A system dynamics approach to the growth of medical expenses in Taiwan

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Abstract

The National Health Insurance (NHI) program was officially launched in Taiwan on 1 March 1995. The NHI program targets all Taiwan citizens as beneficiaries. The initial balance of revenues and expenditures was stable, but there has been a deficit since 1998. As the problem is mostly caused by the payment system of fee-for-service (FFS), the Bureau of NHI (BNHI) is gradually implementing global budget (GB) to limit the payments under FFS. This study uses causal loop diagrams and the prisoners' dilemma to explore the interlocking actions and reactions taken by the players in the NHI and their consequences. According to our analysis, implementing GB will keep the benefit payments under control as planned, but the undesired consequence is a reduction in the quality of medical care. Since better quality medical care is also one of the objectives stressed in the implementation of the NHI program, BNHI should consider its consequences befor comprehensively implementing GB.

Introduction

The National Health Insurance (NHI) program was officially launched in Taiwan on 1 March 1995. Prior to the inception of NHI, the social insurance system of Taiwan was divided into three major programs: Labor Insurance (LI), Government Employee Insurance (GEI), and Farmer Health Insurance (FHI). The inception of NHI consolidated the pre-existing health insurance programs into one unified program with a uniform premium rate and payment system, and instituted compulsory enrollment for

those individuals (42% of the population) not previously enrolled in the health insurance system. The NHI program targets all Taiwan citizens as beneficiaries. Under the principles of self-reliance, mutual assistance, and risk pooling, NHI premiums are shared by individuals, group insurance applicants, and the government. 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 Taiwan citizens. At the end of September 1999, 20,958,262 people were enrolled in the NHI plan, accounting for 95.86% of the target population. The rate of medical care institutions contracted by the Bureau of NHI (BNHI) was also got 90.6%. The initial balance of revenues and expenditures was stable, but there has been a deficit since 1998 (Bureau of National Health Insurance 1999).

As most of the research works analyzing the deficits problem have been based on isolated parts of the NHI program, we use system dynamics to study the interlocking actions and reactions taken by the BNHI, beneficiaries, and contracted medical care institutions (CMCI), and aims to help BNHI design sustainable improvement programs. Due to the deadline of material for the conference proceedings, the research described in this paper is part of the ongoing study. This paper is organized in the following way. The first section states the background of the NHI program in Taiwan and the purpose of the study. The second section uses causal loop diagrams and the prisoners' dilemma to explore the interlocking actions and reactions taken by the players in NHI and their consequences. The last section discusses and concludes our qualitative analysis.

According to the literature review, the deficit problem is mostly caused by the payment system of fee-for-service (FFS). FFS means that the benefit payments based on the volume of care provided. Under FFS, the more medical services the CMCI provide, the more medical benefits the BNHI pays, and the more income the CMCI will receive. Hence, FFS will induce the CMCI to provide many unnecessary medical cares. FFS is a major method of the payment scheme and has taken a major part of benefit payments since the NHI program was launched.

As the deficit problem is mostly caused by FFS, one of the actions of the BNHI is to implement GB to limit the payments under FFS. Therefore, the GB has been implemented in the outpatient care provided by contracted dental institutions (CDI) since July, 1998, and the GB is expected to be implemented in the outpatient care provided by contracted institutions practicing Chinese medicine on July, 2000, as well as in the care provided by contracted institutions practicing western medicine on January, 2001.

Under GB, the BNHI negotiates with the CMCI to set annual medical benefit budget which is not beyond annual premium revenues 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. Hence, annual approved benefit payments by the BNHI is annual medical benefit budget. Because annual medical benefit budget is under annual premium revenues, the BNHI will not have the deficit problem again.

After the GB implemented in the outpatient care provided by CDI, the growth rate of the benefit payments by CDI is 8% in 1999 and it is less than 12% in1998. However, the benefit payments by CDI does not take a major part in total benefit payments, for instance, it is only 7.46% in 1998. Additionally, the degree of satisfaction for the dentists in hospital is very low. Hence, it is worthy of going a step further to study the influence of implementing GB.

