MODEL-BASED ANALYSES OF THE DUTCH HEALTH CARE SYSTEM

Luc Verburgh

Nijmegen Institute of Cognition and Information Technology (NICI) /
Department of Methodology, Catholic University Nijmegen
P.O. Box 9108, 6500 HK, Nijmegen, The Netherlands.

Jan Gubbels

University of Nijmegen, The Netherlands

Jac Vennix

University of Utrecht, The Netherlands

Doeke Post

Regional Health Care Insurance Organization Zwolle

ABSTRACT

In this paper, a system dynamics model of the Dutch health care system will be discussed. The description of the model will start with so called 'patients flows'. It will be followed by a description of the most important factors that affect the patients flows and the costs generated by the system. Having outlined the system dynamics model, the outcomes of three policy alternatives aimed at reducing the costs of health care will be examined. They will serve to demonstrate that the system dynamic model does have the potential to be used in workshops to elicit and increase the knowledge policy makers have regarding the problem of rising costs of health care.

1. INTRODUCTION

The cost of public health care has risen dramatically over the last few decades. At present, some 10 percent of the Dutch net National Product is spend on health care and in light of the increasing population of people of 65 and over, a further rise in the costs of public health care is to be foreseen. Several attempts have been made to reduce the increase in costs. Thus far, however, none of them has proved to be very successful. Together with the complexity of the health care system, lack of understanding of its dynamics seems a very important reason for this.

In order to gain some understanding of the complex problem of rising costs of health care, a conceptual model of the Dutch health care system was developed by a group of modelers and health care specialists (Vennix et al, 1988). Although the conceptual model is occasionally employed for policy-making purposes at a regional health care insurance organisation, it was felt that further understanding of the model was required in order to be able to evaluate the effects of possible policy options - understanding which could only be acquired by means of a formalised and quantified version of the original conceptual model. In order to examine whether health care experts would be interested in a model that could be used to create a computer-assisted learning environment to address the problem of rising costs of health care, we asked those attending a conference concerning the original conceptual model to fill out a form to state whether they would like to be involved in the development and use of a formalised and quantified model. Because most of the attending experts answered this question affirmatively, we decided to continue the project and construct a System Dynamics model.

In this paper, we will focus on the System Dynamics model of the Dutch health care system that has resulted from the formalisation and quantification of the model developed by Vennix et al (1988). Preceding the examination of the effect of some of the most commonly suggested policy options, aimed at reducing the costs of public health care, a description will be given of the main components of the S.D model. Because most of the suggested options focus on the gatekeeper's role general practitioners play in the Dutch health care system, the description of the model will concentrate on that part in particular.

2. THE SYSTEM DYNAMICS MODEL.

As depicted in Figure 1, the original conceptual model consists of three parts: a top part, representing the so called 'patients-flows', a middle part, in which the factors that influence the patients-flows and costs generated by the system are portrayed, and a bottom part displaying the costs of health care.

Figure 1: general practitioner and and people at home section of the original conceptual model (in Dutch)

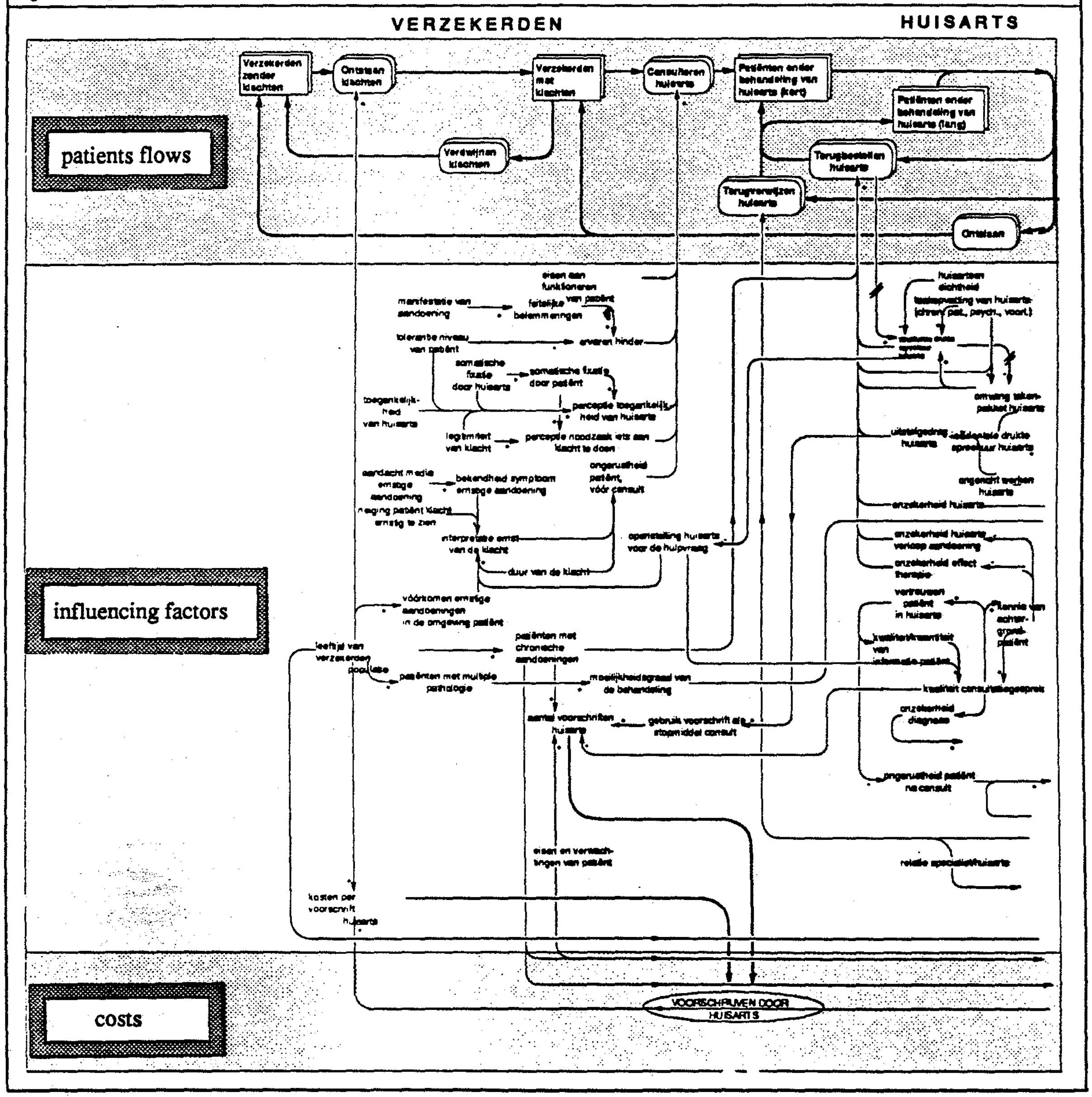
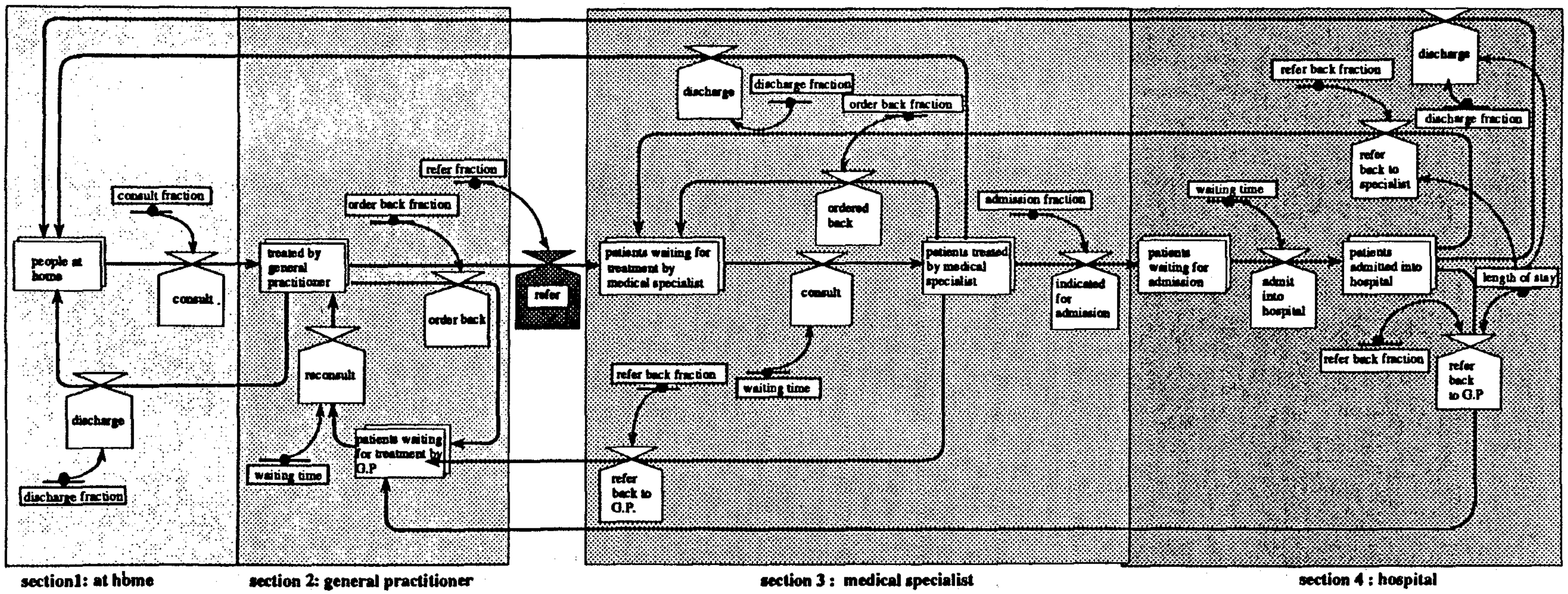


