NHI, three policies and three scenarios are proposed. Each policy is evaluated for each scenario. These are:

Policy 1: do nothing to correct the financial status of NHI.

Policy 2: a 20% increase in premium rate will begin in 2005.

Policy 3: a 20% increase in premium rate will begin in 2005, plus a 2% decrease each year in annual rate of change of benefit payments per beneficiary will begin in 2005.

Scenario 1: nothing will change.

Scenario 2: a 0.00002 increase each month in rate of change of average insured payroll related amount will begin in 2005.

Scenario 3: a 0.00002 decrease each month in rate of change of average insured payroll related amount will begin in 2005.

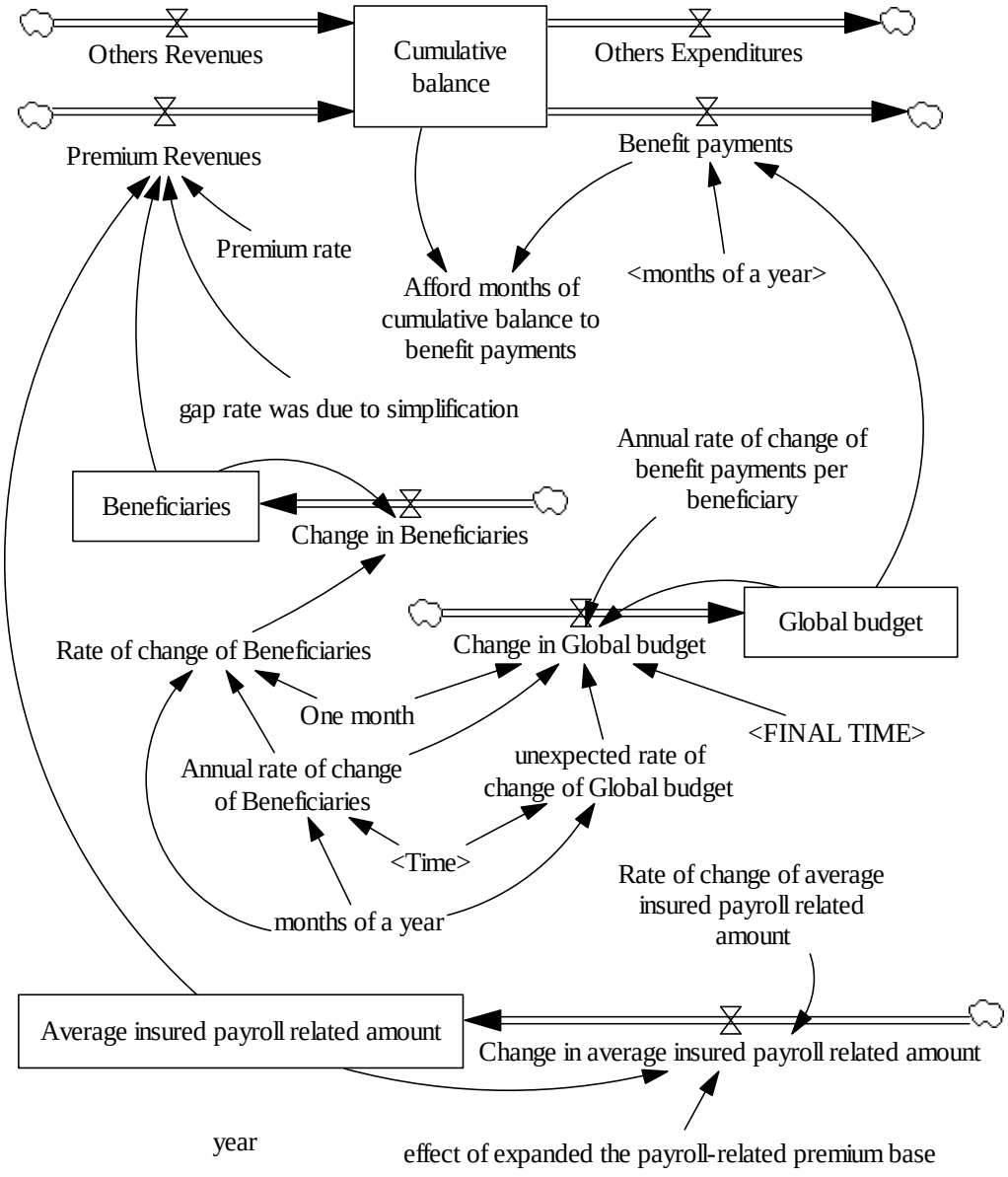

Figure 1. The stock-flow diagram of the system dynamics model

Figure 2 shows a graph of the afford months of cumulative balance to benefit payments under each policy against scenario 1. Figure 3 to 5 show the afford months of cumulative balance to benefit payments under each scenario against policy 1, 2 and 3 respectively.

