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EQUITY IN HEALTH CARE

ADDRESSING THE INEQUITY OF CAPITATION BY VARIABLE SOFT CONTRACTS

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SUMMARY

In the search for greater efficiency and cost-containment, many health systems have introduced the practice of medical care providers operating under a fixed budget, often referred to as the capitation or fundholding contract. Although the capitation contract seems equitable at first glance, the sequential decision-making practice of providers—shaped by their rate of present-preference and their attitude toward the risk of running out of budget—may result in serious violations of basic equity principles. We propose a variable soft (or mixed) payment contract (VSC), where the share of the retrospective payment increases over time, as a way to make the contracts more equitable. We also discuss how the parameters of the capitation contract (length of the budget period, soft or hard contracts, solo vs. consortium practice etc.), which are usually set by efficiency criteria, may have serious implications with regard to the equity of the system. Copyright © 1999 John Wiley & Sons, Ltd.

KEY WORDS — capitation contract; equity; mixed payment contract; principal-agent problems; variable soft contract

INTRODUCTION

In the search for greater efficiency and cost-containment, many health systems have introduced the practice of medical care providers operating under a fixed prospective budget (the capitation contract, denoted CC). A prominent example of such a scheme is the fundholding contract initiated in the UK in April 1991, as part of the NHS 'internal markets' reforms.

Most of the research analysing CCs has concentrated on empirical evaluations of the changes from efficiency and cost-containment points of view [1–3], on issues of risk-selection and risk-adjustment [4,5], and on the fairness of the allocation of funds to fundholders [6,7]. Little attention has been paid to the equity of the CC and, in particular, to the equity implications of the efficiency-minded specifications of the parameters of the contract. A possible reason for this is that the CC seemingly satisfies *ex ante* equity, namely, before the arrival of the first patient, all persons are entitled to equal expected health care.

In an earlier paper [8] we have shown that although the CC seems equitable at first glance, the actual practice of providers might result in serious violations of basic equity principles. In this paper we explore further the equity-implications of the standard CC, and suggest a modification of the standard CC in order to enhance its equity. We show that a variable soft (or mixed) payment contract (VSC), which consists of a mixture of the standard capitation contract and a fee-for-service payment scheme, where the proportions of the two change over time, may be more equitable. In addition, we briefly discuss the

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equity implications of changes in some of the parameters of the CC contract, such as the length of the budget period, the number of practitioners operating under the same contract and more.

THE SETTING

Consider a physician operating under a fixed annual budget (B), and assume that his objective is to maximize the sum of treatment benefits of his patients. More specifically, assume that there are two patients, denoted $i = 1, 2$. Let s_i denote patient i's initial health status and m_i the amount of resources allocated by the physician to her upon observing her health status s_i (higher s means better health). Let $h_i = h_i(m_i, s_i)$ be the health status after treatment. We assume $h_m > 0$, $h_s > 0$, $h_{mm} < 0$ and $h_{ss} < 0$, where subscripts denote partial derivatives. The physician's benefit from the ith patient's post-treatment health status is denoted by $u_i = u_i(h_i)$; $u' > 0$ and $u'' < 0$. Define $U(m_i, s_i) \equiv u(h(m_i, s_i))$. U is the physician's utility from treating a patient with initial health s and providing her with medical care worth m. Clearly, $U_m > 0$, $U_s > 0$, $U_{mm} < 0$ and $U_{ss} < 0$. We also assume that $U_{ms} < 0$, namely, sicker patients derive higher marginal benefits from medical care.