Figure 2: patients flow in the health care system



2.1 PATIENTS FLOWS

The construction of the System Dynamics model was started by formalising and quantifying the **patients flows** first. Not only because these patients-flows form the structural core of any health care system, but also because they are well known and have already been presented in terms of levels and rates in the original hybrid model. The elaboration of the patients flows has resulted in the flow diagram depicted in Figure 2. It shows that the Dutch health care system can be divided into the 4 sections: 'people at home', 'general practitioner', 'medical specialist' and 'hospital'.

The first section represents the people who have nothing to do with the health care system but can become a part of it by consulting their general practitioner. It is called 'people at home'. Note that people with health complaints in the Netherlands initially consult their general practitioner rather than directly visit a medical specialist or go to a hospital.

Having decided to consult a general practitioner, patients flow into the second section, the section in which the g.p. is predominant. They are treated by the general practitioner, who then has to decide whether to refer them to a medical specialist, to discharge them, or to request them to return (order back). Note that the patients who are requested to return for another visit (the outflow called 'ordered back') flow into a level called 'patients waiting repeated treatment'. This because people who are ordered back on the average are requested to return after, say, about 4 weeks and do not, strictly speaking, leave the health care system for they are not being discharged.

In order to enter the third section of the health care system, patients need to be referred by general practitioners. In principle, it is the g.p. who decides whether or not to refer patients to the more expensive third and fourth section of the system. As a result of this, general practitioners are often regarded as gatekeepers, who's task it is to prevent patients from flowing towards the more expensive specialist and hospital.

The third section of the health care system incorporates the main patients flows related to medical specialists. Patients who have been referred by their g.p. and have spent some time in the level 'patients waiting for treatment by a specialist' (the Dutch have waiting-lists for a number of specialisms) are being treated by a medical specialist. Following this treatment, the medical specialist has to decide whether the patient has to be reexamined (ordered back), admitted into a hospital, discharged, or referred back to the g.p. (see Figure 2).

Patients who are admitted into a hospital enter the fourth section of the health care system. Prior to actual admission into a hospital, however, patients need to wait in a level called 'patients waiting for admission' due to waiting lists. In order to depart the level 'patients admitted into hospital', patients are either referred back to a specialist or general practitioner, or discharged as a result of which they return to the level 'people at home'.

Returning to the first section, it is clear that in order to determine the outflow of the level 'people at home', a consult-fraction is required. Together with the number of people in the level 'people at home', this consult-fraction allows for the calculation of the consult rate: the number of people consulting their g.p. in one particular week. In order to determine the initial value of this consult-fraction, research had to be carried out. It was found that 4.9 percent of the 'people at home' consult their general practitioner in one week, leading to an outflow of 9,800 people at an initial value of 200,000 of the level 'people at home' (Van der Ree, et al., 1990).