In comparison with policy 1, both policy 2 and 3 make a significant increase in the afford months of cumulative balance to benefit payments (Figure 2). Under policy 1 against each scenario, the afford months of cumulative balance to benefit payments are negative starting from June 2004 (Figure 3). The afford months of cumulative balance to benefit payments are negative, which means that cumulative balance are negative.

Under policy 2 against each scenario, the afford months of cumulative balance to benefit payments are positive starting from March 2005 to December 2009 (Figure 4). Under policy 3 against scenario 1 and 2, the afford months of cumulative balance to benefit payments are positive starting from March 2005 to December 2010 (Figure 5).

According to the simulation results shown in Figure 2 to 5, policy 3 is the best policy for improving the financial imbalance of the NHI. However, the afford months of cumulative balance to benefit payments are decreasingly starting from January 2008 (Figure 5). This is because that benefit payments are greater than premium revenues starting from January 2008 (Figure 6). So, the financial imbalance of the NHI will present again.

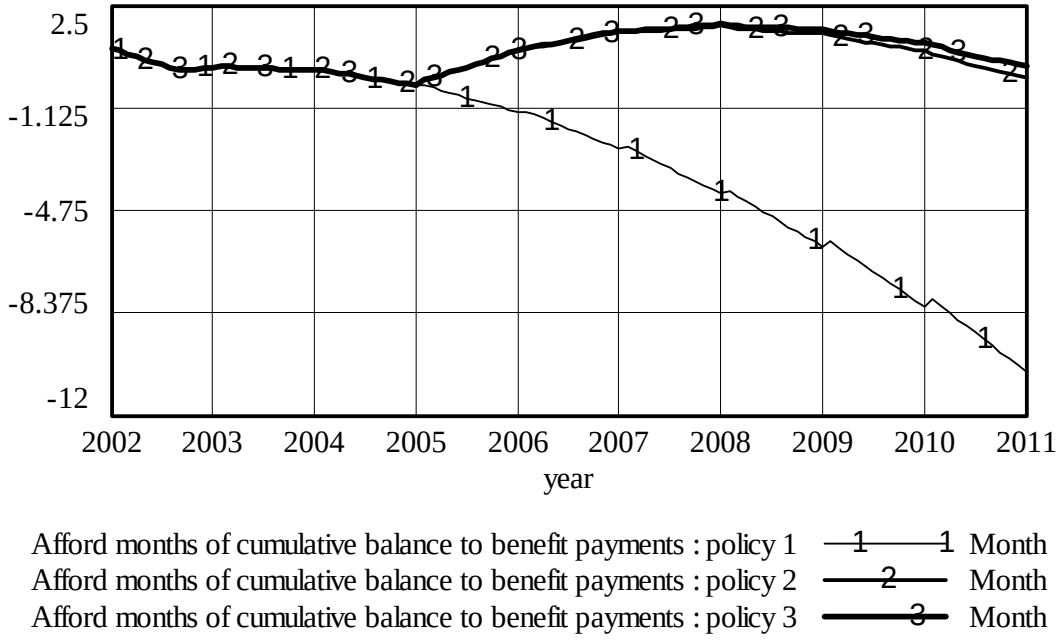

Figure 2. The afford months of cumulative balance to benefit payments under each policy against scenario 1