The standard models analysing such situations assume that the physician behaves as if all patients arrive simultaneously [9,10]. When the patients arrive simultaneously, the health status of *both* patients is known. The physician acts to:

$$\max_{m_1, m_2} U(m_1, s_1) + U(m_2, s_2)$$
$$\text{s.t. } m_1 + m_2 = B.$$

The optimal allocation $m_i^*(s_1, s_2, B)$ is obtained by equating the marginal benefits of care:

$$U_m(m_1, s_1) = U_m(B - m_1, s_2).$$

We focus on the following well-known equity criteria [9,11,12]:

Horizontal equity (*HE*): The contract satisfies *HE* if $m_1 = m_2$ whenever $s_1 = s_2$.
Vertical equity (*VE*): The contract satisfies *VE* if $m_i > m_j$ whenever $s_i < s_j$, $i, j = 1, 2$.

It is not hard to verify that if treatment levels for all patients are chosen simultaneously, both *HE* and *VE* are satisfied.

In reality, however, the patients do not arrive simultaneously. In an earlier paper [8] we have demonstrated that when patients arrive *sequentially*, both *HE* and *VE* may not be satisfied. The purpose of this paper is to further study the physician's behaviour when patients arrive sequentially, to explore the implications of such a behaviour on the equity of the system and, more importantly, to suggest a modified contract which enhances equity in such a case.

THE INEQUITY OF CAPITATION CONTRACTS

Two issues arise when the patients arrive sequentially rather than simultaneously. First, the physician's preferences between present and future patients, and second, his or her attitude toward the uncertainty of the needs (and costs) of future patients (see [8] for a more comprehensive analysis).

The 'present-preference' of physicians

Physicians might have quite a strong preference for the present patient over the future ones. Terms like 'The Rule of Rescue' [13] or 'The Standard of Care' [14] refer to the obligation of the physician to do all that he can for the benefit of the patient presently treated by him, regardless of cost. Under the CC, the 'cost' is the risk of running out of budget in the future, and providing lower quality or quantity of care to similar—or even sicker—future patients. Therefore, patients who come early on during the budget period may get, on average, better treatment than those who come later on.

Formally, with present-preference, upon the arrival of the first patient the physician behaves as to

$$\max_{m_1, m_2} U(m_1, s_1) + \rho U(m_2, s_2)$$
$$\text{s.t. } m_1 + m_2 = B,$$

where $\rho \leq 1$ represents the physician's present-preference. The first order condition (FOC) is $U_m(m_1, s_1) = \rho U_m(B - m_1, s_2)$. It can be easily shown that:

Proposition 1: With $\rho < 1$, the CC does not satisfy either *HE* or *VE*.

Needs uncertainty

At the time he or she provides medical care for the present patient, the physician is uncertain about the needs of the patients in future consultations. The physician makes decisions under uncertainty, and his or her attitude toward risk will shape these decisions. We ignore the present-preference issue in this analysis.

Assume that the pre-treatment health status of the patients is independent random variables with mean μ. Upon diagnosing s_1, the physician's problem is:

$$\max_{m_1, m_2} U(m_1, s_1) + E[U(m_2, S_2)]$$
$$\text{s.t. } m_1 + m_2 = B,$$

where the expectation is taken over the random variable S_2. The FOC is

$$U_m(m_1, s_1) = E[U_m(m_2, S_2)].$$

The equity criteria are somewhat more complicated in the case of needs uncertainty. We define the following criteria:

Ex ante equity (EAE). A contract satisfies *EAE* if, before the arrival of the first patient, the mean expenditures on the patients are equal, namely, if $E[m_1(S_1)] = EE[m_2(S_1, S_2)]$, where the expectation on the left hand side is taken over S_1 and the expectations on the right hand side are taken over S_1 and S_2.

Interim equity (IE). A contract satisfies *IE* if, upon observing s_1, $m_1 =, <, > E[m_2(S_2)]$ whenever $s_1 =, >, < \mu$.

Ex post horizontal equity (EPHE). A contract satisfies *EPHE* if $m_1 = m_2$ whenever $s_1 = s_2$.

Ex post vertical equity (EPVE). A contract satisfies *EPVE* if $m_i > m_j$ whenever $s_i < s_j$, for $i = 1, 2$, $j = 1, 2$, and $i \neq j$.

