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Risk Selection and the Specification of the Conventional Risk Adjustment Formula.

by

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DISCUSSION
PAPER

Risk selection and the specification of the conventional risk adjustment formula*

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Abstract

We argue that a sharp distinction must be made between the empirical problem of finding the best equation to *explain* medical expenditures and the *normative* question of deriving capitations which give health plans the appropriate incentives for efficiency. We propose a procedure, taken from the social choice literature, to go from the estimated equations to the capitations. If the estimated equations are not additively separable in legitimate and illegitimate risk adjusters, it is impossible to remove all incentives for risk selection while respecting at the same time a straightforward requirement of horizontal equity. In so far as the conventional risk adjustment literature only includes so-called "legitimate" risk adjusters in the estimations, its results may suffer from omitted variables-bias. Moreover, it is necessary to introduce health plan behaviour in the estimated equations. We illustrate our general methodological points with empirical results, obtained from a cross-section of 321,111 Belgian patients.

*The empirical work in this paper is based on a databank, financed by and constructed under the supervision of the Belgian Health Administration (RIZIV/INAMI). The construction of this databank has been joint work with Paul Kestens and his collaborators (DULBEA, University of Brussels). Neither RIZIV/INAMI nor DULBEA are responsible for the ideas expressed in this paper, however. Moreover, the estimation results in the following sections are provisional. They are only used to illustrate the methodological points in the paper and should not be seen as a concrete proposal for a new capitation formula in Belgium. We thank Marc Fleurbaey, Wynand van de Ven, Eddy van Doorslaer and the participants of the ISPE-conference (especially our discussants Tom McGuire and Amir Shmueli) for many useful comments.

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1. Introduction

In many countries the move towards prospective financing of health plans has been accompanied by the gradual introduction of risk adjustment schemes. Fairness considerations are important in countries where a central authority has to allocate the financial means over various regional authorities. They also play a role in countries with premium regulation and (most often partially) prospective financing of competitive health plans[1]. But in the latter systems there is an additional consideration: the risk adjustment scheme has to be designed so as to minimize the danger of cream-skimming. Policy makers are then confronted with a difficult trade-off. They introduce prospective payments to create incentives for efficiency. These prospective payments, however, create a potential danger of risk selection. We will use the latter broad term to indicate all behaviour by health plans which leads to the socially unacceptable unequal treatment of individual patients (either through unequal access or through differences in quality of services). The purpose of risk adjusting the prospective payments is to reduce the incentives for such risk selection[2]. In this paper we focus on the specification of the risk adjustment formula in a competitive environment.

This question has received much attention from the policy-makers in the different countries involved. In the first place they have to decide about the variables to include, the so-called risk adjusters. Although in actual practice the choice has been most often determined by considerations of data availability, there is at the same time a consensus that ideally the risk adjusters should reflect the health risks of the insured population. However, the clause "socially unacceptable" in our definition of risk selection is crucial. Not all the factors which influence medical expenditures are considered to be legitimate risk adjusters: think about differences in drinking and smoking behaviour, or about interregional differences in the practice style of the medical profession. The choice of which variables to include is in the first place a normative issue which is determined by the dominant social values about (the limits of) solidarity.

In the second place, the weights to be given to the different risk adjusters have to be fixed. Current practice uses empirical information on actual expenditure patterns to estimate these weights. Average historical costs per group have played

[1] Van de Ven and Ellis (1999) describe the concrete situation in eleven countries which have introduced risk adjustment within a scheme of prospective financing of competitive health plans. Rice and Smith (1999) include in their overview also many countries with a health care system of the NHS-type.

[2] Because we focus on situations with a universal compulsory health insurance scheme, we concentrate on the behaviour of health plans. We therefore neglect the possibility that risk adjustment can also be used to reduce the problems following from consumer behaviour in the case of adverse selection - see, e.g., Keeler et al. (1998).

a dominant role in these calculations. Some countries have based the capitation amounts for different groups on simple cell means, where the cells are defined on the basis of demographic variables (mostly age and gender). Where sufficient individual data are available one can improve upon this procedure through the estimation of a medical expenditure function. Of course, if the model is linear and all the explanatory variables are dummies we are back in a somewhat more sophisticated version of the cell means approach. Again, actual applications have been determined mainly by considerations of data availability. In countries where such individual data are not available, there have been attempts to derive the risk adjustment formula through estimation with aggregate data at a regional level (Carr-Hill et al., 1994, Schokkaert et al., 1998). It is obvious that the latter method is not sufficiently refined to remove the danger of risk selection in a competitive environment.

Policy makers have been looking at the academic world for econometric advice about the risk adjustment scheme to be used. There is by now a huge literature comparing the statistical performance of various risk adjusters and analysing their potential to curb risk selection. Large sets of individual data have been used to show the limited explanatory power of demographic variables and the importance of introducing more direct information on health status (see van de Ven and Ellis, 1999, for a survey including the most important references). While the large bulk of this literature has concentrated on statistical aspects and "typically uses explained variance to judge the goodness of risk adjusters" (Newhouse, 1996), there also seems to be a growing awareness about the normative aspects of the question. What to do with statistically significant but illegitimate risk adjusters? These worries are strengthened by some recent theoretical papers, which analyse the risk adjustment question basically as a second best-pricing problem (Lewis and Sappington, 1997, Ellis, 1998, Glazer and McGuire, 1998, Encinosa, 1999). It turns out that it is crucial to incorporate the behavioural reactions of the health plans into the analysis. Optimal risk adjustment does not generally require the capitations to equal average costs. At this moment, there is a rather large gap between this theoretical literature and the empirical work on "estimating" risk adjustment schemes.

With this paper we try to bridge part of that gap. Our starting point is the conventional empirical risk adjustment literature and we will illustrate our ideas with empirical results from a sample of 321,111 Belgian patients. In section 2 we summarize the point made by Schokkaert et al. (1998) that recent theories of responsibility-sensitive fair compensation offer a useful framework to analyse the tension between the econometric and statistical work on the one hand and the normative questions on the other hand. The notion of risk selection will be formalised taking explicitly into account the difference between legitimate and il-

legitimate risk adjusters, between "compensation" and "responsibility"-variables. In this paper we concentrate on the implications of this theoretical approach for the direction of further empirical work. We therefore put ourselves in the position of an econometrician who has to give concrete advice about the risk adjustment scheme to be implemented. Our real-world background is the Belgian situation, as sketched in section 3. Section 4 shows some empirical results concerning the introduction of (il)legitimate risk adjusters in a simple linear model, estimated with individual data. In section 5 we comment on the implications for risk selection of working with a non-linear model. Section 6 offers some very first insights on the importance of modelling explicitly the behaviour of the health plans. Section 7 concludes.

2. A simple model of responsibility-sensitive risk adjustment

Let us first take the position of an empirical economist who wants to explain and/or predict individual medical expenditures. She will estimate a function relating individual medical expenditures x_i to a set of individual and environmental characteristics a_i:

$$x_i = f(a_i) \quad i = 1, ..., n \tag{2.1}$$

In this section we will neglect the appearance of a stochastic error term in (2.1). We will return to its treatment in the following section. We suppose that the function $f(.)$ is monotonous and we define the variables a in such a way that $\forall i,\ \frac{\partial f}{\partial a_i} \geqslant 0$. The functional form $f(.)$ and the variables to be included in the model will be chosen on the basis of theoretical and empirical considerations. A whole range of potential variables can be considered. Demographic variables such as age and gender definitely are important but not sufficient. Additional information on morbidity considerably increases the explanatory power of the regressions. Economic, environmental and behavioural factors also play a role: think about the importance of income and social class or about the influence of smoking and drinking behaviour. Moreover, there is much evidence on interregional variation in medical expenditures, linked to differences in factor prices or in the practice style of the medical profession. As to the functional form, there is a large literature comparing different approaches to capture the empirical phenomena of (a) a large fraction of zero medical expenditures in the individual data; (b) the non-existence of negative medical expenditures; (c) the right skewed distribution of the positive observations on medical expenditures (see Jones, 1999, for an overview). Our empirical economist has to solve a whole series of difficult but interesting questions.