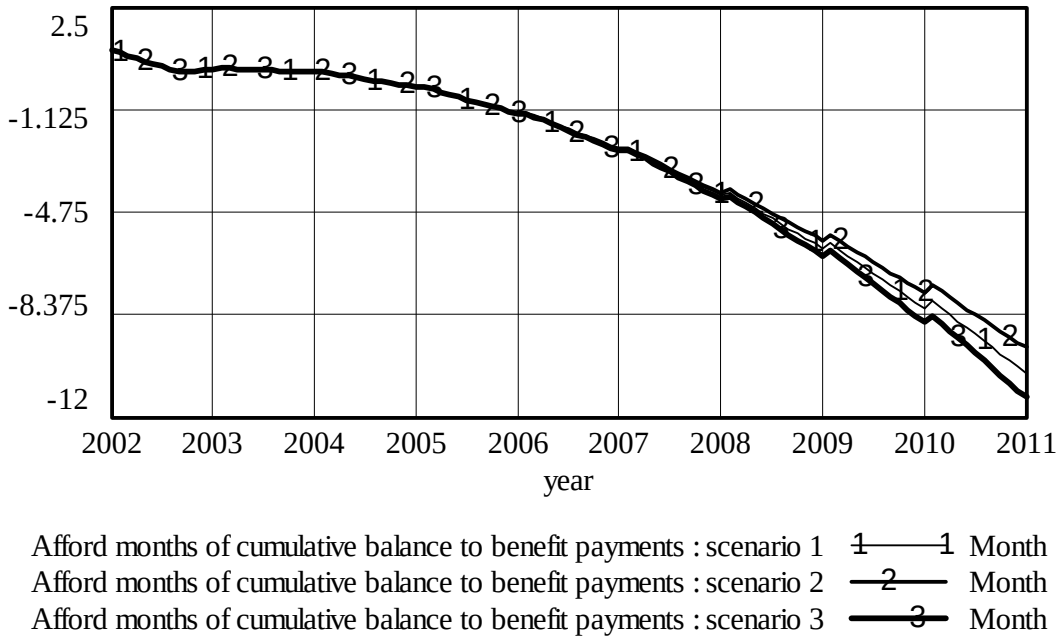

Figure 3. The afford months of cumulative balance to benefit payments under policy 1 against each scenario