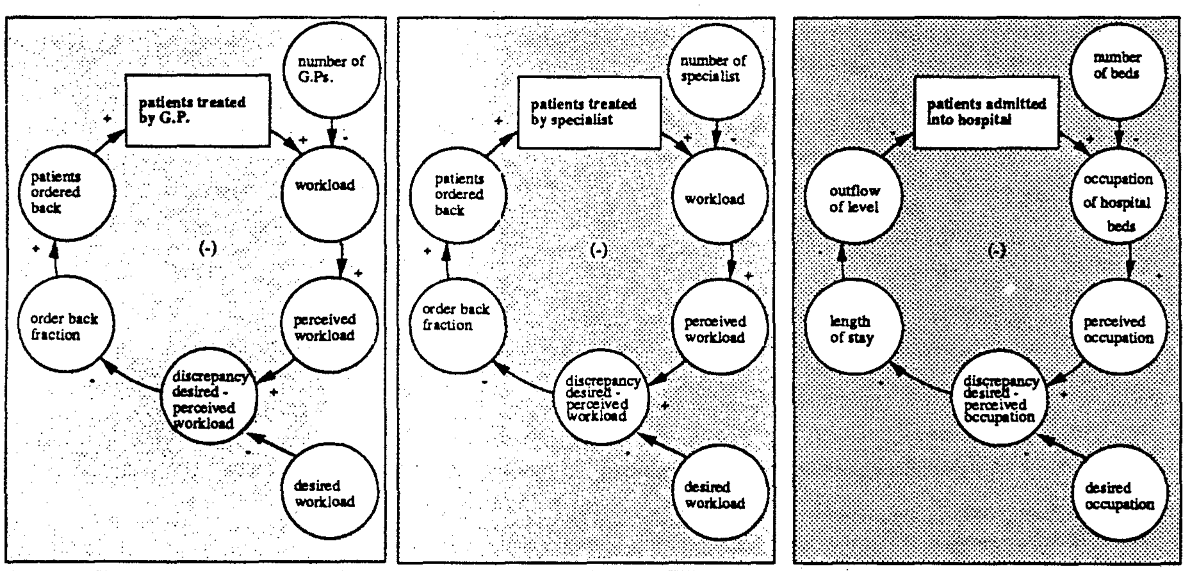
Quantification of the 'general practitioner section' proved to be more difficult, for regional data regarding the number of patients treated by a general practitioner, the discharge-, order back-, and refer fractions, and waiting time, were not available. This because general practitioners are not paid per treated patient but per person registered at a practice. As a result, the number of treated patients are not registered on a regional level, in contrast to the number of registered persons. Because of the large differences in health care consumption and behaviour among regions, it was decided to have again some research carried out (Van der Ree et al., 1990), rather than employing data of a national level. It was found that on the average, general practitioners discharge 59 percent, order back 28 percent, and refer 13 percent of the people they treat. The total number of patients treated by the 104 general practitioners of the Zwolle region, was found to be equal to 13,400. The initial value of the level 'patients waiting for treatment by the G.P. cannot be observed directly (the patients are not really sitting in a waiting-room) and it is only by multiplication of the inflow 'patients ordered back' and 'average waiting time' that the initial value of the level (13,500) could be inferred.

With respect to the section of the medical specialist, quantification was quite straightforward for most of the required data could be derived from annual reports of hospitals (they also collect data regarding the medical specialists) and databases from a regional health insurance organization. Based on this, it was found that 9,000 patients were treated by the 171 medical specialists of the region in one week. From these 9,000 patients 10 percent is discharged, 2 percent is referred back to their G.P., 9 percent is sent to hospital (indicated for admission), and 79 percent is ordered back. Note the vast difference in order back fraction between the G.P. and the medical specialist. An average G.P. orders back some 28 percent of the treated patients whereas a medical specialist has an order back fraction of nearly 80 percent. This high order back fraction is one of the reasons why policy makers argue that the more patients flow into the 'expensive' right hand side of the Dutch health care system, the more difficult it becomes to leave the system. The expensiveness of the medical specialist section is due to the fact that, by contrast to general practitioners, medical specialists are paid per patient they treat and per medical transaction they carry out. To illustrate the difficulty of leaving the expensive medical specialist section, note that medical specialists have a discharge fraction of only 10 percent. Analogously to the level 'patients waiting for treatment by G.P.', the initial value of the level 'patients waiting for treatment by medical specialist' had to be inferred. Multiplication of the waiting time (its value is based on a telephone-survey carried out by the Zwolle health insurance organization, and research recently carried out by the National Society of Medical Specialists (LSV, 1990)), and order back flow led to an initial value of the level of 18,000.

Finally, regarding the quantification of the patients flows in section four, annual reports of the five hospitals in the particular region served to provide the necessary data. We found that the level 'patients admitted into hospital' contains 1,320 people, with an average length-of-stay of 11.4 days (1.623 weeks, for the model's computation time is 1 week). Moreover, we were able to determine the fractions belonging to the outflows 'refer back to G.P.' (2,5 %), 'refer back to specialist' (10 %) and 'discharge (87,5 %). However, concerning the level 'patients waiting for admission into hospital', it took great pains to estimate its initial level for hardly any information about the waiting-time prior to admission had been available. It was not until recently (LSV, 1990) that a value of the waiting-time parameter could be derived at. Based on this recent information, it was decided to assign an initial value of 3 weeks to the average waiting-time for admission into hospital.

2.2 INFLUENCING FACTORS

Figure 3 : three negative feedback loops



Having formalised and quantified most of the patients flows of the Dutch health care system, we decided to elaborate on the group of **influencing factors** (see figure 1) next. It is important to include those influencing factors for they constitute feedback loops, which are essential to understand the system's behaviour. Note however, that, as depicted in figure 2, feedback loops also exist in the patients flows part of the model.

Close examination of the original conceptual model revealed that the block of influencing factors contains three negative feedback loops of a more or less identical structure. The first loop affects the flows that are related to the general practitioner, the second one belongs to the medical specialists, and the third one is related to the section of the hospital. In all three cases, an increase in the number of patients leads to an increase in workload, as a result of which the sub-system's behaviour is adjusted in order to reduce the difference between the desired and experienced workload. Note that, as a result of the inclusion of influencing factors, the fractions depicted in Figure 2 as constant, have become variable.

The three negative feedback loops, depicted in Figure 3, are clearly intended to keep the experienced workload at the desired level. To illustrate, a measure taken to reduce the G.P.s refer-fraction will lead to less patients being referred to medical specialist, thereby affecting the workload of medical specialists. As a consequence, these specialists may want to adjust their workload to equal the desired workload. One way to compensate for a potential reduction in workload is to intensify their treatment by increasing the order back fraction and reducing the admission and discharge fractions. As to whether measures taken to strengthen the second section, the section of the G.P., do indeed result in adjustment of behaviour in other sections, will be examined in more detail in one of the next sections. Preceding this description, however, account needs to be given of the formalisation and quantification of the third part of the original hybrid model: the costs generated by the health care system.