Proposition 2: The CC does not satisfy *EAE*, *IE*, *EPHE* or *EPVE*.

Proof:
Suppose that $U_{mss} > 0$ and $s_1 = \mu$, then $m_1 < B/2$ and $m_2 > B/2$ and *IE* is not satisfied. If $s_2 = \mu$ as well, then *EPHE* is not satisfied and if $s_2 > \mu$, then *EPVE* is not satisfied. The violation of *EAE* is proved using an example which is included in Appendix A to this paper. Similar arguments can be made for the case $U_{mss} < 0$. □

In [8] we classified physicians according to their attitude toward the risk of running out of budget. A *risk-neutral* physician ($U_{mss} = 0$) will always satisfy *EPHE*. A *risk-averse* physician ($U_{mss} > 0$) will allocate less than the per capita budget to a patient with average need, seen early in the budget period, in order to reserve more resources for patients with more serious problems that *may* come later on. However, there might also be (*risk-takers*) physicians who will allocate a share greater than the per capita budget to a patient with an average need seen early in the budget period (see [15] for a similar treatment of consumers' saving behaviour under uncertainty). Unless physicians are risk-neutral ($U_{mss} = 0$), uncertainty about the needs of future patients will cause inequity in the allocation of the budget. Note that risk-aversion may temper physicians' present-preference, while risk-taking enhances it.

Propositions 1 and 2 show that under the common CC, patients with identical needs may get unequal treatment and a sicker patient may get less intensive treatment than a healthier one by the same physician, depending on the date of their visit during the budget period.

A MODIFICATION OF THE CAPITATION CONTRACT: A VARIABLE SOFT CONTRACT

A widely discussed modification of the CC is to allow for a mixed payment to the physician. The mixture is between prospective budgetary payment and retrospective (FFS) reimbursement. In the UK fundholding contract, for example, the share of retrospective payment depends on the level of expenditure on the patient: it is null up to £5000 and 1 thereafter. The properties of mixed payment schemes have been explored mainly in an efficiency context (see, for example, [16–19]), and these contracts were found to be optimal, under certain circumstances. In this paper we show that mixed payment schemes can sometimes also address equity considerations. The novelty of our proposed mixed contract, however, is that the level of mixtures should vary over time in order for equity to be restored.

The present-preference case

Assume that the two patients are equally sick. Under the CC contract, because of present-preference ($\rho < 1$), $m_1 > m_2$. Now consider the following (R, α) contract: The physician receives a budget R to treat both patients. In addition, he will be paid retrospectively a fraction $1 - \alpha$ of his expenditures on the second patient. Under such a contract, the physician acts to:

$$\underset{m_1, m_2}{\text{Max}}\ U(m_1, s_1) + \rho U(m_2, s_2)$$
$$\text{s.t. } m_1 + \alpha m_2 = R.$$

The FOC is $U_m(m_1, s_1) = [\rho/\alpha]U_m((R - m_1)/\alpha, s_2)$. Since $s_1 = s_2$, *HE* requires that $m_1 = m_2$. This will be the case when $\rho/\alpha = 1$ or when $\alpha = \rho$. *VE* is satisfied as well.

Note that when there is no present-preference ($\rho = 1$), $1 - \alpha = 0$, and our proposed VSC becomes the standard CC. The stronger the rate of present-preference (the smaller ρ), the larger the share of the retrospective payment. Notice also that the rate of mixture is independent of the patients' health status: the rate of mixture depends only on the sequential appearance of the patients through the present-preference rate.

Finally, R can be chosen so that the total health expenditures remain constant (B). Since *HE* is satisfied, $m_1 = m_2 = B/2$. Consequently, inserting m_1 and m_2 back in the budget constraint, we get $R = (1 + \alpha)B/2 = (1 + \rho)B/2$.