The purpose of the estimation exercise, however, is to give advice to a central fund, which has to decide about the allocation of a total amount ω over different health plans $v(v = 1, ..., V)$ through a set of prospective but risk adjusted capitation amounts. We assume that the amount ω is fixed a priori by the central fund. Therefore, there is in general no reason why ω would exactly cover total medical expenditures ex post. The difference $\sum x_i - \omega$ has to be paid for by the health plans, i.e. they have to cover all costs. For simplicity, we assume that there are no copayments to be paid by the patients. Moreover, health plans are not allowed to differentiate the premia for different groups of patients. The purpose of the risk adjustment is then to reduce the incentives for risk selection. These incentives to treat patients differently are directly linked to the monetary loss or gain made on the patients, which can be written as

$$\pi_i = \omega_i - x_i \tag{2.2}$$

where ω_i denotes the amount received for individual i by the health plan which includes i among its members (with $\sum_i \omega_i = \omega$)[3].

Equation (2.2) immediately suggests that the capitation payments will have to be related in one way or another to the differences in medical expenditures. It is therefore not surprising that empirical information plays a crucial role everywhere capitations have been introduced. But, as noted before, not all significant explanatory variables are acceptable as risk-adjusters. Actual expenditures will also reflect the existing inefficiencies in the system, which the prospective payment scheme is aiming to remedy. It is therefore better to assume that the capitation payments have to reflect an "acceptable" cost level (van de Ven and Ellis, 1999), i.e. the expenditures to deliver medically necessary care in a cost-effective way. It is then no longer obvious how to use the information from the estimated expenditure function (2.1). The central fund will have to take an explicit decision about what risk-adjusters are considered as legitimate for the calculation of ω_i, in the sense that they contribute to the definition of the "acceptable" cost level. Let us denote these "compensation"-variables as a^C. It seems reasonable to assume that $a^C \subseteq a$, since it is not sensible for the central fund to work with risk adjusters that have no influence on medical expenditures. However, typically the central fund will not want to include all variables a: we have mentioned already the examples of drinking and smoking behaviour, or of differences in practice styles[4]. Let us

[3]This expression completely neglects the fact that the incentives for risk selection will be determined by *future* and not by actual expenditures and that these future expenditures are uncertain. A more adequate approach would be to define $E(\pi_i) = \omega_i - E(x_i)$. However, in this section no additional insights are gained by this complication and we keep to the assumption that the stochastic error terms in (2.1) can be neglected. We will return to this issue in the next section.

[4]Let us emphasize that we mention these cases only as examples. The exact split between

denote by a^R the "responsibility"-variables which have an influence on medical expenditures, but are not included in the set of risk adjusters, i.e. $a^R = a \setminus a^C$. The health plans will remain responsible for differences in medical expenditures linked to these a^R-variables. Using this notation we can write an adapted version of (2.1):

$$x_i = f(a_i^C, a_i^R) \tag{2.3}$$

Against this background it is now possible to formulate two requirements on the risk adjustment scheme. The first can be summarized as follows:

Axiom 1. ***(NICI)*** *For any two individuals i and j with $a_i^C = a_j^C, \omega_i = \omega_j$.*

If two individuals have exactly the same value for all legitimate risk adjusters (for all compensation variables) the health plans should get the same subsidy for these two individuals. All risk adjustment schemes in the world satisfy this apparently innocuous horizontal neutrality assumption.

Moreover, it is also possible to formulate the "no incentives for risk selection" requirement in a precise way. We noted already that these incentives are related to differences in π_i. However, not all these differences have to be avoided. If differences in π_i follow from factors for which the central fund does not want to compensate there is no problem. We will therefore consider two individuals which have the same value for all responsibility variables a^R, i.e. which differ only in the values of some accepted risk adjusters. In that case we want to avoid incentives for differential treatment of these individuals, i.e. we want to impose

Axiom 2. ***(NIRS)*** *For any two individuals i and j with $a_i^R = a_j^R, \pi_i = \pi_j$.*

The interpretation of *NIRS* is easy. If two individuals have the same value for the responsibility variables, they differ only in the level of legitimate risk adjusters. These differences should *not* lead to differential treatment of the individuals, because this would involve socially unacceptable risk selection. Therefore, the risk adjustment scheme should remove the incentives for such differential treatment. Note that *NIRS* immediately implies

$$\forall i, j : a_i^R = a_j^R, a_i^C > a_j^C, \omega_i > \omega_j \tag{2.4}$$

or: to avoid risk selection, health plans must receive a larger capitation for individuals with a larger value for the risk adjusters.

"compensation" and "responsibility"-variables implies difficult ethical and/or political questions, upon which we do not want to elaborate in this paper. We simply assume that the decision-maker takes an explicit decision on this point and we take his decision as given.

Note also that, following an analogous reasoning, *NICI* implies

$$\forall i,j : a_i^C = a_j^C, a_i^R > a_j^R, \pi_i < \pi_j \tag{2.5}$$

Equation (2.5) shows that imposing a seemingly innocuous axiom of horizontal neutrality has strong consequences. This explains why Schokkaert et al. (1998) have interpreted *NICI* in a more ambitious way ("no incentives for cost inflation"). Health plans have to bear themselves the higher expenditures, resulting from differences in the a^R-variables. This may give them the incentive to curb inefficiency[5]. However, it also may induce incentives for selection of certain individuals (see the interpretation in Shmueli, 1999): if smoking and drinking habits are not included in the list of risk adjusters, health plans will make predictable losses on smoking and drinking individuals. If differences in practice styles are regionally determined, health plans may be motivated to leave certain "expensive" regions and concentrate their activities in other regions. However, in our setting -and given that a decision has been taken on the partitioning of the explanatory variables into legitimate "compensation" and illegitimate "responsibility"-variables- this kind of behaviour does not reflect "socially unacceptable risk selection"[6].

Schokkaert et al. (1998) have argued that the formal setting of this problem is similar to the analysis of responsibility-sensitive fair compensation in the recent social choice literature (Fleurbaey, 1994, 1995, Bossert, 1995, Bossert and Fleurbaey, 1996)[7]. It turns out that the rather straightforward axioms *NICI* and *NIRS* have very strong consequences for the risk adjustment scheme. A first important result is the following

Proposition 2.1. *(Bossert, 1995, Bossert and Fleurbaey, 1996) If the medical expenditure function $f(.)$ is additively separable in the variables a^C and a^R, i.e. if $\forall i, f(a_i^C, a_i^R) = g(a_i^C) + h(a_i^R)$, then the following natural mechanism satisfies both NIRS and NICI:*

$$\omega_i = \frac{\omega}{n} + g(a_i^C) - \frac{1}{n}\sum_k g(a_k^C) \tag{2.6}$$

[5] Efficiency is interpreted here in the sense of cost containment. The possibility of quality distortions (Glazer and McGuire, 1998, 1999) is not modelled explicitly. It will turn out later that in the empirical context of many European countries in general, and Belgium in particular, quality competition between insurers is very limited.