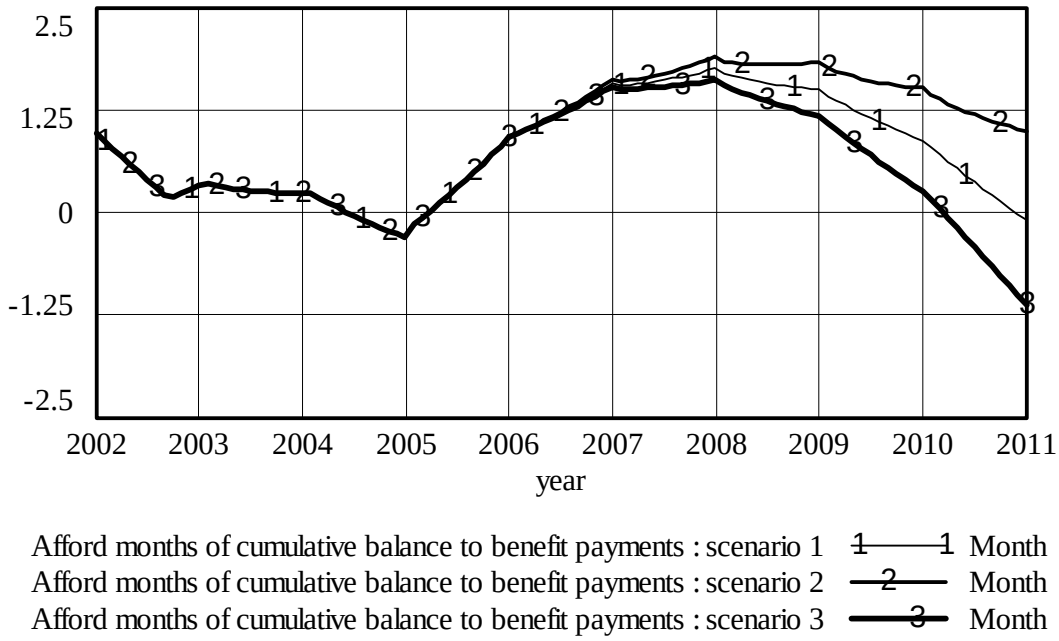

Figure 4. The afford months of cumulative balance to benefit payments under policy 2 against each scenario

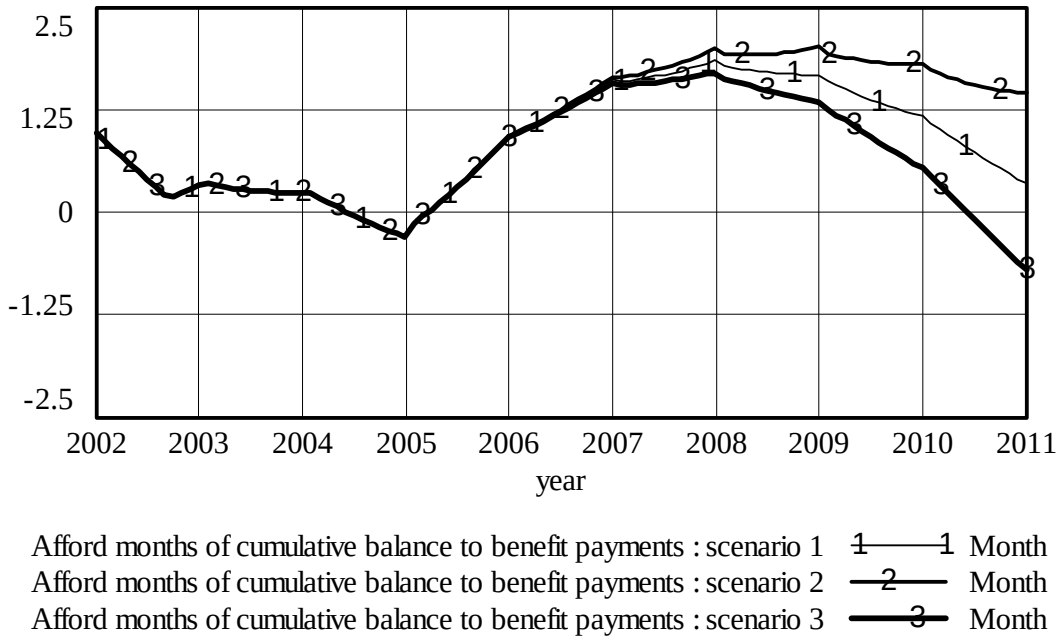

Figure 5. The afford months of cumulative balance to benefit payments under policy 3 against each scenario