We can summarize the discussion by the following proposition:

Proposition 3: For every CC (B), there is a VSC (R, α) which satisfies both *HE* and *VE*.

A similar restoration of *HE* and *VE* could be achieved by designing a contract (R, r), where r is the interest rate offered on the unused budget by the first patient.

The needs uncertainty case

Under needs uncertainty, there is no capitation contract that assures *EPHE* (unless the physician is forced to allocate his budget equally among the patients) and *EPVE* for every s_1 and s_2. Consequently, we focus on *EAE* and *IE*.

As we have discussed above, with uncertain needs, equity problems may arise under the CC contract whenever the physician is not risk-neutral. In such cases, the physician will allocate too little or too much resources to patients that arrive early on during the budget period. Obviously, the modified contract to address these problems will be different depending on whether the physician is risk-averse or risk-taker. We shall start the analysis assuming the physician is risk-taker. Consider again the VSC (R, α). Under such a contract, the physician, at the interim stage, solves the following optimization:

$$\underset{m_1, m_2}{\text{Max}}\ U(m_1, s_1) + E[U(m_2, S_2)]$$
$$\text{s.t. } m_1 + \alpha m_2 = R.$$

The FOC is $\alpha U_m(m_1, s_1) = E[U_m((R - m_1)/\alpha, S_2)]$.

Proposition 4: There exists a α^{IE} such that the VSC (R, α^{IE}) satisfies *IE*.

Proof:
For $s_1 = \mu$, *IE* requires that $m_1 = m_2 = R/(1 + \alpha)$. We can, consequently, chose α^{IE} to solve the equation $\alpha^{IE} U_m(R/(1 + \alpha^{IE}), \mu) = E[U_m(R/(1 + \alpha^{IE}), S_2)]$. As long as $U_{ms} < 0$, m_1 is inversely related to s_1, and *IE* is satisfied. □

Proposition 5: There exists a α^{EAE} such that the VSC (R, α^{EAE}) satisfies *EAE*.

Proof:
From the FOC we derive $m_1 = m_1(S_1, R, \alpha)$. We chose α^{EAE} to solve the equation $(1 + \alpha^{EAE})\mathrm{E}[m_1(S_1, R, \alpha^{EAE})] = R$. □

In both cases, R is chosen so that the total health expenditures remain constant (B). Since $B/2 = R/(1 + \alpha)$, $R = (1 + \alpha)B/2$. We note that in general α^{IE} is not equal to α^{EAE}, so that it is impossible to achieve both *IE* and *EAE*. The regulator has to decide which criterion is more important and to choose the appropriate parameter accordingly.

As an illustrating example of the working of the VSC, suppose that because of present-preference or risk-taking behaviour, the health gains from care given to patients who arrive later on are valued as only 90% of the same gains from care provided at present. The physician will clearly allocate more resources to early patients. The mixed payment modification of the CC can reduce this inequity: the physician will be allocated a yearly budget of, say, $0.93B$ to treat all patients. In addition, the physician will receive a retrospective payment of 5% of the cost of treatment provided during the *second half* of the year. In such a case, patients who arrive during the first half of the year receive somewhat less intensive care, and patients who arrive during the second half of the year will receive somewhat more intensive treatment, compared to what they receive under the standard CC.

The reason for the restoration of equity is twofold. First, early patients become relatively 'more expensive' to the physician. Second, late patients become less risky since part of their 'cost' is not financed out of the budget. Clearly, the modified contract is more equitable than the standard one without hurting its efficiency, and furthermore, total cost of treating all patients remains about the same (B). One can also see that this modification is better, as far as equity is concerned, than the standard mixed payment contract where the physician receives a yearly budget of, say, £0.95B, and receives a retrospective payment at the rate of 5% of his total cost throughout the year. Intuitively, the differential rate of mixture constitutes a series of risk (of running out of budget)-related 'insurance policies' that induce the physician to have equal concern for the sequentially arriving patients.