[6] Let us emphasize once again that this is a normative statement and that in this paper we do not want to discuss in detail the possible motivations leading to the partitioning of the set of explanatory variables. We take this partitioning as determined by the decision-makers and therefore as given for the analyst. We concentrate on the methodological implications of the fact that there is such a partitioning and our examples are only meant to be examples.

[7] See Fleurbaey (1998) for a general overview.

It is obvious that mechanism (2.6) indeed satisfies both requirements. Moreover, it can be derived from the more general results in Fleurbaey (1995) that adding a rather weak consistency assumption to *NIRS* and *NICI* is sufficient to characterise the mechanism. To interpret (2.6) it is useful to define so-called "normative expenditures" of individual i as

$$N_i = g(a_i^C) + \frac{1}{n}\sum_k h(a_k^R) \tag{2.7}$$

Differences in expenditures following from differences in the a^C-variables are fully taken into account in the definition of the normative expenditures. For the a^R-variables, however, only the average value is used as a normative reference point[8]. Using (2.7) the natural mechanism can also be written as

$$\omega_i = N_i + \frac{\omega}{n} - \frac{1}{n}\sum_k (g(a_k^C) + h(a_k^R)) = N_i + \frac{\omega}{n} - \frac{1}{n}\sum_k x_k \tag{2.8}$$

Although the natural mechanism (2.6) may look rather convoluted, this only follows from the imposition of a budget constraint. As (2.8) shows, if $\omega = \sum_k x_k$, i.e. if the total subsidy is just sufficient to cover total medical expenditures of all health plans, then the natural mechanism boils down to the simple rule

$$\forall i, \;\; \omega_i = N_i \tag{2.9}$$

This is the approach which is often adopted in practice. To simplify the exposition, we will later on neglect the presence of a binding budget constraint in our empirical illustrations, i.e. we will work with (2.9). However, it is important to emphasize that proposition 1 shows that there is only one correct way of "adapting" (2.9) in the situation of a binding budget constraint- and this is the method described in (2.6).

While proposition 1 is an interesting result in the specific context of risk adjustment, the social choice literature has spent much more attention on

Proposition 2.2. *(Bossert, 1995, Fleurbaey, 1994,1995) If the medical expenditure function $f(.)$ is not additively separable in the variables a^C and a^R, then no risk adjustment scheme can satisfy both NIRS and NICI (if $n \geqslant 4$).*

The implications of this result are very strong. If the central fund does not want to depart from horizontal neutrality (as defined in *NICI*) it will be impossible

[8]The concept of "normative expenditures" gives a concrete content within our setting to the notion of "acceptable costs" in the terminology of van de Ven and Ellis (1999).

to satisfy *NIRS*. This conclusion is not dependent on the availability of information or on the imperfect knowledge about the medical expenditure function (2.1): it basically follows from the fact that *NICI* imposes strong restrictions on the choice of the vector of instruments $(\omega_1, ..., \omega_n)$. If the central fund is willing to give up horizontal neutrality, it could opt for the so-called egalitarian-equivalent mechanisms (Bossert and Fleurbaey, 1996, Schokkaert et al., 1998), which satisfy *NIRS:*

$$\omega_i^{EE} = \frac{\omega}{n} + \left\{ f(a_i^C, a_i^R) - f(\widetilde{a}^C, a_i^R) - \frac{1}{n} \sum_k \left[f(a_k^C, a_k^R) - f(\widetilde{a}^C, a_k^R) \right] \right\} \quad (2.10)$$

where $\widetilde{a}^C$ is a freely chosen benchmark vector. This expression can be simplified by bringing together all individual-independent elements in a constant κ:

$$\omega_i^{EE} = \kappa + f(a_i^C, a_i^R) - f(\widetilde{a}^C, a_i^R) \quad (2.11)$$

which shows immediately that π_i does not depend on the level of the legitimate risk adjusters a_i^C and that in this sense all incentives for risk selection have been removed.

However, we do not have the impression that a system in which health plans get different capitations for individuals within the same (acceptable) risk category will become politically feasible in the short run. Therefore, in reality the central fund will have to content itself with a risk adjustment scheme which does not take away all incentives for risk selection. Here also, Bossert and Fleurbaey (1996) have a suggestion. They propose the family of so-called conditionally egalitarian mechanisms:

$$\omega_i^{CE} = \frac{\omega}{n} + \left[f(a_i^C, \tilde{a}^R) - \frac{1}{n} \sum_k f(a_k^C, \tilde{a}^R) \right] \quad (2.12)$$

where $\tilde{a}^R$ is again a freely chosen benchmark vector. To understand (2.12) it is useful to write it as

$$\omega_i^{CE} = \lambda + f(a_i^C, \tilde{a}^R) \quad (2.13)$$

where λ is a constant amount, the same for all individuals i and introduced to satisfy the budget constraint. If $\omega = \sum_k x_k$, then we see immediately that $\lambda = (1/n)(\sum_k x_k - \sum_k f(a_k^C, \tilde{a}^R))$. Expressions (2.13) and (2.2) imply

$$\pi_i^{CE} = \lambda + f(a_i^C, \tilde{a}^R) - x_i \quad (2.14)$$

Expression (2.13) shows that the conditionally egalitarian mechanism (2.12) indeed satisfies horizontal neutrality. At the same time, (2.14) indicates that it

does not satisfy *NIRS*, since π_i will in general depend on a_i^C. However, (2.12) satisfies a weaker axiom[9], which can be described as follows

Axiom 3. *(**NIRSREF**) For any two individuals i and j with $a_i^R = a_j^R = \tilde{a}^R, \pi_i = \pi_j$.*

We will analyse in sections 5 and 6 some of the implications of proposition 2 in the context of risk adjustment.

3. Our real-world background: Belgium[10]

To analyse the empirical implications of the approach sketched in the previous section, we will make use of Belgian data. Health insurance in Belgium is compulsory and centralised. The insurance cover in the compulsory system is very broad. All insured pay an income-related premium to a central fund. The sum of all these contributions is supplemented by a subsidy from the central government, financed out of general tax revenue. The management and administration of health insurance is left to about one hundred local sickness funds, which are grouped into five national associations of private sickness funds and one (residual) public fund[11]. These historically developed along political and religious lines: the socialist and the christian mutualities are dominating. The central fund distributes the financial resources over the sickness funds. The market for compulsory health insurance is closed for new entrants. In each region there are therefore at most six competing health plans. The insured can choose their own sickness fund and can change sickness fund every three months. They pay a small flat rate premium to the sickness fund of their choice. This premium can be different for different sickness funds but must be community rated within a sickness fund. Sickness funds have to enroll all interested members. They can compete for new members by offering supplementary insurance and by the quality of their services (including the speed of settling claims). In the compulsory scheme, selective contracting with providers is not allowed. The sickness funds negotiate as a cartel with the providers to fix the official fee schedule. However, they have more individual freedom in the supplementary insurance market. It is well known that this offers ample scope for risk selection, even when there is forced enrollment and

[9] See Bossert and Fleurbaey (1996) for a complete characterisation of both the egalitarian-equivalent and the conditional-egalitarian mechanisms.

[10] A more detailed description of the Belgian system of health insurance and risk adjustment is given in Schokkaert and Van de Voorde (1999).

[11] In addition there is a specific sickness fund for the employees (and pensioners) of the National Railway Corporation.

some official quality control (van de Ven and Van Vliet, 1992, and for a theoretical analysis Kifmann, 1999). Citizens can freely choose their doctors, which are remunerated through a fee-for-service system. About 25% of the expenditures are covered through the own payments of the patients, the remainder is reimbursed by the insurers.