Qualitative analysis

This section uses causal loop diagrams (Wolstenholme 1999) and the prisoners' dilemma (Dixit and Nalebuff 1991) to explore the interlocking actions and reactions taken by the players in NHI and their consequences. The players in NHI are the BNHI, the CMCI, and beneficiaries.

The actions taken by the CMCI and their consequences under FFS

FFS is a major method of the payment scheme since the NHI program was launched. Under FFS, the CMCI increase the volume of care to make the maximum wealth. The most convenient way in increasing the volume of care is to request patients to return for another visit. Most of the patients who are ordered back will see the doctor again because their medical knowledge is less than that of the doctor. Once the patients come back to see the doctor, the volume of care provided will increase. Due to one dollar per payment point, the more medical services the CMCI provide, the more medical benefits the BNHI pays, and the more income the CMCI will receive.

Because the action of requesting patients to return is convenient and effective, the CMCI increase the order back fraction to achieve their target incomes. The loop 1 in Figure 1 outlines a balancing process in which the CMCI' response to discrepancy (target income exceed income) increase the order back fraction, increase the patients

who are ordered back, increase the patients who are treated, increase payment points claimed, increase approved benefit payments, increase the CMCI' income, and decrease discrepancy. But, the loop 2 in Figure 1 outlines a reinforcing process in which the CMCI' response to increasing income raise target income, increase discrepancy, increase the order back fraction, increase the patients who are ordered back, increase the patients who are treated, increase payment points claimed, increase approved benefit payments, increase the CMCI' income, and raise target income again. As illustrated in Figure 1, the effects of raising target income and increasing the order back fraction are not only an increasing in the CMCI' income but also an decreasing in the BNHI's net income. In fact, the initial balance of premium revenues and approved benefit payments was stable, but there has been a deficit since 1998.
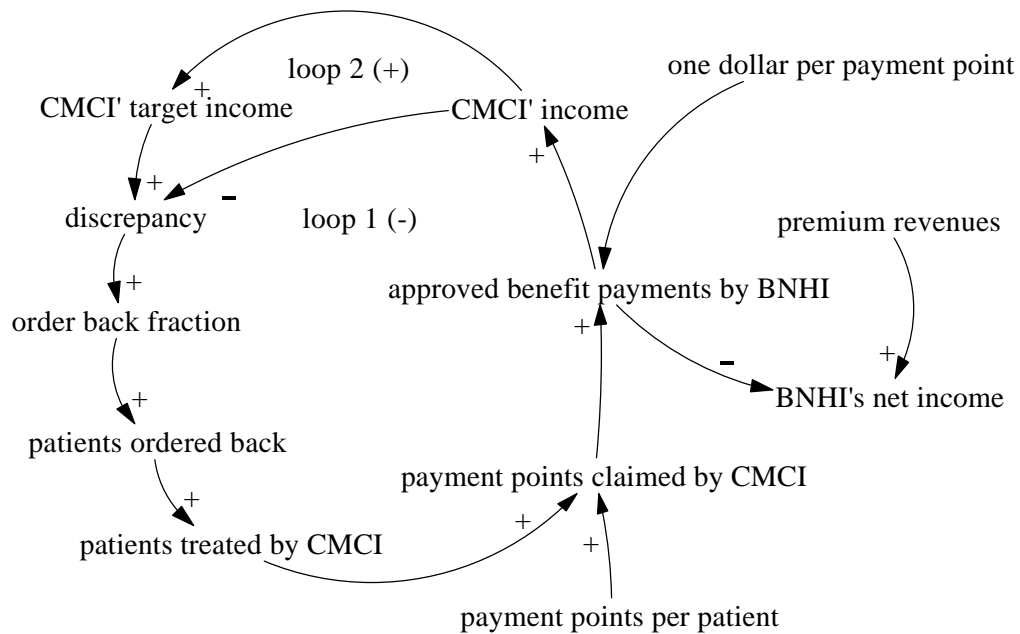
Figure 1. The actions taken by the CMCI and their consequences under FFS