So far we have assumed that the physician is risk-taker. If the physician is risk-averse, the optimal contract should also be of the form (R, α), but in this case the fraction $1-\alpha$ of the *first* patient's medical care expenses should be reimbursed retrospectively.

THE CASE OF HETEROGENEOUS PHYSICIANS

Obviously, the optimal parameters of such a VSC, namely, the size of the prospective budget and the rate of the retrospective reimbursement, depend on the parameters of the physicians' preferences—the rate of present-preference and/or the measure of risk-aversion. In the analysis above, we assumed that all the physicians have the same preferences and that the regulator knows these preferences. Under these assumptions, the optimal VSC soft contract achieves the First Best, and equity is restored. When the physicians are heterogeneous in their preferences and the regulator does not know each physician's preferences or she is simply constrained to offer only one contract to all, the optimal VSC will achieve only a Second Best. In such a case, the optimal contract will be determined by an optimization of the regulator's objective. The regulator's objective may be some general Social Welfare Function (such as $\text{Max}\ \Sigma\ U$) or an equity-specific criterion. Following [9], possible formulations would be equality of post-treatment health (utility), namely $\text{Min}\ \Sigma(U-\bar{U})^2$, equality of marginal benefits ($\text{Min}\ \Sigma(U_m-\bar{U}_m)^2$), or minimizing another measure of inequality [21].

To illustrate the working of such regulation, we focus on the 'present-preference' case. Assume there are two types of physicians ($j=1, 2$). The rate of present-preference among physicians of type j is denoted by ρ_j. These rates are known by the regulator. There are np_j physicians of type j in the population ($p_1+p_2=1$). Since physicians cannot be identified by their type *ex ante*, the regulator offers a single VSC (R, α) to all physicians. Given that contract, and recalling the proof of Proposition 1, the allocation of medical care of a physician of type j ($j=1, 2$) is described by the equation:

$$U_m(m_{1j}, s_{1j}) = [\rho_j/\alpha]U_m((R-m_{1j})/\alpha, s_{2j}),$$

where m_{1j} is the care given to the first patient of the type j physician, and s_{ij} is the pre-treatment health of patient i ($i=1, 2$) visiting a type j physician.

Let $W=\Sigma\ U$ be the regulator's objective, which is to be maximized under a budget constraint. Let G be the total budget to be allocated to the n physicians. The regulator's expenditures consist of the prospective budgets (nR) and the retrospective reimbursements ($np_1[1-\alpha][R-m_{11}]/\alpha + np_2[1-\alpha][R-m_{11}]/\alpha$). Combining and rearranging terms, the budget constraint becomes $-R+(1-\alpha)(p_1m_{11}+p_2m_{12})+\alpha B=0$, where $B=G/n$.

We can now formulate the regulator's optimization problem:

$$\begin{aligned}\underset{\alpha,\, R,\, m_{11},\, m_{12}}{\text{Max}}\ W = p_1[&U(m_{11}, s_{11}) \\ &+ U((R-m_{11})/\alpha, s_{21})] \\ &+ p_2[U(m_{12}, s_{12}) \\ &+ U((R-m_{12})/\alpha, s_{22})]\end{aligned}$$

$$\text{s.t. } U_m(m_{1j}, s_{1j}) - [\rho_j/\alpha]U_m((R-m_{1j})/\alpha, s_{2j}) = 0, \quad j=1, 2$$

$$-R+(1-\alpha)(p_1m_{11}+p_2m_{12})+\alpha B=0.$$

Note that this is a standard principal-agent problem. The principal (the regulator) wishes to maximize her objective function (W) subject to the incentive compatible constraint (the physicians' choice of m) and the national budget constraint.

The analysis of the solution to the general problem is complex and hard to follow. Instead, we will focus on a special case which was used earlier (see Appendix A), namely $U(m, s) = \ln(s + cm)$. Furthermore, in order to simplify the analysis we take $c = 1$, and since our main interest lies in horizontal equity—the medical care provided to patients with similar pre-treatment health, s—we take $s = 0$.