Before 1995 the sickness funds got basically all their expenditures reimbursed by the central fund. Since 1995 there is a gradual shift towards a system of prospective risk-adjusted capitations. Each year the government fixes ex ante an overall budget: this is the Belgian equivalent of ω in the previous section. Normative expenditures are derived from a regression analysis with aggregate (per capita) data at the level of the local sickness funds. Since the regression equation is a simple linear specification, the additive separability-assumption is satisfied and the rule from proposition 1 can be applied. Because there is no a priori reason why one would have $\omega = \sum_i x_i$, the risk-adjusted capitations are computed with (2.6) or (2.8). While medical supply (provider density) is a significant variable in the estimated regressions, it was decided by the policy makers and by the central fund to treat it as an a^R-variable. The effect of medical supply is therefore averaged out to calculate N_i as in (2.7). We will return to this choice in the following section.

It is well known that the use of aggregate data does not give sufficient information to remove all the incentives for risk selection in a competitive environment[12]. Moreover, the Belgian government wanted to be cautious in introducing a reform which was perceived as a real break with the historical tradition. Therefore it implemented a risk-sharing system in which the subsidy received by the sickness funds S_i does not equal ω_i but is determined partly by actual expenditures. In addition, the individual sickness funds are only responsible for a fraction of the difference between their actual expenditures and their subsidies: the remainder is covered by a mechanism of redistribution between the sickness funds[13]. Even with all these safety measures, there is still a real danger of risk selection. Moreover, the weight of the prospective capitations in the subsidy scheme and the degree of individual financial responsibility are planned to increase over time (Schokkaert and Van de Voorde, 1999). It is therefore important to think about the refinement

[12] Note the difference between the English and the Belgian system. In both the risk adjustment formula is based on aggregate data. However, in England the scheme is used to distribute the financial means over different regional authorities. As there is no real danger of risk selection, the objective of overall fairness is dominating. On the contrary, in Belgium health plans are operating in a more or less competitive environment and there is a threat of risk selection. The use of aggregate data is much less satisfactory in the latter than in the former situation.

[13] In 1999 normative expenditures had a weight of 0.20 in the determination of the subsidy received by the sickness funds. These funds were responsible for 20% of the difference between their actual expenditures and the subsidy.

of the risk adjustment formula using individual data.

To this end a large databank with individual information has been set up by the sickness funds under the supervision of the central fund. This databank contains for a representative sample of individuals from all the sickness funds (a) the medical expenditures in 1995, as reimbursed by the sickness funds and therefore *not* including the own payments of the patients[14]; (b) all individual information on social and economic characteristics which is available from the sickness funds and the central fund; (c) additional information on regional variables (such as population density and the number of medical providers). In the future, the databank will be complemented with diagnostic information, but this is not yet available at this stage. Moreover, in the future a panel will be constructed for the period 1995-1999. However, even without this morbidity information and with only one cross-section available, the material is rich enough to offer the opportunity of improving considerably upon the prevailing scheme. At this stage, the data for 1995 have been controlled and (provisionally) deemed sufficiently reliable for four mutualities. Since it is impossible to follow the identity of the individuals when they move from one sickness fund to another, we will only use the data for all individuals who have remained with the same sickness fund for the whole year 1995. Those who are born in 1995 or died in that same year were also included. Since the number of moves is rather limited and -in the present situation- not related to the morbidity or the expenditures of the insured, this does not bias our sample. The estimates in the following sections are based on a resulting sample of 321,111 individuals, which is representative for the whole Belgian population (including all age groups in both the active population and the pensioners, and also the disabled)[15]. Per capita (reimbursed) health expenditures (without medicines) amount to 38,299 Belgian francs, i.e. 949 Euro.

4. Conventional risk adjustment with a linear model

In this section we will first discuss what can be called the "standard procedure" in the conventional risk adjustment literature[16]. This procedure has the following

[14] Expenditures for medicines can not be allocated by the sickness funds to their individual members, since they are paid within a third-payer arrangement. They are therefore *not* included in our concept of medical expenditures.

[15] The self-employed are not included in the sample, since they have in Belgium a separate and different health insurance system, in which the compulsory scheme covers only the so-called large risks.

[16] We are fully aware that this is an extremely dangerous statement. There are very probably examples in the literature which do not follow the sketched procedure. However, our judgment follows van de Ven and Ellis (1999)- although they are more in sympathy with the traditional approach than we are.

characteristics:

(a) One works with a simple linear model. There are good reasons for this choice. In the first place, with very large samples the robustness of OLS regression is an attractive property. More complicated functional forms -such as two-part models with a logarithmic specification for the second part- often raise difficult statistical problems of retransformation, certainly when the error term is heteroskedastic (Mullahy, 1998). In the second place, the final purpose of the estimation exercise is to derive an understandable and flexible risk adjustment formula, which can be interpreted correctly and used by policy makers. The simple linear model stays closely to the cell-based approach, which is used so often in practice. We will return to the choice of functional form in the following section.

(b) The analyst takes an explicit decision about what risk adjusters are acceptable and includes these variables in the equation to be estimated. Other variables are omitted. This is not always due to data considerations. To give but one example: in the pathbreaking work on diagnostic cost groups (Ellis et al., 1996; Lamers, 1998) it is quite explicitly stated that some diagnostic groups are exluded from the estimations because of the concern for discretionary admission and for creating inappropriate incentives. This basically implies that normative considerations influence the specification of the functional form to be estimated. We will analyse the implications of this procedure in section 4.1.

(c) In going from the estimated equation to the capitation formula the disturbances are simply neglected. This choice is discussed in section 4.2.

4.1. What variables to include?

Opting for a linear specification, we can write (2.3) as follows

$$x_i = \alpha_0 + \alpha' a_i^C + \beta' a_i^R + u_i \tag{4.1}$$

where we make an explicit distinction between the vectors of "legitimate" and "illegitimate" risk adjusters a_i^C and a_i^R respectively and where we now introduce a stochastic error term u_i. In (4.1) the parameters to be estimated are given by $[\alpha_0, \alpha, \beta]$. The standard procedure however consists of estimating (4.1), but with the a^R-variables omitted. If (4.1) is the true model, this may lead to an omitted variables-bias. Are there any good reasons for this omission?

An explicit discussion of the problem can be found in the work of the York-group on the English capitation scheme for regional authorities (Carr-Hill et al., 1994). They estimate the expenditure equation with aggregate data at a regional level. The relevant a^R-variable is "medical supply" and is deliberately omitted from the final estimated equation. The argumentation to do so rests on the problem of simultaneity bias. Medical supply is partly endogenous, i.e. dependent

on the regional differentiation in morbidity and, hence, medical expenditures. Including medical supply in the estimated equation would then lead to an underestimation of the total effects of the morbidity-variables, because the indirect link via medical supply is neglected. The procedure of estimating (4.1) with medical supply excluded can be interpreted as a direct estimation of the reduced form, which is what really matters for the correct calculation of the capitations. An alternative approach with aggregate data at a regional level is followed in Belgium (Schokkaert et al., 1998, Schokkaert and Van de Voorde, 1999). In this approach, (4.1) is estimated with medical supply included and the capitations are then computed with formula (2.6). This Belgian procedure underplays the simultaneity problem and rather focuses on the omitted variable-bias which results if one leaves out medical supply from the "true" model (4.1). With aggregate data, a way out of this dilemma can probably only be found in the estimation of a complete multi-equation structural model, in which one then will have to indicate explicitly what are "legitimate" and "illegitimate" components of the medical supply effect.