Implementing GB by the BNHI and its desired effect

That the approved benefit payments by the BNHI have exceeded the premium revenues has caused a deficit and jeopardized the goal of balanced finances and long-term operational viability since 1998. Hence, one of the actions taken by the BNHI is gradually implementing GB. Under GB, the payment per point is floating and equal to the answer of benefit payment budget dividing by total points claimed by the CMCI. As total points claimed by the CMCI are over the benefit payment budget, the payment per point will be less than one dollar. On the contrary, as total points claimed by the CMCI are under the benefit payment budget, the payment per point will be

more than one dollar. Hence, annual approved benefit payment by the BNHI is equal to annual benefit payment budget. Because annual benefit payment budget is under annual premium revenues, the BNHI will not have the deficit problem again. The desired effect of implementing GB can be shown as the loop 3 in Figure 2. But, what will happen to the CMCI and beneficiaries?
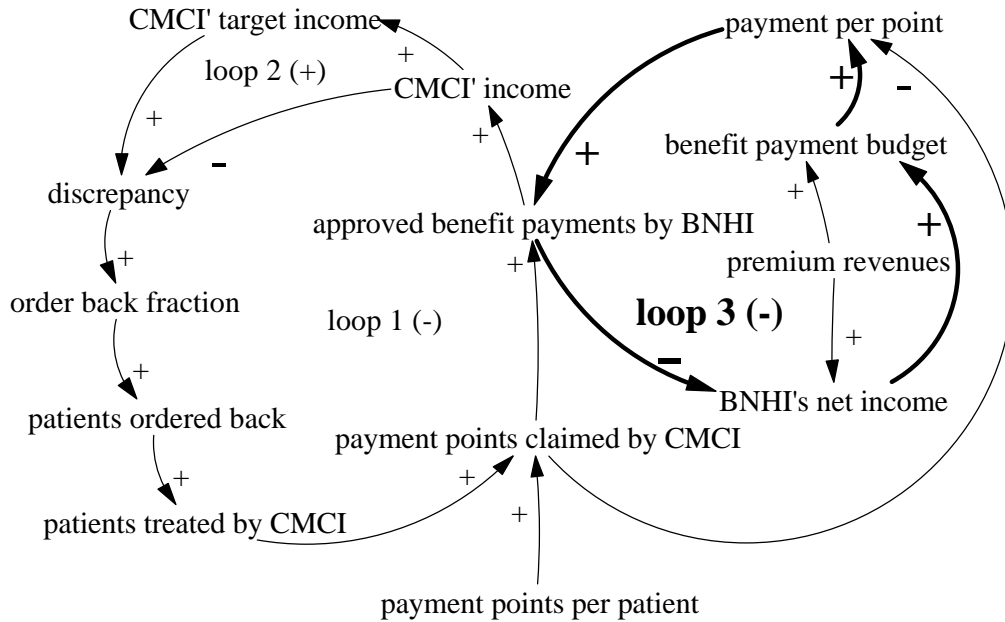

Figure 2. Implementing GB by the BNHI and its desired effect

The actions taken by the CMCI and their consequences under GB

As for the provider's income, it is no longer unlimited increase by increasing services owing to the limitation of the benefit payment budget. Under GB, what actions will the CMCI take to pursue wealth maximization? In order to explain clearly, we assume that the CMCI is simplified as two providers, A and B; the initial volume of care provided by A is equal to that provided by B (i.e. $Qa = Qb = q$); both have the same cost structure (i.e. $Ca = Cb = Cq$); the actions are simplified as increasing the volume of care and maintaining the volume of care; the increasing volume of care provided by A is equal to that provided by B (i.e. $qa = qb = q1$) and the cost of providing q1 is Cq1; and the benefit payment budget of the BNHI is BPB. Thus, if both A and B maintain the volume of care, each will have net income $R = 1/2 * BPB - Cq$. If they both increase the volume of care, each will have net income $P = 1/2 * BPB - Cq - Cq1$. If A (B) increases and B (A) maintains, then A (B) will have net income $T = (q + q1) / (q + q1 + q) * BPB - Cq - Cq1$ and B (A) will have net income $S = q / (q + q1 + q) * BPB - Cq$. An illustration of the conditions and the providers' net income is shown in Table 1.