Under these assumptions, the first order conditions are (after some simplifications):

$$m_{1j} - R/(1+\rho_j) = 0, \quad j = 1, 2$$

$$-R + (1-\alpha)AR + \alpha B = 0$$

$$-1/\alpha + \lambda(B - RA) = 0$$

$$2/R + \lambda[-1 + (1+\alpha)A] = 0,$$

where λ is the LaGrange multiplier of the budget constraint and

$$A = [1 + (1-p_1)\rho_1 + (1-p_2)\rho_2]/(1+\rho_1)(1+\rho_2).$$

The solution to the regulator's problem is:

$$\alpha = 1/A - 1 = [p_1\rho_1 + p_2\rho_2 + \rho_1\rho_2] /[1 + (1-p_1)\rho_1 + (1-p_2)\rho_2]$$

$$R = B/2A$$

$$m_{1j} = R/(1+\rho_j) = B/2A(1+\rho_j)$$

and

$$m_{2j} = B - m_{1j} = [2BA(1+\rho_j) - 1]/2A(1+\rho_j), \quad j = 1, 2.$$

Note that when $\rho_1 = \rho_2 = \rho$ we have the homogenous physicians case discussed earlier. The solution to the problem above becomes: $\alpha = \rho$; $A = 1/(1+\rho)$; $R = B(1+\rho)/2$; and $m_{1j} = m_{2j} = R/(1+\rho) = B/2$, $j = 1, 2$.

The optimal contract is admissible, as is shown in Proposition 6.

Proposition 6: The optimal contract satisfies $0 < \alpha < 1$ and $R < B$.

Proof:
Clearly, since $A < 1$, $\alpha > 0$. Since $p_1, p_2, \rho_1, \rho_2 < 1$, $\alpha < [1 + p_1\rho_1 + p_2\rho_2/[1 + \rho_1 + \rho_2]$. If $\rho_1 > \rho_2$, then

$$\alpha < [1 + p_1\rho_1 + p_2\rho_2/[1 + \rho_1 + \rho_2] < [1 + \rho_1]/[1 + \rho_1 + \rho_2] < 1.$$

If $\rho_1 < \rho_2$, then

$$\alpha < [1 + p_1\rho_1 + p_2\rho_2/[1 + \rho_1 + \rho_2] < [1 + \rho_2]/[1 + \rho_1 + \rho_2] < 1.$$

When $\alpha < 1$, $A > 1/2$, and $R < B$.□

We can see, therefore, that the VSC may increase social welfare in the case of heterogeneous physicians as well. We turn now to the question of how do the CC and the VSC compare in terms of equity. Under the CC, each physician maximizes his or her utility subject to the prospective budget B (we assume that the national budgets are the same under CC and VSC). The allocation of care is determined by $U_m(m_{1j}, s_{1j}) - \rho_j U_m((B - m_{1j}), s_{2j}) = 0$, $j = 1, 2$. Under the assumptions in this section, the CC levels of care are $m_{1j}^{CC} = B/(1+\rho_j)$ and $m_{2j}^{CC} = \rho_j B/(1+\rho_j)$. The VSC levels are $m_{1j}^{VSC} = B/2A(1+\rho_j)$, and $m_{2j}^{VSC} = [2BA(1+\rho_j) - 1]/2A(1+\rho_j)$, $j = 1, 2$.

Define the following levels of (horizontal) (in)equity resulted from the CC and the VSC:

Within equity (WE_j): $WE_j^{CC} = |m_{1j}^{CC} - m_{2j}^{CC}|$ and $WE_j^{VSC} = |m_{1j}^{VSC} - m_{2j}^{VSC}|$.
Between equity (BE_i): $BE_i^{CC} = |m_{i1}^{CC} - m_{i2}^{CC}|$ and $BE_i^{VSC} = |m_{1i}^{VSC} - m_{2i}^{VSC}|$.