As soon as one starts working with individual data, however, the argument of simultaneity bias loses much of its force and only the potential omitted variables-problem remains. We then do not see any good theoretical reason for the standard procedure of omitting the a^R-variables from the estimated equation. As we have shown in section 2, the legitimate concern not to create inappropriate incentives can be perfectly met by using (2.7) to compute the capitation payments. Of course, it is possible that the omitted variables-bias is not a serious problem, because the correlation between the a^C-variables and the excluded a^R-variables is negligible. But this will depend on the dataset analysed and can hardly be a general argument for use of the standard procedure.

Table 1. Estimation results

The problem is illustrated for our empirical data in the first two columns of Table 1. The first column shows the estimation results of what could be seen as an example of the standard procedure[17]. The "legitimate" risk adjusters included are a series of age-gender dummies[18], additional dummies for deaths, for the disabled (for more and less than 1 year) and for the individuals with a preferential treatment[19], and a number of environmental variables: housing quality (an indicator

[17] The standard errors are made heteroskedasticity-consistent with the White-correction.

[18] The reference category is a man between 25 and 30 years old.

[19] Our sample contains a group of individuals (low-income pensioners, disabled, widowers, widows and orphans) with a so-called "preferential treatment". Their co-payments are lower.

of unfavourable socioeconomic circumstances) and housing density (an indicator of urbanisation). The non-dummy variables are calculated as deviations from the mean. All these variables get the expected signs and are significant. The R^2 is relatively high, which can be explained by the fact that we work with a sample of the whole population, including children and pensioners. The variance in medical expenditures is large but at the same time a large part of this variance can be explained by demographic variables (see also van de Ven and Ellis, 1999). This reasonably well estimated equation leads to the normative expenditures for some "typical" individuals in the first column of Table 2. For the computations in Table 2 all the variables which do not appear explicitly in the description of the types are put at the value of their sample mean.

However, our dataset also contains some information on variables which influence medical expenditures but could be interpreted as "illegitimate" risk adjusters. A first example is the variable "medical supply", which was already introduced in the discussion about the York-procedure and plays an important role in the Belgian political debate. A second example is the variable "loyalty to a general practitioner", which we calculate as the (individual-specific) ratio of the number of consultations with a preferred general practitioner over the total number of consultations with a general practitioner[20]. In the Belgian context patients are free to consult directly a (more expensive) specialist and many argue that a strenghthening of the gatekeeper-role of the general practitioner could reduce medical expenditures per capita. *If* this is indeed the case, we would expect to find smaller expenditures for patients who are more loyal to their GP. Since it seems reasonable that the central fund would like to stimulate this behaviour (and would like to give the insurers the appropriate incentives to stimulate this behaviour) the insurers should be allowed to reap the fruits of the larger loyalty, i.e. the variable should *not* be included in the capitation formula. Estimation results for the broader model, including medical supply and GP-loyalty are shown in the second column of table 2[21]. Both variables have a significant effect.

Table 2. Normative expenditures with a conventional and a complete model

Since our dependent variable represents reimbursements, it will be larger for this group even if their medical consumption were the same. If there is in addition a moral hazard effect, this will further increase the effect of "preferential treatment" in our estimations.

[20] For those individuals who did not have any consultation with a general practitioner in 1995, the effect of this variable was neutralised by giving them the average value in the sample.

[21] Again, both variables are defined as deviations from the mean.

For our discussion, it is interesting to look at the effects of introducing the a^R-variables on the estimates of the other coefficients. In general, these are relatively minor, indicating that the omitted variables bias in the first column remains limited. There are some serious shifts in the point estimates of older men and of housing density, however. Therefore, the normative expenditures shown in the second column of table 2 also show some nonnegligible differences. For a male child (younger than five) living in a densely populated area of low housing quality (a suburb?) the overestimation with the conventional approach amounts to 4,327 BEF (107 Euro) or 18% of the estimate with the complete model. For an old man (aged between 75 and 80) living in a similar area the conventional model yields an overestimate of 3,183 BEF (79 Euro, or 4% of the "correct" amount). Similar differences could be shown for some other groups, as suggested by the coefficients in Table 1. Moreover, as emphasized before, the finding of relatively minor differences is contingent on the data used and could change with the inclusion of other a^R-variables. One can only be sure by checking the correlation between the legitimate and the illegitimate risk adjusters.

Let us conclude. Given the ease with which it is possible to go from a full estimated equation to a capitation formula including only legitimate risk adjusters, there seems to be no reason at all not to include all available and potentially relevant explanatory variables in the equations to be estimated. So doing, one can be sure to minimize the problem of omitted variables-bias. Moreover, from a broader scientific point of view it seems eminently sound to distinguish explicitly between the *explanatory* exercise on the one hand and the *normative* decisions w.r.t. the determination of legitimate risk adjusters on the other hand. In the first step one thinks as a social scientist trying to get a better insight into observed behaviour and including all theoretically relevant explanatory variables. In the second step one takes the position of a policy maker who wants to create appropriate incentives- where "appropriate" can only be defined in a meaningful way on the basis of a well-defined ethical framework. In the standard procedure of conventional risk adjustment, these two sets of considerations get mixed.

This statement also has immediate consequences for a simple cell-based approach: if the cells (as usual) are defined only on the basis of the legitimate risk adjusters, the results are equivalent to the ones obtained by a linear estimation of (4.1) with only a^C-variables included. In so far as the cell means reflect the correlation between legitimate and illegitimate risk adjusters, they are imperfect building blocks for a capitation system.

4.2. Disturbances, measurement error and risk sharing

The standard procedure has another specific characteristic: in going from the estimated equation (4.1) to the risk-adjustment formula the disturbance term usually is simply omitted. As (2.7) shows, this can easily be rationalised in our framework if one accepts that u_i reflects only the effect of variables for which the health plans have to be kept responsible. But this is not always an obvious assumption to make, since it implies that all relevant legitimate risk adjusters are included in the estimated equation. This is definitely not realistic. In general, the risk adjusters included will *not* perfectly capture (or signal) the differences in risk types in the population of patients.

A first (and obvious) approach to this problem within the context of the empirical estimations is to see it as an example of measurement error. This interpretation suggests immediately that the coefficients in table 1 give a downward biased estimate of the true indicators of risk type. This can be a reason to argue in favour of an *overweighting* of the estimated coefficients when applying them in (2.7) or (2.8), where the degree of overweighting is related to the degree of measurement error, i.e. to the degree of imperfectness of the signal. Such overweighting comes quite close to the proposals derived by Glazer and McGuire (1998) from an explicit regulatory optimisation exercise.

A second approach to this problem is to look more carefully at the disturbance terms. In a real world-setting with an imperfect specification, the unexplained part in the regressions will reflect both "compensation" and "responsibility" aspects, i.e.

$$u_i = u_i^C + u_i^R \tag{4.2}$$

where it seems reasonable to assume

$$\begin{array}{ll} Eu_i^C = 0 & E(u_i^C)^2 = \sigma_C^2 \\ Eu_i^R = 0 & E(u_i^R)^2 = \sigma_R^2 \\ E(u_i^C u_i^R) = \sigma_{RC} & \end{array}$$

and (u_i^C, u_i^R) is assumed independent from (u_j^C, u_j^R) for $i \neq j$. Making use of the notation $u_i^C = \delta_i u_i$, the "correct" application of (2.7) would then imply

$$N_i = \alpha_0 + \alpha' a_i^C + \delta_i u_i + \beta' \overline{a}^R + (1/n) \sum_k (1 - \delta_k) u_k \tag{4.3}$$

Of course, the problem for applying (4.3) is that the decomposition in (4.2) or, equivalently, the value of δ_i, are unobservable. In Schokkaert et al. (1998) we have shown that the "best" approximation of the "true" normative expenditures is obtained by putting

$$\forall i,\ \delta_i = \delta = \frac{\sigma_C^2 + \sigma_{RC}}{\sigma_C^2 + \sigma_R^2 + 2\sigma_{RC}} = \frac{\sigma_C^2 + \sigma_{RC}}{Var(u_i)} \tag{4.4}$$

Using the result that $\delta_i = \delta$, $\forall i$, one can rewrite (4.3) as

$$N_i = (1-\delta)(\alpha_0 + \alpha' a_i^C + \beta' \overline{a}^R) + \delta(x_i - \beta(a_i^R - \overline{a}^R)) \tag{4.5}$$

which shows that δ can be seen as the parameter in a risk-sharing arrangement, where the subsidy from the central fund is a weighted average of the prospective capitation and the actual expenditures, corrected for observable differences in the responsibility variables.