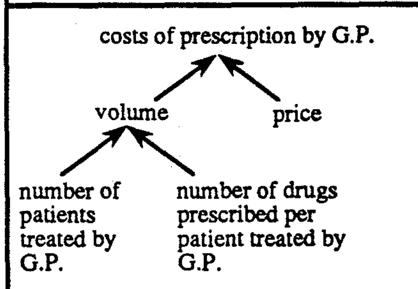
2.3 COSTS

Because the S.D. model is going to be used by health insurance organisations which heavily rely on costs in policy making, we decided to include all the cost factors of the original hybrid model. Moreover, we added some cost factors in order to be able to evaluate the effects of policy alternatives. When we focus on the way in which the costs have been built into the model, it is clear that, generally speaking, they have been regarded as a multiplication of volume, the number of products offered or 'sold', and price: costs = volume * price. Volumes are derived from the patients flow part of the model. For instance, the number of patients referred to the medical specialist, the flow 'referred patients' is a measure of the volume belonging to 'costs of referred patients'. Prices, by contrast, are looked upon as exogenous variables. Although the above mentioned procedure to calculate the costs generated by the health care system seems quite straightforward, it turned out to be more complicated than expected for most of the data regarding the prices were only available on an aggregate level such as price of consult per patient per year, and had to be converted in units such as 'price per contact', or 'price per prescribed drug'. Although many costs have been included in the final S.D. model (see Figure 4), we will limit ourselves to one example to illustrate the way in which patients flows and exogenous factors such as prices have been combined to arrive at costs (Figure 5):

Figure 4 : costs included in the model

1. prescription by G.P.
2. prescription by specialist
3. treatment by G.P.
4. treatment by specialist
5. admission into hospital
6. medical transaction by specialist

Figure 5: costs of prescription by G.P.



To summarize the description of the Dutch health care system, it is clear that four sections can be discerned: a people at home section, a general practitioner section, a medical specialist section, and a hospital section. The more patients move towards the right hand side of the system, the more expensive their treatment becomes. In light of this, general practitioners are thought to play a crucial role in reducing the costs of public health care. As a consequence, policy alternatives aimed at strengthening the general practitioner section while reducing the third and fourth sections (the medical specialist and hospital) thereby focusing on the number of referred patients, are currently being discussed in Dutch politics. In the next section of this paper, we will focus in more detail on three of these policy alternatives and examine whether they do indeed have the potential to reduce the costs of Dutch health care.

3. POLICY EXPERIMENTS

The policy alternatives to be examined stem from workshops held to construct the original conceptual model (Vennix et al, 1988). In these workshops policy makers were asked to select a number of policy alternatives aimed at decreasing the number of patients treated by the specialist or admitted into hospital. From the alternatives selected by the policy makers, we selected three which all focus on the gatekeeper's role of the general practitioner. In other words, the selected alternatives all intend to affect the number of referred patients. They can be expressed as follows:

1. Increase the number of general practitioners (or reduce the population ratio per general practitioner).

2. Introduce a financial incentive for general practitioners to carry out particular medical transactions that are currently being carried out by medical specialists.

3. Reduce the uncertainty general practitioners have regarding their diagnosis and the effect of their treatment.

3.1 INCREASE THE NUMBER OF GENERAL PRACTITIONERS

Figure 6: policy alternative 1 : increase number of general practitioners

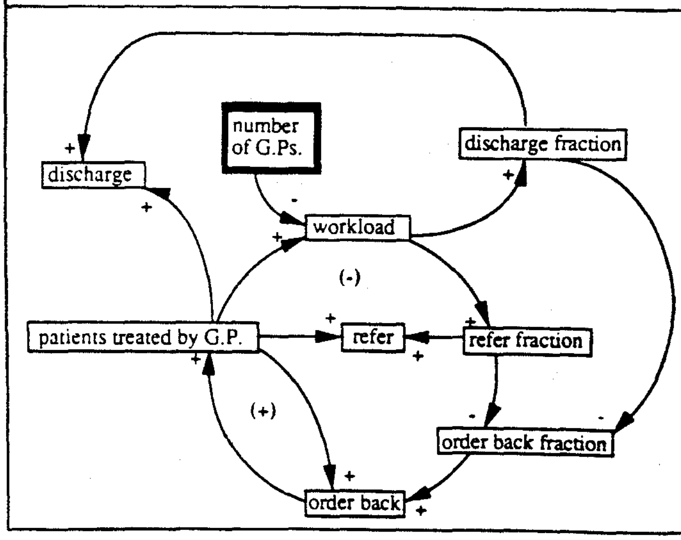
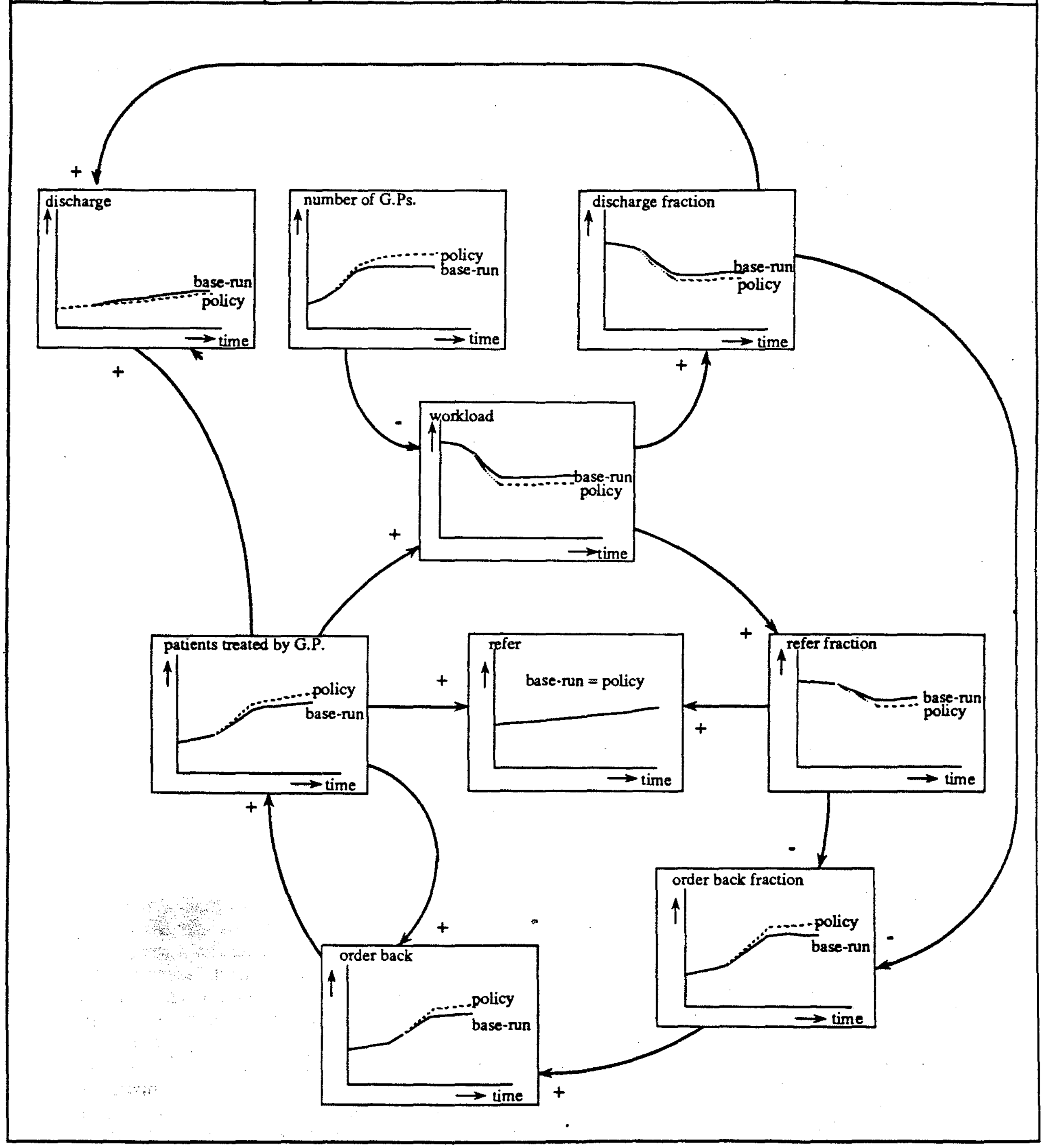