The within equity measures the difference in care provided to the two (similar in pre-treatment health) patients of the same physician ($j = 1, 2$). The between equity measures the difference in the care provided to two (similar in health and in order of appearance) patients treated by two physicians of different type ($i = 1, 2$). Note, however, that $|BE_1| = |BE_2|$. Clearly, when there is no present-preference, the inequity within is zero. When all the physicians are similar, the inequity between is zero (for a discussion of the two kinds of equity and the relationship between them in capitated systems in general, see [22]).

We can now state the following:

Proposition 7: When physicians are heterogeneous in their present-preference, the VSC results in lower inequity both within and between than the CC.

Proof:
For the inequity within: using the solutions noted above, we have

$$\begin{aligned} WE_j^{CC} &= |m_{1j}^{CC} - m_{2j}^{CC}| \\ &= |B/(1+\rho_j) - \rho_j B/(1+\rho_j)| \\ &= B(1-\rho_j)/(1+\rho_j), \end{aligned}$$

and

$$\begin{aligned} WE_j^{VSC} &= |m_{1j}^{VSC} - m_{2j}^{VSC}| \\ &= |B/2A(1+\rho_j) \\ &\quad - [2BA(1+\rho_j) - 1]/2A(1+\rho_j)| \\ &= B[1 - A(1+\rho_j)]/A(1+\rho_j). \end{aligned}$$

Now, $1 - A(1+\rho_j)]/A = (1+\alpha) - (1+\rho_j) = \alpha - \rho_j$ which is smaller, since $\alpha < 1$, than $1 - \rho_j$. Consequently, $WE_j^{CC} > WE_j^{VSC}$. For the inequity between:

$$\begin{aligned} BE_i^{CC} &= |m_{i1}^{CC} - m_{i2}^{CC}| = |B/(1+\rho_1) - B/(1+\rho_2)| \\ &= B|\rho_1 - \rho_2|/(1+\rho_1)(1+\rho_1), \end{aligned}$$

and

$$\begin{aligned} BE_i^{VSC} &= |m_{i1}^{VSC} - m_{i2}^{VSC}| \\ &= |B/2A(1+\rho_1) - B/2A(1+\rho_2) \\ &= B|\rho_1 - \rho_2|/2A(1+\rho_1)(1+\rho_1). \end{aligned}$$

Since $2A > 1$, $BE_i^{VSC} < BE_i^{CC}$.□

As in all cases which involve mixed contracts and, in fact, as in many other cases of regulation, the regulator will have to estimate the parameters of the physicians' preferences in order to implement the optimal contract. Such an estimation can be based on data about physicians' past behaviour which may provide some indication about physicians' present-preferences and attitude towards risk. In any case, it is clear that the search for the optimal parameters of the contract will involve some period of trial and error as is often true with optimal regulation. A practical suggestion could be to start with a simple modification such as suggested in the example above or even with a retrospective payment rate that increases every quartile—from 0% in the first quartile to around 15% in the last one—and to improve the contract as more information on the actual costs and their allocation among patients accumulates.

THE EQUITY IMPLICATIONS OF THE CC'S PARAMETERS

The parameters of the capitation contracts have usually been determined by efficiency criteria and risk-spreading considerations. Their equity implications in the case where patients arrive have not been analysed. In fact, the very essence of spreading the risk in CC by making the populations more heterogeneous results in greater variance of needs, and leads to greater inequity in the need uncertainty case. The following discussion is not meant to exhaust these implications, but rather to open some questions for further thought and investigation, and to stress the need to incorporate equity considerations into the decision-making process.