The denominator in (4.4) can be estimated, but this is not true for the numerator. However, (4.4) indicates how we can think about the value of δ. Look at the extreme cases. If $\sigma_C^2 = 0$ (respectively $\sigma_R^2 = 0$) we immediately get $\delta = 0$ (respectively $\delta = 1$). In the former case one assumes that the disturbance term only captures the effect of "illegitimate" risk adjusters- the assumption which is implicit in the conventional risk adjustment literature. No risk sharing is needed. In the latter case one is extremely cautious and ascribes the unexplained part completely to legitimate risk adjusters. If there were only legitimate risk adjusters included in the estimated model -as in the traditional approach- this implies that one would have to give up completely the idea of risk-adjusted prospective capitations and resort to retrospective reimbursement of actual expenditures. As soon as one explicitly introduces a^R-variables in the estimated equation, this is no longer true. Putting $\delta = 1$ would then imply that one reimburses expenditures, but *corrected for the observable effects of the "illegitimate" risk adjusters*. This is not a priori unreasonable in countries attaching a large weight to the avoidance of risk selection (and a small weight to efficiency). In the traditional approach (i.e. $\delta = 0$) the capitations for different groups are only allowed to differ if one can show a statistically significant effect on expenditures- the unexplained part is related to stochastic factors or to inefficiencies. Equation (4.5) with $\delta = 1$ puts the "burden of proof" at the other side: differences in expenditures are completely reimbursed unless one can show that they follow from non-morbidity characteristics. Of course, both $\delta = 0$ and $\delta = 1$ are extreme cases. In general, application of (4.5) will result in the kind of risk-sharing arrangement which is very often applied in actual practice (see van de Ven and Ellis, 1999) and has also been proposed in the theoretical literature as a means to overcome the risk selection problem in a situation with prospective payments (see, e.g., Ellis and McGuire, 1993).

Both interpretations -in terms of measurement error or through the reinterpretation of the disturbances- move the empirical exercises in the direction of the theoretical literature: the former offers an argument for overweighting if the signals are imperfect, the latter shows a way to justify risk-sharing arrangements. Perhaps the gap between the theoretical and the empirical approaches, between "theoretical" and "conventional" risk adjustment is not as large as it may seem at first sight.

5. A non-additively separable specification

Until now we have remained within a linear setting. Although there are good reasons to adopt such a linearity-assumption if extremely large datasets are available (as in our case), there are also arguments to introduce non-linearities in the specification. At the very least, one could keep the estimated equation linear in the coefficients but introduce multiplicative relationships between variables. Many econometricians would go much further and advocate a sophisticated treatment of the null-expenditures and the choice of a logarithmic transformation of the dependent variable to take account of the skewed distribution of medical expenditures.

Going from a linear to a nonlinear specification does not affect the applicability of the theoretical framework sketched in section 2, because (2.1) and (2.3) represent general functions. However, it turns out that most practical applications soon lead us into trouble, because the estimated equations do no longer satisfy the requirement of additive separability between the responsibility- and the compensation variables. We will illustrate the resulting problems, first for multiplicative effects and then for a semilogarithmic specification.

5.1. Multiplicative effects

The third column of Table 1 gives the estimates for a model including some significant cross-effects between a^R- and a^C-variables: GP-loyalty has a much stronger negative effect on the expenditures of the elderly, and the cost of invalidity and handicaps is larger in regions with a high density of medical providers. Both effects are theoretically meaningful. By themselves they are already sufficient to make the specification no longer additively separable between legitimate and illegitimate risk adjusters[22]. Therefore, the natural mechanism (2.6) or (2.8) cannot be applied and we have to resort to the conditional-egalitarian capitations in (2.12). This means that we have to choose a reference value $\widetilde{a}^R$ for provider density and GP-loyalty. The optimal choice of these reference values is an interesting theoretical problem, but for our purposes it is sufficient to take as a reasonable first approximation the mean values in our sample (as an estimate of the population means). This choice of $\widetilde{a}^R$ is suggested by a naive extension of (2.7) to the non-separable case. We know of course that the resulting capitations will not satisfy the *NIRS*-axiom, i.e. that there will remain incentives for risk selection. This problem is illustrated in Table 3.

[22] Of course, cross-effects between two (or more) compensation variables or two (or more) responsibility variables do not lead to any difficulties for applying the natural mechanism of section 2.

Table 3. Incentives for risk selection with a multiplicative model

In this table we consider four "risk types", differing with respect to legitimate risk adjusters: age and the presence of disability. Their medical expenditures are also influenced by the provider density in their region of residence and by their own loyalty to a general practitioner. Hence we distinguish between four "responsibility"-levels, ranging from the lowest expenditures (minimal provider density and maximal GP-loyalty) to the highest expenditures (maximal provider density and minimal GP-loyalty). The first column gives the expected expenditures for these different possibilities, as computed with the coefficients in Table 1. This can be interpreted as $E(x_i) = f(a_i^C, a_i^R)$ were the expectations-operator refers to the fact that we have neglected the disturbance term[23]. As could be expected, there are large divergences in these expected expenditures. In so far as these differences are due to the responsibility variables, there is no problem from a social point of view. However, differences *within* a responsibility-level should be compensated for by the risk adjustment mechanism. Implementing the conditional-egalitarian capitations under the assumption $\widetilde{a}^R = \overline{a}^R$ and using the notation of (2.13), the second column of Table 3 shows the values of $f(a_i^C, \overline{a}_i^R)$, i.e. $\omega_i^{CE} - \lambda$. The last column gives $f(a_i^C, \overline{a}_i^R) - f(a_i^C, a_i^R)$, i.e. $\pi_i^{CE} - \lambda$ (see (2.14)). In so far as there are differences within the four "responsibility"-blocks of this last column, there are incentives for risk selection. It is obvious that these incentives are considerable- although of course dependent on the level of provider density and GP-loyalty[24].

There seems to be a real problem here. Note that this problem is *not* due to lack of adequate data. The conventional risk adjustment literature tries to minimise the dangers of risk selection by looking for better risk adjusters, i.e. less imperfect signals of risk type. This is an important task. However, even with perfect information the problem sketched in this section would remain[25]. The magnitude of the differences in the last column of Table 3 indicates that it is not negligible.

[23] Note that this notation is not fully consistent with section 2, in which we have neglected the stochastic aspects.

[24] It is obvious that the incentives for risk selection are nil for the individuals with $a_i^R = \widetilde{a}_i^R$, or in our specific illustration with $a_i^R = \overline{a}_i^R$.

[25] This point might be somewhat surprising for economists who tend to think that in a perfect information setting the first best can be reached. However, in this case the *NICI*-axiom imposes additional restrictions on the choice of instruments.