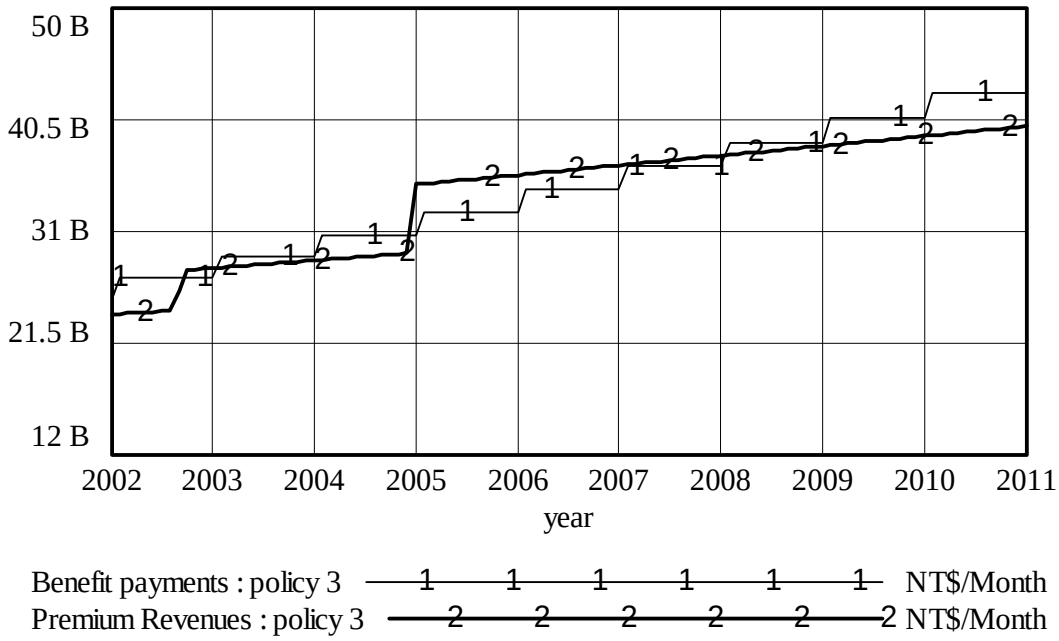

Figure 6. Premium revenues and benefit payments under policy 3 against scenario 1

Summary and future prospects

This research reaches two achievements. First, submitting the stock-flow diagrams focused on the financial problem of the NHI, can provide the BNHI, the insured, and medical care institutions to have a further understanding on the financial problem of the NHI. Second, building the model of the financial problem and policies of the BNHI can simulate and evaluate the results of multiple policies on handling the financial problem of the NHI.

This research has two reservations. First, only explore the financial problem and those policies of the BNHI. Second, the affording months of cumulative balance to benefit payments is the main variable to evaluate that whether all the policies of the BNHI accomplish the desired objective of balanced finances. However, different criteria using for judging the priority of policies under single objective may have different results.

Hence, the future research can consider extending the model boundary and selecting the criteria using for judging the priority of policies under multilple objectives.

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Appendix: Equations of the model

(01) Afford months of cumulative balance to benefit payments = Cumulative balance / Benefit payments
Units: Month

(02) Annual rate of change of Beneficiaries = 0.01 × 0.98 ^ INTEGER (Time / months of a year)
Units: Dmnl
From 1996 to 2002, statistical annual rate of change of beneficiaries was 0.048, 0.022, 0.013, 0.016, 0.015, 0.012 and 0.01 respectively.

(03) Annual rate of change of benefit payments per beneficiary = 0.03883 + STEP ((0.03899 - 0.03883) , 12) + STEP ((0.03813 - 0.03899) , 24)
Units: Dmnl
The NHI Cost Arbitration Committee has negotiated a 0.03883, 0.03899 and 0.03813 growth rate for medical expenditure per person in 2001, 2002 and 2003 respectively. So, under policy 1 or 2, annual rate of change of benefit payments per beneficiary = 0.03883+STEP((0.03899-0.03883) , 12) + STEP((0.03813-0.03899) , 24). Under policy 3, annual rate of change of benefit payments per beneficiary = IF THEN ELSE(Time < 36, (0.03883+STEP((0.03899-0.03883) , 12)+STEP((0.03813-0.03899) , 24)), (0.03883+STEP((0.03899-0.03883) , 12)+STEP((0.03813-0.03899) , 24)) × 0.98^INTEGER(Time/months of a year-2))

(04) Average insured payroll related amount = INTEG(Change in average insured payroll related amount , 25693)
Units: NT$/(Month×person)
In the end of 2001, statistical average insured payroll related amount was NTD $25693.

(05) Beneficiaries = INTEG(Change in Beneficiaries , 2.16536e+007)
Units: person
As of December 2001, there were 21653555 enrolled in the NHI program.