The length of the budget period: The traditional budget period is 1 year. This is obviously arbitrary. Longer budget periods allow more flexibility and risk spreading, since they allow for more visits. In fact, some thoughts have been raised recently regarding the possibility of extending the budget period of the UK fundholding contracts. It is not at all clear, however, that longer budget periods are preferred on equity grounds. In case of present-preference, for example, it would be better, from an equity point of view, to divide a given budget period into several sub-periods holding the per capita budget constant. Compare, for example, the resources allocated to the first patient with those allocated to the last one, assuming they both have a similar health status. If the budget period is short, the difference between the resources allocated to these two patients will be rather small, even when the physician has present-preference. If, however, the budget period is long, the difference might become quite large.

'Soft' contract: Soft capitation contracts are contracts where the physician is allowed to deviate from the budget at some price [20]. Like mixed payment contracts, soft contracts are becoming more and more popular on efficiency grounds, to reduce the risks of risk-selection and of temporary financial losses, and to allow for more flexibility over time. In the UK, fundholders may exceed their budget by 5% to be discounted from their following year's budget. Following the arguments for a variable mixed payment contract discussed above, soft contracts will not make the CC more equitable, since they do not introduce differentiation among patients arriving at different dates.

Network practice: Another way to deal with temporary losses and to pool financial risk is to form networks consisting of several physicians operating under a joint budget. Such a policy will not generally be equity neutral. Even though the larger budget is supposed to provide care for a larger population, the present-preference, for example, of each physician may induce him to allocate even more resources to his early patients than in the case where he is practicing alone.

CONCLUSIONS

With the changes in health systems taking place on both sides of the Atlantic, many innovative contracts between governments and insurers as well as between insurers and providers are implemented. Most of them are driven by efficiency considerations. Using a simple model of physician's behaviour under a capitation contract with sequentially arriving patients we showed that the pursuit of efficiency might violate universally accepted equity criteria. Interestingly, a remedy for that violation is found in a modification of an efficiency-oriented contract. We demonstrated that a simple variable soft payment capitation contract would restore equity among similar physicians, and will enhance equity within and between physicians when they differ in their preferences.

In the above analysis we considered the physicians' populations as given. In reality, in the long run, sorting of individuals to physicians is shaped by the individuals' choices. Individuals may 'dislike' the dependence of the treatment they get on the timing of their arrival to the physician office, leading them to value, on a completely selfish basis, *ex post* horizontal and vertical equity. This will be the case, for example, when individuals are risk-averse, so that they wish their utility (health) not to change much with the timing of their arrival at the physician's office, given the severity of their sickness. In such cases, individuals will choose physicians with practice-style that follows more closely these principles. Consequently, with common knowledge about physicians' practices and with a possibility to chose periodically the treating physician, competition among physicians may assure some level of equity. However, as with the assurance of quality of care by competition among providers in a prospective payment system, informational imperfections and patients' loyalty and passivity make the competitive assurance quite limited, and may call for a regulation, for example, by a variable soft contract. Furthermore, when discussing across-physicians differences, risk-selection and selective attractions by physicians, regulated by risk-adjustment mechanisms, must be considered as well.

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APPENDIX A: PROOF OF THE VIOLATION OF *EAE*

This appendix completes the proof that the CC does not generally satisfy *EAE* (Proposition 2), using an example. Consider the physician's utility function $U(m, s) = \ln(s + cm)$, where $c > 0$ is a given constant. Pre-treatment health, s, is a random variable where $s = -1$ with probability of 0.5 and $s = 1$ with probability of 0.5 ($\mu = 0$). Under these assumptions, $m_1^*(s_1) = \{3cB - s_1 - [8 + (s_1 + cB)^2]^{1/2}\}/4c$, and $m_1^*(\mu) = \{3cB - [8 + (cB)^2]^{1/2}\}/4c < B/2$. Conditional on s_1, the solution m_1^* is concave in s_1, so that $E[m_1^*(s_1)] < m_1^*(\mu) < B/2$, and *EAE* is violated.

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