5.2. A semilogarithmic specification

Suppose now that one adopts a semi-logarithmic specification to account for the skewed distribution of medical expenditures:

$$\ln x_i = \alpha_0 + \alpha' a_i^C + \beta' a_i^R + u_i \tag{5.1}$$

Estimation results for this specification are shown in the last column of Table 1[26]. It is well known that predicting expenditures on the basis of (5.1) entails a potentially difficult retransformation problem, but for our purposes it is sufficient to look at the consequences of applying the following naive translation of the "natural" normative expenditures (2.8) in this context:

$$\ln N_i = \alpha_0 + \alpha' a_i^C + \beta' \overline{a}^R \tag{5.2}$$

Applying (5.2) and (5.1) one sees immediately that

$$\pi_i = \exp(\alpha_0 + \alpha' a_i^C) \left[\exp(\beta' \overline{a}^R) - \exp(\beta' a_i^R + u_i)\right] \tag{5.3}$$

which is clearly dependent on the a^C-variables. Therefore, again, there will remain incentives for risk selection. This is not surprising, since specification (5.1) implies that $f(.)$ in (2.3) is not additively separable in legitimate and illegitimate risk adjusters. In fact, apart from the constant λ, the naive approach based on (5.2) boils down to the conditional egalitarian mechanism (2.13) for reference values of the a^R-variables equal to their mean values. Note that in this case the problem of risk selection would remain even if one did not include explicit a^R-variables in the specification: the presence of the disturbance term in (5.3) is sufficient to generate the problem.

To get an idea about the magnitude of the risk selection incentives, it is useful to note that (5.1) and (5.3) imply

$$\frac{\pi_i}{x_i} = \exp\left[\beta'(\overline{a}^R - a_i^R) - u_i\right] - 1 \tag{5.4}$$

The expression at the right-hand side is independent of a_i^C and can be denoted as $\zeta(a_i^R)$. Therefore the naive mechanism (5.2) makes the incentives for risk selection proportional to the actual expenditures, i.e. it satisfies the following axiom:

Axiom 4. *(**IRSPROP**) For any two individuals i and j with $a_i^R = a_j^R = a^R$, $(\pi_i/x_i) = (\pi_j/x_j) = \zeta(a^R)$.*

[26] For observations with zero expenditures, we put $\ln x_i = 0$ (i.e. $x_i = 1$).

The results in this section are worrying. As emphasized before, it is crucial to distinguish carefully between the "explanatory" power of estimated expenditure equations and the use of the resulting estimates in a capitation formula. At the same time, there may be very sound econometric reasons to introduce cross-effects in a linear equation or to move to (semi)logarithmic specifications - not to mention the use of two-part models which would still further complicate matters. If one were unaware of proposition 2.2, it would be tempting to try to derive from such more sophisticated specifications a capitation formula which would satisfy *NIRS* (and the neutrality assumption *NICI*). But proposition 2.2 shows that all such attempts are futile: if the "true" model is not additively separable, then no risk adjustment scheme can remove all the incentives for risk selection. Of course, basing the capitations on a fully linear model, when this is not the "true" model and when insurers have knowledge about that true model, does not solve the basic problem. Nor can this basic problem be solved by collecting better data or by using more sophisticated statistical techniques. The only possibility to remove the incentives for risk selection when the expenditure equations are not additively separable in the variables a^C and a^R would be to give up horizontal neutrality *NICI* (a restriction on the set of possible instruments) and to apply e.g. the egalitarian-equivalent mechanism (2.10). A more realistic approach in most real-world policy contexts is probably to keep *NICI*, to work with what is the best possible estimation of the "true" model and to try to minimize the incentives for risk selection in the concrete setting, i.e. to choose the "best" possible rule within the family of conditional-egalitarian mechanisms (2.12). This "best" possible rule will be dependent on the concrete empirical setting and on an "ethical weighting scheme" to be applied to the various risk groups involved. This seems to be a useful topic for further research[27].

6. A special case: the introduction of health plan behaviour

In the previous sections we have followed the conventional risk adjustment literature and completely neglected the behaviour of the health plans themselves. More specifically, we did not take into account the reactions by these health plans -and possibly the patients- on the introduction of the risk adjustment formula. However, the introduction of the a^R-variables makes the theoretical framework of section 2 sufficiently general to incorporate these effects. Indeed, there is no reason why (2.3) could not result from a complete structural model, incorporating the behavioural reactions of both patients and health plans. Such a complete

[27] One interesting way forward is suggested by Glazer and McGuire (1999). They minimize (for a given data set) the incentives for risk selection under the restriction that quality distortion has to be completely avoided.

structural specification could take the following form:

$$x_{ij} = f(m_i, dp_i, dh_j) \tag{6.1}$$

where x_{ij} represents the medical expenditures of patient i, insured by health plan j, m_i represents a set of morbidity variables, typical for patient i and beyond her own responsibility, dp_i is a set of decision variables of patient i and dh_j a set of decision variables for health plan j. A variable like "loyalty to one general practitioner" is an example of a dp_i-variable. Examples of dh_j-variables are the availability of preferred provider arrangements, the creation of a set of incentives for the patients to choose the less expensive providers or to keep loyal to one general practitioner, efforts to put pressure on providers to minimize supply-inducement.

If we were able to collect information on all such variables we could estimate the full model (6.1). Again, as before, this is in the first place an exercise in positive econometrics. The next step then would be the derivation of the capitation payments along the lines described in section 2. Since the central fund wants to create appropriate incentives for both health plans and patients, a logical choice would be to put $a_i^C \equiv m_i$ and $a_i^R \equiv (dp_i, dh_j)$ - but there is no problem to include some patient decision variables (e.g. whether to live in a rural or an urban environment) among the legitimate risk adjusters. However, there seems to be no good reason to do the same with the health plan-variables dh_j.

Suppose now that the expenditure function $f(.)$ is additively separable in the a^C- and a^R-variables and that one can therefore apply the natural mechanism (2.6). The behavioural variables in a_i^R do *not* appear in the resulting capitations. This implies that different health plans will get the same capitation for the same (morbidity) type of patients, even if the expenditures of these patients are different because of differences in health plan behaviour. Also, if health plans change their behaviour as the consequence of the introduction of the risk adjustment scheme, this will not lead to a change in the amount of capitations received. In the situation of additive separability all incentives for efficiency remain intact[28].

If the expenditure function $f(.)$ is *not* additively separable in the a^C- and a^R-variables, this nice result does no longer hold. In that case the decisions of the health plans will have differential effects on different risk groups, or formulated more rigorously, $\partial f(.)/\partial dh_j$ will depend on the level of the morbidity-variables m. As shown before, the policy maker will then face a trade-off between minimizing the incentives for risk selection and safeguarding the incentives for efficiency. If her priorities are cost containment and efficiency, she can opt for the conditional-egalitarian form (2.13); but in that case -as illustrated before- she will not be

[28] In fact, in this more elaborate setting it is easier to understand the more ambitious interpretation of the *NICI*-axiom as "no incentives for cost inflation" (the interpretation proposed in Schokkaert et al., 1998).

able to remove all incentives for risk selection. Alternatively, she can turn to the family of egalitarian-equivalent mechanisms (2.11)- but then health plans can influence through their behaviour the capitations they receive. Of course, there are also other solutions which would not satisfy *NICI* nor *NIRS*, but possibly offer an attractive middle course. These trade-offs can be analysed as a second best-pricing problem, possibly with the horizontal neutrality assumption *NICI* as an additional restriction on the set of instruments. The estimated equation (6.1) would be a necessary input for the empirical application of such a second best-pricing approach, playing the same role as the consumer demand and labour supply equations in an optimal taxation-exercise. Note again that the absence of additive separability is a crucial assumption - and one which can be tested on the basis of empirical data.