Table 1. The conditions and the providers' net income under GB

provider B

		maintains the volume of care	increases the volume of care
provider A	maintains the volume of care	A has net income R B has net income R	A has net income S B has net income T
	increases the volume of care	A has net income T B has net income S	A has net income P B has net income P

What are the mathematical relationships among the net income R, P, T, and S? It is certain that the net income R is greater than P. For the net income T and R, we will find out that T is greater than R. This is because the easy way to increase the volume of care is to request patients to return, and the part of unnecessary return costs the providers nothing except their time. For the providers who like to increase the volume of care at the expense of their time, the cost of providing q1 counts for little. Hence, the net income T is greater than R. As for P and S, the same reasons explain that the net income P is greater than S. Thus, the mathematical relationship among the net income R, P, T, and S is $T > R > P > S$.

Consider provider A' net income. If B chooses to maintain the volume of care, A will have net income T if A chooses to increase the volume of care but only R if A chooses to maintain the volume of care. If B chooses to increase the volume of care, A will have net income P if A chooses to increase the volume of care but only S if A chooses to maintain the volume of care. Hence, increasing the volume of care is A' best choice against B' choice of maintaining the volume of care, as well as against B' choice of increasing the volume of care. Increasing the volume of care is preferable for B for the same reasons. Thus, increasing the volume of care is dominating for both A and B, although each only having the net income P.

In fact, the most possible condition is that the increasing volume of care provided by A is not equal to that provided by B (i.e. $qa \neq qb$). Thus, if the increasing volume of care provided by A is greater than that provided by B (i.e. $qa > qb$), then A will have net income $Pa = (q+qa)/(q+qa+q+qb) * BPB - Cq - Cqa$ and B will have net income $Pb = (q+qb)/(q+qa+q+qb) * BPB - Cq - Cqb$. For the same reasons described above, both Cqa and Cqb count for little. Hence, the net income Pa is greater than Pb, and we can deduce the expression of $Pa > R > Pb$. The expression of $Pa > R$ means that the net

income Pa in the first round is greater than the net income R in the initiation. The expression of R > Pb means that the net income Pb in the first round is less than the net income R in the initiation. Why the net income of A increase, yet the net income of B decrease after both taking the same action of increasing the volume of care? This is because the increasing volume of care provided by A is greater than that provided by B, which can make up for the effect of descending payment per point. On the contrary, because the increasing volume of care provided by B is less than that provided by A, which can not make up for the effect of descending payment per point.

What actions will A take in the second round? Because the net income Pa of the first round is greater than the net income R of the initiation, A will again raise target income and then increase the order back fraction. The loop 1 in Figure 3 outlines this reinforcing process. On the other hand, what actions will B take in the second round? Under the condition of A' increasing the volume of care, B will have the net income Pb' if B chooses to increase the volume of care but only Sb' if B chooses to maintain the volume of care. Since the net income Pb' is greater than Sb', B will again choose to increase the volume of care in the second round.

As both A and B continue to increase the volume of care in the second round, if A is confident due to the effectiveness of the same action in the first round and B is not confident due to the ineffectiveness of the same action in the first round, then the most possible condition is that the volume of care provided by A is still greater than that provided by B and the differences between the volume of care povided by A and that by B is grater than that in the first round. Thus, A will have net income Pa' in the second round, and Pa' will be greater than the net income Pa in the first round and the net income R in the initiation (i.e. Pa' > Pa > R). The actions taken by A and their consequences can be shown as the loop 1 in Figure 3. On the other hand, B will have net income Pb' in the second round, and Pb' will be less than the net income Pb in the first round and the net income R in the initiation (i.e. R > Pb > Pb'). The actions taken by B and their consequences can be shown as the loop 2 in Figure 3.