Figure 6, representing the causal structure affecting the number of referred patients, can also be used to depict the reasons policy makers have for suggesting this particular alternative. It shows that by decreasing the number of general practitioners, the workload is expected to decrease, as a result of which general practitioners have more time to deal with their patients and refer less patients because of lack of time. In other words, it is thought that a decreasing workload results in a decreasing refer fraction and consequently causes the number of referred patients to decrease. As a consequence, the number of patients in the expensive third section would decrease thereby causing a reduction in the cost of health care. In order to examine whether this alternative does indeed lead to a decreased number of referred patients, the policy run, in which the number of G.Ps. is gradually increased by 10 percent, is compared to the model's base-run. The outcome of this comparison is depicted in Figure 7. Note that the structure of the presentation is identical to the structure of Figure 6. This is done to facilitate the interpretation of the curves.

Figure 7 shows that the additional 10 percent increase in the number of G.Ps. does indeed lead to an extra decrease in workload, as a result of which the refer- and discharge fraction are being reduced. However, because of this decrease in refer- and discharge fraction, the order back fraction is raised for patients who are not discharged or referred are ordered back -there is no alternative way of leaving the level 'patients treated by the G.P.'. Note that this increase in order back fraction results in an increase in

Figure 7 : Effects of policy alternative 1: a 10 percent increase in number of general practitioners



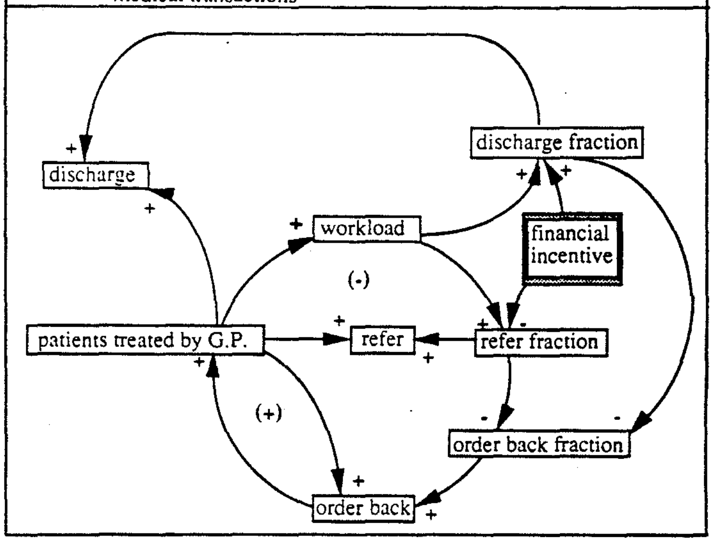
the number of patients ordered back, which, in turn, leads to an increase in the number of patients treated by the general practitioner. The number of patients referred by the G.P., however, is not reduced. In spite of the reduction of the refer fraction, it remains equal to the base-run because of the increase of the level 'patients treated by the G.P.' of which it is a fraction: the decrease of the refer fraction is compensated by the increase of the number of patients treated by the G.P. Because the outflow 'patients referred by the G.P.' is not affected substantially by the additional increase in number of G.Ps., the number of patients treated by the medical specialist remains unchanged. As a result, medical specialists do not adjust their behaviour for their workload remains unchanged.

To sum up, it has been shown that an increase in the number of G.Ps. does not lead to a reduction in the number of referred patients for a decrease in the refer fraction inevitably results in an increase in the order back fraction, in the number of patients ordered back, and consequently in the number of patients treated by the general practitioner. The policy proves to be successful in strengthening the section of the G.P. (more patients were being treated by the G.P. as a result of it), however, it failed to accomplish a reduction in the number of patients treated by the medical specialist'.

3.2 INTRODUCE A FINANCIAL INCENTIVE FOR MINOR MEDICAL TRANSACTIONS

Although G.Ps. are quite capable of carrying out medical transactions such as removal of wrats, it is thought that because they are not paid for these time-consuming transactions, many patients are, unnecessarily, referred to more expensive medical specialists to have these transactions carried out. If, however, medical transactions like these become financially rewarding, policy makers believe it would lead to a decrease in the number of referred patients. The causal mechanism related to the number of referred patients and the financial incentive is represented in Figure 8 as follows:

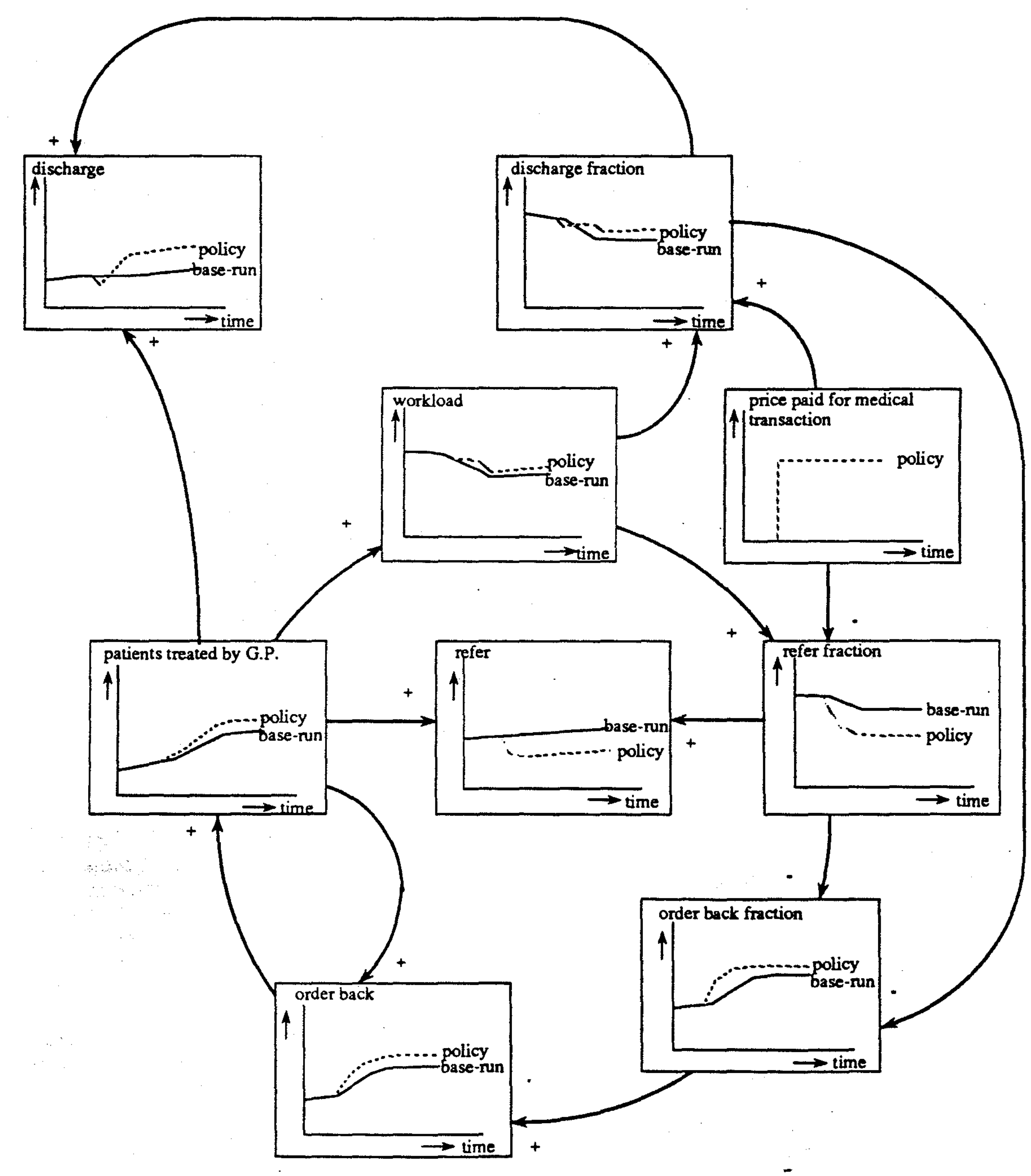
Figure 8: policy alternative 2: introduce financial incentive to carry out medical transactions



The figure shows that although policy makers mainly focus on the link between financial rewards and refer fraction, introduction of the policy also affects the discharge and order back fraction. First of all because the sum of the three always needs to be equal to 100, because the patients referred, ordered back and discharged always add up to the number of patients treated by the g.p.: at the end of the week the level is completely emptied: all the patients flow out of it. An other reason why the adjustments made to the refer fraction as a result of the increase in medical transactions affect the discharge and order back fraction is that patients who are not referred either are discharged or ordered back. We assume that half the number of patients who are not referred because of the introduction of the policy, are being ordered back to have their treatment reexamined or carried out. Thus the order back fraction increases as a consequence of the decrease in refer fraction. The other half of the patients who would have been referred but have not because of the policy, are thought to receive their medical transaction immediately as a result of which they can go home (are discharged) leading to an increase in the discharge fraction. To illustrate, if we assume that, as a consequence of the introduction of the policy, the refer fraction decreases by 10 percent (from 13 percent to 11.7 percent), an additional 1.3 percent of the people treated by the G.P. need to flow out of the level using either the flow 'patients ordered back' or the flow 'patients discharged'. As mentioned before, we decided to add one half of this decrease in refer fraction to the discharge fraction and the other half to the order back fraction.

To examine whether the policy succeeds in reducing the number of referred patients thereby leading to a reduction of the number of patients treated by the medical specialist, a comparison is made between the base-run and the run that results from the introduction of the policy. This comparison is depicted in Figure 9. Note that the causal structure of Figure 9 is identical to the structure of Figure 8. This to facilitate the interpretation of the results.

Figure 9 : Effects of policy alternative 2: introduction of a financial incentive for G.Ps.



The incentive is represented as an increase in the price paid for medical transactions. It causes a decreasing refer fraction and, as explained before, an increase in the discharge fraction as well. Moreover, it causes the order back fraction to increase, leading to an increase in the number of patients ordered back. Because of the positive causal relationship between the order back rate and the patients treated by the G.P., the policy run exceeds the base-run as far as the number of patients treated by the G.P. is concerned. Since the decrease in refer fraction is not completely compensated by the increase in the number of patients treated by the G.P., the number of referred patients is reduced substantially. In other words, if the policy alternative does indeed affect the discharge- and refer fraction as explained earlier, it succeeds in reducing the number of referred patients by strengthening the section of the G.P. Whether the decreased number of referred patients does lead to a temporary or permanent reduction of the number of patients treated by the medical specialist need to be examined next. For it may well be that, according to the feedback loop depicted in Figure 3, medical specialists adjust their behaviour in order to compensate for the reduced inflow.

Figure 10: patients treated by specialist

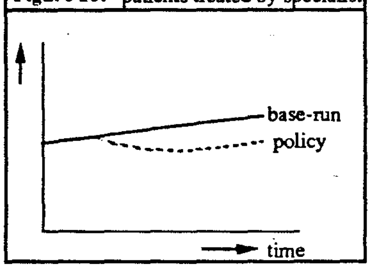


Figure 11: order back fraction of specialist

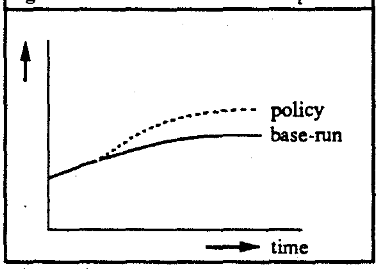


Figure 12: admission fraction

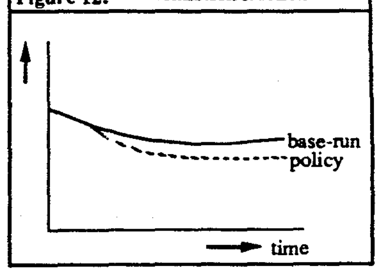
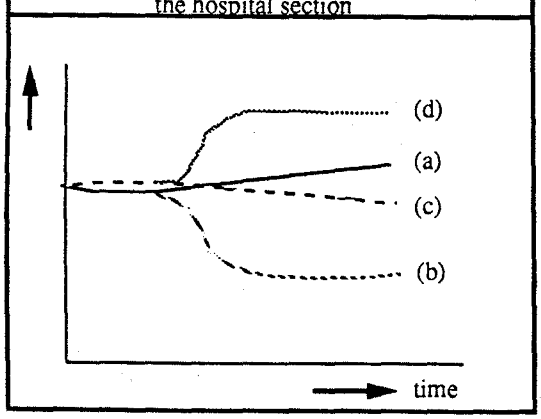