We are not aware of any attempt in the risk adjustment literature to estimate a complete equation like (6.1). An easy way to introduce behavioural variables is the introduction of a fixed health plan-effect as a short-cut for differences in dh_j. This is quite feasible in most applications with individual data. Results with our data are shown in the fourth column of Table 1. The health plan-dummies add to the explanatory power of our model. Since they are not strongly correlated with any of the other variables included, they have only a negligible effect on the normative expenditures- as shown in the third column of Table 2. The discussion here is completely analogous to the one in section 4.1. *If* the fixed health plan effects affected the estimates of other coefficients, it would be essential to include them in the equation. The fact that they do not have this effect here is contingent on the data used. Given the ease with which these health plan fixed effects can be included (and neutralised in the calculation of the capitations), there is no reason not to include them in the estimated equation.

We also looked for significant cross-effects between the health plan and the legitimate risk adjusters. The fifth column of Table 1 shows that there is a significant negative interaction effect between one health plan and the disability variable. While for the others the additional cost of a disabled is 88,474 BEF (2193 Euro), for health plan 1 this additional cost is only 52,473 BEF (1301 Euro). The consequences for the capitations are analogous to the general case of multiplicative effects. Suppose we would neglect the existence of the cross-effect and base the capitations on the results in the fourth column of Table 1. In that case all the health plans would *ceteris paribus* get an additional 70,970 BEF (1759 Euro) for a disabled member. This is also what would result from a cell-based approach giving all health plans the overall average as a capitation. However, if the real world looks like column (5) this capitation would imply that all health plans (except health plan 1) make losses on their disabled- and that health plan 1 makes profits. In fact, starting from column (5), this naive approach is an implicit

application of a conditional-egalitarian mechanism with as reference value for the health plan-"responsibility" variable $\widetilde{a}^R = 0.49$. Reasoning along the lines of the previous sections, accepting the estimation results in column (5) as the true model and taking into account that the health plan-effect is a dummy variable, there are two other straightforward choices for the reference value $\widetilde{a}^R$: we can take either health plan 1 or the other health plans as the reference. In the former case, all the health plans but health plan 1 will make losses on their disabled and will therefore be motivated to get rid of them. Health plan 1 is indifferent between disabled and able-bodied members. In the latter case, health plan 1 will make profits on its disabled members and will try to attract more. The others, however, are fully compensated for the additional expenditures of their disabled members. While in all cases there is some pressure for the disabled to move to health plan 1, the financial consequences for the health plans -and hence the behavioural reactions to be expected- are completely different. Moreover, in a dynamic context, these reactions will tend to change the expenditures of the disabled for the different health plans and therefore possibly remove the significance of the cross-effect.

The social desirability of these reactions will depend on the exact interpretation of this cross-effect. There are at least three possible interpretations. In the first, health plan 1 has lower expenditures simply because it is more efficient in treating the disabled while delivering services of the same quality. In that case the described moves could well be desirable and the central fund could opt for taking health plan 1 as the reference. In a second interpretation, expenditures may be lower because the quality of services for the disabled is lower. In that cases it would be dangerous to take health plan 1 as the reference. A third interpretation is possible if the health plans have some influence on the decision to classify a patient as "disabled". A health plan which applies the regulations in a laxer way, will have more disabled among its members and, as a direct consequence, the average expenditures of its disabled will be lower than for the other health plans. In this interpretation the estimation result for the multiplicative term could be an argument to remove "disability" as such from the list of legitimate risk adjusters.

These are difficult choices to make for a central fund and the final decision will necessarily depend on the concrete social and political context. However, the theoretical model of section 2 offers an interesting framework to structure the problem and to make the link between the empirical -scientific- work and the normative -political- discussions. It shows that the only way to avoid the described incentives for risk selection is to go for an egalitarian-equivalent solution, in which different health plans get a different capitation for their equally disabled. It is difficult to imagine a real-world situation in which this would be politically feasible. Moreover, it goes very much against the basic rationale of introducing a system of prospective payments. If this solution therefore is not adopted the

difficult choices cannot be avoided. And estimation results like the ones in column (5) of Table 1 indicate the interests at stake. Of course, in our concrete example the problem is exacerbated by the use of simple dummies to capture the health plan-effects. If better information were available on dh_j-variables, it would be possible to estimate a more informative model and possibly even to choose (on the basis of the data) between the different possible interpretations. The problem of risk selection would not disappear, but one would have a better basis to choose an adequate reference value for dh_j- obvious possibilities are the mean or the "best practice"-value. This kind of empirical exercises could be useful if we want to bridge the gap between the theoretical and the conventional risk adjustment literature.

7. Conclusion

The conventional risk adjustment literature tends to underemphasize the basic difference between *explaining* medical expenditures and formulating *normative* capitations. We sketch a framework, derived from social choice theory, which makes it possible to handle this distinction explicitly. More specifically, we show how to derive in a rigorous way normatively acceptable capitations from estimated equations, even if these estimated equations contain "illegitimate" risk adjusters, i.e. if real-world expenditures are codetermined by variables for which one does not want to compensate. This will always be true in the real world.

Our starting point is the empirical literature, but we suggest that further thinking along the lines sketched in this paper could contribute to bridging at least part of the gap between this empirical work and the now rapidly expanding theoretical literature on risk adjustment. At the very least an acceptable estimation of a full structural model, incorporating health plan behaviour, seems to be a necessary building-block in both approaches. It also seems worthwhile to explore further the connections between the equity/efficiency trade-off as it appears in our framework and the more traditional public economic interpretation of this trade-off. We are well aware that much remains to be done and that this track may look non–promising to non-believers.

However, the lessons we can derive from our approach for future empirical work on risk adjustment are less ambiguous. Let us briefly summarize:

(a) The theoretical setting suggests that it is possible to neutralise the effect of responsibility-variables for the computation of the capitations. There is therefore no good argument for the standard procedure of omitting these variables during the estimations, because this may lead to biased estimates of the effects of the legitimate risk adjusters. A better procedure consists in explicitly distinguishing between two phases. First, one tries to do the econometric work as carefully as

possible, i.e. one tries to find the best *explanatory* model. Second, one argues explicitly about the *normative* distinction between legitimate and illegitimate risk adjusters and one uses equations (2.6)-(2.8) to calculate the capitations.

(b) The variables included in the equations will in general be only an imperfect signal of the true risk type of the individuals concerned. This can be taken into account through an overweighting of the relevant coefficients or through a mixed risk-sharing scheme. The weights in these theoretical proposals can be related in a natural way to -partly unobserved- characteristics of the empirical data.

(c) There may be good econometric reasons to drop the assumption of linearity in the variables. Introducing a (semi) logarithmic specification will lead to a model, which is no longer additively separable in the compensation and the responsibility variables. The same is true if one finds significant cross-effects between a compensation and a responsibility-variable. If the true model is not additively separable, it becomes impossible to remove all incentives for risk selection while at the same time respecting a requirement of horizontal neutrality. The empirical work should be interpreted from this point of view.

(d) A full structural model should (and can) incorporate the behaviour of the health plans in the expenditure equations to be estimated. A very simple first step is the introduction of health plan dummies. If the assumption of additive separability is satisfied, the natural mechanism yields a set of lump sum capitations, sufficient to remove the incentives for risk selection. However, it is useful to look for cross-effects between the health plan and the legitimate risk adjusters. If some of these cross-effects are significant, one has to face again the trade-off between efficiency and equity. The statistical testing of the additive separability-assumption yields useful insights into the feasibility of (pseudo) first best-solutions, where the "pseudo" refers to the fact that the risk adjusters included in general will not be perfect.

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