(06) Benefit payments = Global budget / months of a year
Units: NT$/Month

(07) Change in average insured payroll related amount = Average insured payroll

related amount × (Rate of change of average insured payroll related amount + PULSE (7, 1) × "effect of expanded the payroll-related premium base")
Units: NT$/(Month×Month×person)

(08) Change in Beneficiaries = Beneficiaries × Rate of change of Beneficiaries
Units: person/Month

(09) Change in Global budget = PULSE TRAIN (0, 1, 12, FINAL TIME) × (Global budget × (1 + Annual rate of change of benefit payments per beneficiary) × (1 + Annual rate of change of Beneficiaries) × (1 + unexpected rate of change of Global budget) - Global budget) / One month
Units: NT$/Month

(10) Cumulative balance = INTEG(Premium Revenues + Others Revenues - Others Expenditures - Benefit payments , 2.43181e+010)
Units: NT$
In the end of 2001, statistical cumulative balance was NTD $24318057655.

(11) "effect of expanded the payroll-related premium base" = 0.063
Units: dimensionless/Month
The BNHI expanded the payroll-related premium base in August 2002.

(12) FINAL TIME = 108
Units: Month
The final time for the simulation.

(13) gap rate was due to simplification = 0.01
Units: dimensionless

(14) Global budget = INTEG(Change in Global budget , 3.01788e+011)
Units: NT$
The global payment system was fully implemented in July 2002. Benefit payments were NTD $301,788,035,254 in 2001.

(15) INITIAL TIME = 0
Units: Month
The initial time for the simulation.

(16) months of a year = 12
Units: Month

(17) One month = 1
Units: Month

(18) Others Expenditures = 2.99922e+008
Units: NT$/Month
In 2002, statistical total others expenditures was NTD $3599074042. Average others expenditures per month was NTD $299922500.

(19) Others Revenues = 6.48549e+008
Units: NT$/Month

In 2002, statistical total others revenues was NTD $7782590265. Average others revenues per month was NTD $648549167.

(20) Premium rate = 0.0425 + STEP ((0.0455 - 0.0425) , 9) + STEP ((0.0455 × 0.2) , 36)
Units: dimensionless
The BNHI raised the premium rate from 4.25% to 4.55% in September 2002. Under policy 1, premium rate= 0.0425+STEP((0.0455-0.0425) , 9). Under policy 2 or 3, premium rate= 0.0425+STEP((0.0455-0.0425) , 9)+STEP((0.0455×0.2) , 36).

(21) Premium Revenues = Average insured payroll related amount × Premium rate × Beneficiaries × (1 + gap rate was due to simplification)
Units: NT$/Month

(22) Rate of change of average insured payroll related amount = 0.0011
Units: dimensionless/Month
In December 2001 and July 2002, average insured payroll related amount were 25693 and 25886, respectively. So, rate of change of average insured payroll related amount by month=(25886-25693)/7/25693=0.00107. In scenario 1, rate of change of average insured payroll related amount= 0.0011. In scenario 2, rate of change of average insured payroll related amount= 0.0011+RAMP(2e-005, 36, FINAL TIME). In scenario 3, rate of change of average insured payroll related amount= 0.0011+RAMP(-2e-005, 36, FINAL TIME)

(23) Rate of change of Beneficiaries = EXP (LN (1 + Annual rate of change of Beneficiaries) / (months of a year / One month)) - 1
Units: dimensionless/Month
Suppose monthly rate of change of beneficiaries=r, and annual rate of change=y, and a year has 12 months, then, (1+r)^12=1+y, then, ln((1+r)^12)=ln(1+y)=12ln(1+r), so, ln(1+y)/12=ln(1+r), then, e^(ln(1+y)/12)=e^(ln(1+r))=1+r, so, r=e^(ln(1+y)/12)-1

(24) SAVEPER = TIME STEP
Units: Month
The frequency with which output is stored.

(25) TIME STEP = 1
Units: Month
The time step for the simulation.

(26) unexpected rate of change of Global budget = 0.02 × 0.9 ^ INTEGER (Time / months of a year)
Units: dimensionless

(27) year = TIME BASE (2002, 0.0833333)
Units: year