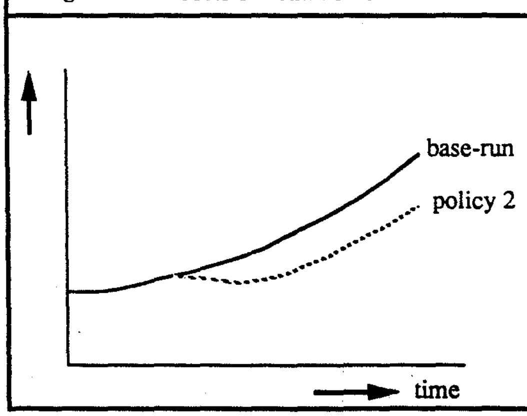
Figure 10 shows that specialists are unable to compensate completely for the decrease in inflow for the number of patients treated by them remains lower in the policy run than in the base-run. However, as depicted in Figure 11, some compensating treatment-intensification does take place. For instance, the ordered back fraction is increased (resulting to an increase in the number of patients treated by medical specialists), and less patients are being admitted into hospital, i.e. the admission fraction is decreased (Figure 12). As a result of the latter, the level 'patients admitted into hospital' decreases, leading to compensating actions of the medical specialists who work at the hospital. They increase for instance the length of stay of their patients in order to compensate the decreased occupation of hospital beds. The number of patients admitted into hospital and the length of stay are depicted in Figure 13.

Figure 13: effect of policy alternative 2 on the hospital section



— base-run : patients admitted into hospital (a)
---- policy 2: patients admitted into hospital (b)
— base-run : length of stay (c)
.... policy 2: length of stay (d)

Figure 14 : costs of health care



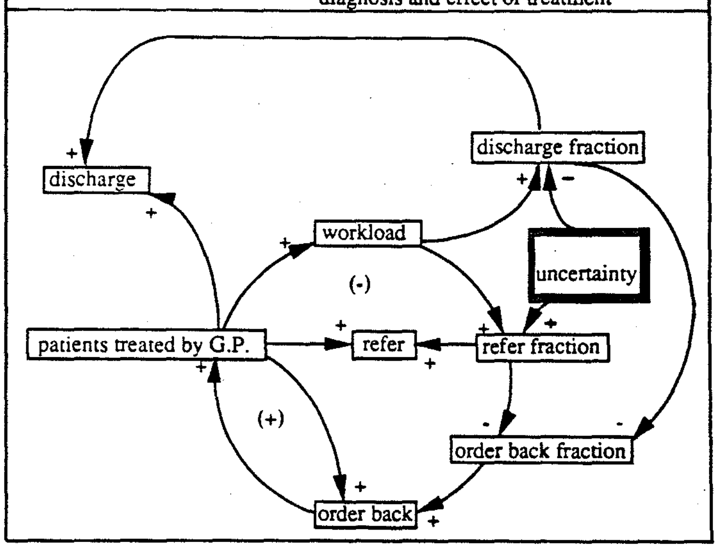
To summarize the effects generated by thé introduction of a financial incentive for G.Ps. to carry out minor medical transactions, it is clear that such a policy is capable of strengthening the section of the G.P. at the cost of the section of the medical specialist (and even of the hospital). The rise in volume of the G.P. section (more patients are treated by the G.Ps.) coincides with a decrease in volume of the medical specialist- and hospital section. As such, the policy appears to be succèssful in shifting patients from one section into another; from the right-hand side of the health care system back to the left-hand side. Moreover, as depicted in Figure 14, this shift coincides with a reduction of the cost of health care.

3.3 REDUCE UNCERTAINTY REGARDING DIAGNOSIS AND EFFECT OF TREATMENT

The third policy alternative aims to reduce the number of patients referred to a medical specialist by reducing the uncertainty general practitioners have regarding their diagnosis and the effect of their treatment. One way to accomplish this reduction of uncertainty is to have G.Ps. attend additional lectures concerning these two issues. It is thought that by providing lectures and subsequently reducing the uncertainty, a reduction in both the refer fraction and order back fraction can be accomplished. The refer fraction is reduced because G.Ps. who have more confidence in their diagnoses refer less patients to ask the medical specialist for a so called second opinion. The reduction in order back fraction is brought about by the fact that G.Ps. who are more confident regarding the effects of treatment, order less patients back to examine the effect of their treatment. The policy thus aims to reduce the number of patients ordered back 'just to make sure'.

Prior to the examination of the effects of this policy, we will, analogously to the presentation of the preceding two policy alternatives, provide a causal diagram to depict the way in which the policy is thought to affect the number of referred patients (Figure 15).

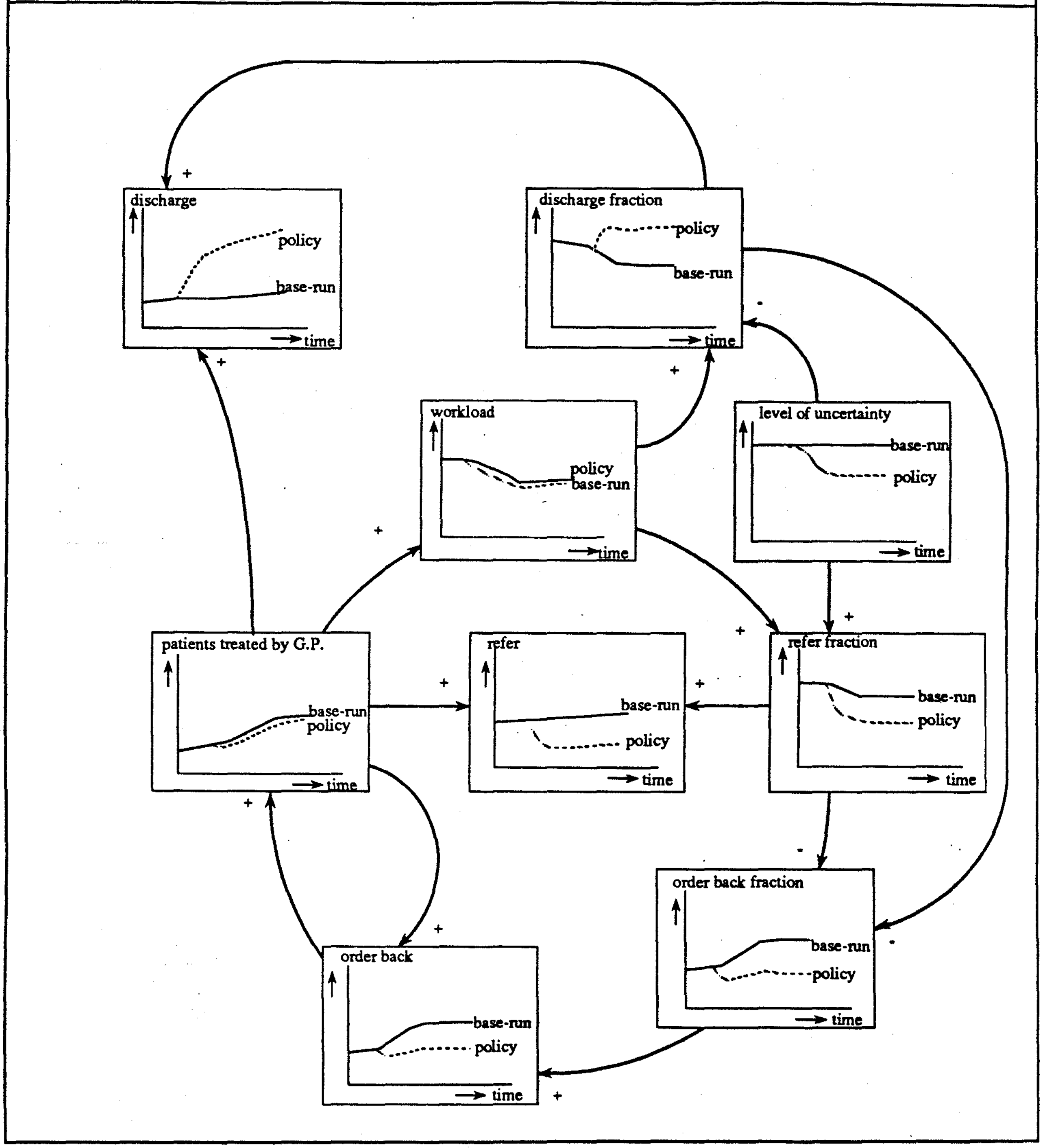
Figure 15: policy alternative 3 : reduce uncertainty regarding diagnosis and effect of treatment