As both A and B continue to increase the volume of care in the second round, however, it is still possible even not easy for the volume of care provided by B being greater than that provided by A. Under this condition, B will have net income Pb', and Pb' will be greater than the net income Pb in the first round and the net income R in the initiation (i.e. Pb' >R > Pb). On the other hand, A will have net income Pa', and Pa' will be less than the net income Pa in the first round and the net income R in the initiation (i.e. Pa > R > Pa').
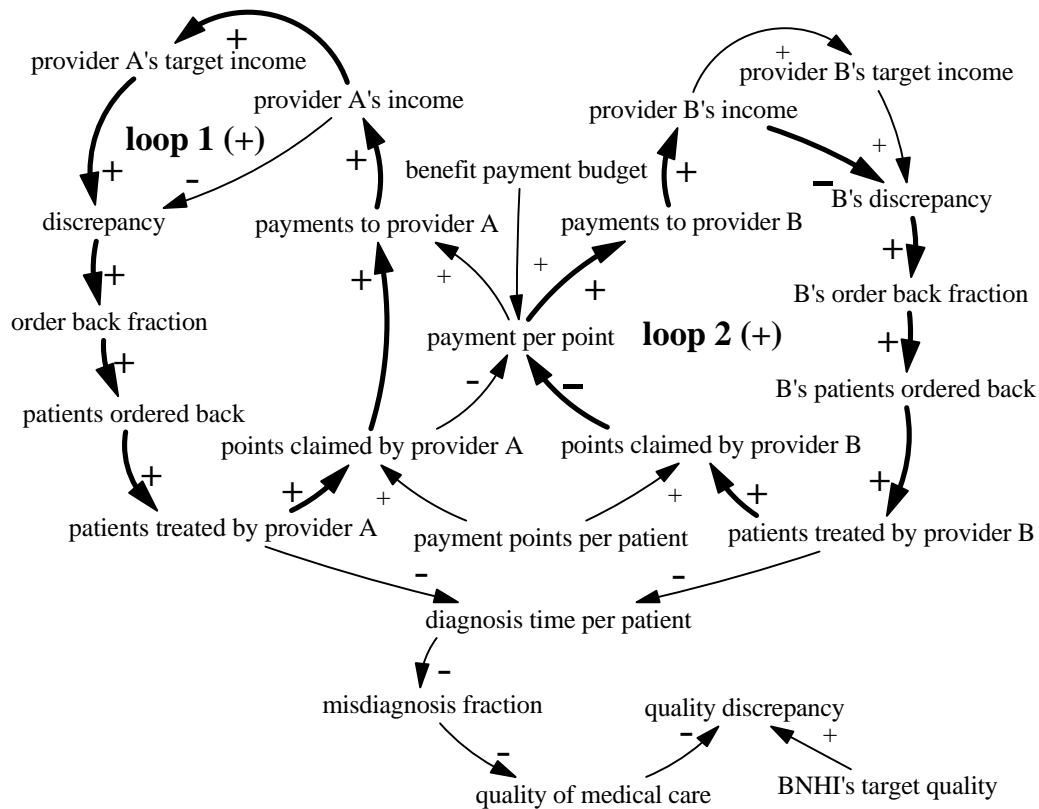
Figure 3. The actions taken by the CMCI and their consequences under GB

What do both A and B do after the second round? For the same reasons stated above, both will choose to increase the volume of care if their marginal costs are still less than marginal revenues.