Note that because of the fact that the refer-, discharge- and order back fraction always have to add up to 100 percent, the reduction in order back fraction has been conceptualized as an increase in the discharge fraction. As such it is identical to the second policy alternative. However, note that, in contrast to the second policy alternative, the increase in refer fraction is less than the increase in discharge fraction, as a result of which the order back fraction has to decrease to add up to 100 percent. Examination of the results will show that in spite of the complex way in which the third alternative appears to have been built into the model, the outcomes are in accordance with the way in which policy makers suggested the policy had to be implemented in the system dynamics model, that is decreasing both the refer and order back fraction.

To examine whether the reduction of uncertainty does indeed result in a reduction of the number of referred patients, we use Figure 16. Its structure resembles the structure of the causal diagram depicted in Figure 15 to facilitate the interpretation of the results.

Figure 16: Effects of policy alternative 3: reduction of uncertainty regarding diagnosis and effect of treatment



It is clear that the confidence G.Ps. have can only be increased gradually. This increase in confidence causes the refer fraction to fall and the discharge fraction to rise gradually, as a result of which the order back fraction decreases. Because of the decrease of order back fraction, the number of patients ordered back drops and the number of patients treated by a general practitioner falls as well. Note that in this case both the number of patients treated by the G.P. and the refer fraction affect the number of referred patients in the same direction, that is to decrease that variable. As a consequence, the influence the policy has on the number of referred patients is larger than in the preceding two policy alternatives.

The third policy thus succeeds in reducing the number of patients referred to the medical specialist: the flow called 'refer' is substantially decreased. However, as shown by the decrease in the number of patients treated by the g.p., the decreasing volume of the second section does not coincide with an increase in the volume and cost of the section of the general practitioner. Since the effects the third policy alternative has on the third and fourth sections of the health care system are identical to the effects that are brought about by the second policy alternative, that is, a decrease in the volume of these two sections, we will not extrapolate upon these effects in detail, but describe them in relationship to the other alternatives.

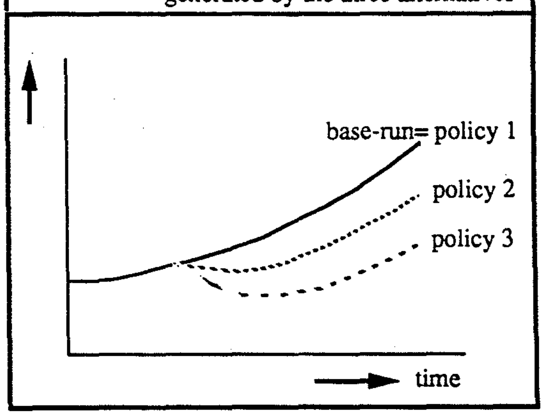
Summarizing and comparing the three policy alternatives

As to the first policy alternative, its aim was to decrease the number of referred patients by decreasing the general practitioner's workload. However, in spite of the reduction in workload and refer fraction, the number of referred patients remained constant because of the increase in the number of patients treated by the general practitioner. As a consequence, the cost of health care were not affected by the policy (figure 17).

Regarding the second alternative, it was thought that by increasing the number of medical transactions carried out by G.Ps., the number of referred patients would decrease at the cost of an increase in the number of patients treated by the general practitioner. As shown earlier, the volume of the section of the medical specialist was reduced at the cost of an increase in the volume of the g.p. section. However, because the decrease in costs produced by the medical specialist exceeded the increase in costs generated by the G.P., a reduction of the total costs of health care could be achieved (figure 17).

With respect to the third policy, reduction of the uncertainty led to a reduction of the order back and refer fraction. As a result, it did not only cause a decrease in the volume and cost of the g.p. section, but also of the section of the medical specialist. The reduction in costs therefore has been exceeding the reduction caused by the second alternative.

Figure 17 : comparing the costs of health care generated by the three alternatives



4. DISCUSSION AND CONCLUSIONS

In this paper we have been concerned with a system dynamics model of the Dutch health care system. We have used the model to examine the potential effects of policy alternatives aimed at reducing the number of patients referred by the g.p. thereby reducing the cost of health care. As such, it met one of the reasons for formalising and quantifying the original model: to provide a deeper understanding of the dynamics of the system, understanding which could not be acquired by means of the conceptual model alone.

As stated in the introduction, another reason for constructing the system dynamics model was to create a computer-assisted learning environment that could be used by policy makers to elicit their knowledge and assumptions regarding the problem of rising costs of health care. This computer-assisted learning environment will consists of the following three stages:

1. During the first session, policy makers are made familiar with the model's structure and are invited to

challenge the model. One way to accomplish this is to have them examine and discuss the effects of policy alternatives. If, as has been the case with the first policy alternatives, there exists a difference between what policy makers expect to result from policy alternatives and the actual outcomes of the model, policy makers are challenged to find out why such a difference has occurred, thereby automatically familiarizing themselves with the model's structure.

2. The second session is used to have policy makers think carefully about the model's environment and the way in which changes in this environment may affect the model and its behaviour. The growing number of people of 65 and over, for example, will be discussed in this session for it is thought that it will affect the health care system's behaviour substantially in the near future.
3. Finally, policy makers are invited to carry out policy runs themselves based on the way théy think the problem should be modelled and based on policy alternatives théy think are important to examine in light of the information acquired in the first and second session.

For a more detailed description of the way in which the system dynamics model is used in the computer-assisted learning environment, we refer to Vennix, Verburgh, Gubbels, Post (1990).

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