What will happen if the actions are simplified as decreasing medical services and maintaining medical services in the begininning? If both maintain the volume of care, each will have net income R. If both decrease equal volume, each will have net income J which is more than R. If A (B) decreases and B (A) maintains, then A (B) will have net income M which is less than R and B (A) will have net income K which is more than R and J. For the same reasons stated above, maintaining medical services is dominating for both A and B, although each only having the net income R. As for the actions of increasing medical services and maintaining medical services, we have already got that increasing medical services is dominating for both A and B.

Facing the global budget taken by the BNHI, the CMCI understand that their incomes are no longer unlimited increase with the increasing volume of care. According to the analysis described above, however, we can deduce that the CMCI will still increase the volume of care if they pursue wealth maximization. Of course, not all of the CMCI

pursue wealth maximization. But, even if some providers of the CMCI only want to maintain the same level of income, they still have to increase the volume of care. This is because the income is the answer of the volume of care multiplying the payment per point and the payment per point will lower due to others of the CMCI pursuing wealth maximization and then increasing the volume of care. Certainly, there are also some providers of the CMCI do not want to increase the volume of care, yet the numbers of providers who can stand their incomes on the decrease may be few.

The action taken by the beneficiaries and its effects under GB

According to the analysis described above, implementing GB will induce more and more providers to increase the volume of care. The easy way in increasing the volume of care is to request patients to return for another visit. Most of the patients who are ordered back will see the doctor again because their medical knowledge is less than that of the doctor. The part of unnecessary return is useless for the patients and it wastes the time and vigor of the patients. The unnecessary returns also occupy some of the providers' time, which causes the diagnosing time for the patients who really need treatments be shortened, increases the opportunity of misdiagnosis, and reduces the quality of medical care (please see Figure 3).

Better quality medical care for Taiwan citizens is also one of the objectives stressed in the implementation of the NHI program. When the BNHI attempts to fix the deficit problem by implementing GB, the benefit payments are under controlled as planned, but the unintended consequence is a reduction in the quality of medical care.

Discussion and conclusion

By studying the dynamic operation process existing in the NHI program, we improve our understanding of how the deficit problem behave over time and the actions and reactions taken by the players in the NHI.

Under FFS, most of the CMCI increase medical services to raise their income. Due to one dollar per payment point, their actions will not hurt the providers who only want to maintain the same level of income by providing the same volume of care. Under GB, however, the action of increasing medical services will lower the payments per payment point, reduce the income of the providers who only want to maintain the same level of income by providing the same volume of care. Therefore, implementing GB will force the providers who want to maintain the same level of income to increase services, and induce more and more providers to increase more and more unnecessary services. The unnecessary services occupy some of the providers' time, which causes

the diagnosing time for the patients who really need treatments been shortened, increases the opportunity of misdiagnosis, and reduces the quality of medical care.

Under GB, the CMCI' income are no longer unlimited increase by increasing medical services. For pursuing wealth maximization, the CMCI can also increase the services which are not included in the NHI program. Since the services are not included in the NHI program, the patients must pay the services themselves. The payments which are paid by the patients are no longer limited to the benefit payment budget of the BNHI, thus, relieve the impact of GB on the CMCI' income.However, the medical services which are not included in the NHI program are not many.

Under GB, if the CMCI can find a way to let all of the CMCI decrease medical services, then the CMCI will have the highest joint net income. But, it is very difficult, given the temptation for each to cheat and gain at the expense of the others.

In short, under FFS, the CMCI attempt to raise their income by increasing medical services.The CMCI' income go up as planned, but the undesired consequence is the deficit problem in NHI. The BNHI, in turn, tries to fix the deficit problem by gradually implementing GB. This has the desired effect of keeping the benefit payments under control, but also will hurt the quality of medical care. Since better quality medical care is also one of the objectives stressed in the implementation of the NHI program and the GB is expected to be implemented in the outpatient care provided by contracted institutions practicing Chinese medicine on July, 2000, as well as in the care provided by contracted institutions practicing western medicine on January, 2001, BNHI should consider its consequences befor comprehensively implementing GB.

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