Topics in Economic Analysis & Policy

Volume 3, *Issue* 1 2003 *Article* 10

Preventive Health Care and Payment Systems

Pedro P. Barros* Xavier Martinez-Giralt†

*Universidade Nova de Lisboa, ppbarros@fe.unl.pt

†Universitat Autónoma de Barcelona, xavier.martinez.giralt@uab.cat

Preventive Health Care and Payment Systems*

Pedro P. Barros and Xavier Martinez-Giralt

Abstract

Prevention has been a main issue of recent policy orientations in health care. This renews the interest on how different organizational designs and the definition of payment schemes to providers may affect the incentives to provide preventive health care.

We focus on the externality resulting from referral decisions from primary to acute care providers. This makes our analysis complementary to most works in the literature allowing to address in a more direct way the issue of preventive health care. The analysis is performed through a series of examples combining different payment schemes at the primary care center and hospital. When hospitals are reimbursed according to costs, prevention efforts are unlikely to occur. However, under a capitation payment for the primary care center and prospective budget for the hospital, prevention efforts increase when shifting from an independent to an integrated management. Also, from a normative standpoint, optimal payment schemes are simpler under joint management.

KEYWORDS: preventive health care, payment system

*The authors wish to express their gratitude to David Li, Randall Ellis, Albert Ma, Matilde Machado, participants in the International Health Conference held in Hong Kong, an anonymous referee, and the editor Kyle Bagwell for their useful comments. Financial support of 2001SGR-00162 and BEC2000-0172 and CREA (Xavier Martinez-Giralt) and Praxis XXI 13132/1998 (Pedro Pita Barros) is gratefully acknowledged. The usual disclaimer applies.

1 Introduction.

Prevention is one of the points of attention of the recent policy orientation in health care to maintain the objectives of equity, efficiency, and quality in face of the increasing budgetary difficulties to finance universal health care systems.

Despite its policy relevance, we do find a shortage of economic analysis of how market interaction affects prevention. Moreover, there are several notions of prevention. Kenkel (2000) distinguishes among primary, secondary and tertiary prevention; The American Board of Preventive Medicine, as quoted by Dranove (1998), proposes a global definition of preventive medicine; Oliver and Berger (1979), quoting Kasl and Cobb (1996), provide an individualistic approach to preventive health care behavior; Boxx and Chambless (1975) adopt the perspective of the firm.

Here, we are interested in the industrial organization of the health care market and the role of prevention. According to Kenkel (2000, pp. 1684-1685) "The field of health economics has not developed explicit models of the supply of prevention. (...) A complete understanding of the supply of preventive medical care would require analysis of the structure of the physician services markets and the health insurance market, recognizing the multiple agency relationships between the physician, consumer, and third party payer."

Within this general framework, we address the effects of providing preventive health services according to whether this provision is centralized or decentralized among first and second level providers. The driving force behind these effects is the externality imposed by the referral of patients from the primary care center to the hospital. This is a new element not present in the previous literature.

Several previous contributions in the literature have looked at different aspects related to our model. The payment rules vary according to the service and according to the risk burden imposed upon the provider (see Mossialos and Le Grand (1999) for a review of systems in place in the European Union countries). For example, capitation payments defined for a narrow scope of services are usually coupled with additional mechanisms to restrict unnecessary, burden-shift referrals. This is very much in line with our results. In particular, the optimality of vertical integration can be replicated by an appropriate transfer contract in a non-integrated structure.

Barigozzi (2001) studies optimal reimbursement for secondary prevention and treatment when insurance uses a linear mechanism and treatment and prevention may be either substitute or complementary goods. In this regard the WHO (1998) supports the idea of mixed payment systems, with a significant prospective component. Nonetheless, there is the worry of prospective payments leading to excessive referrals. We address the question explicitly in our model. Also, Fournier and

McInnes (2002) study the role of referrals in the provision of quality of surgical services according to patients holding a traditional insurance or being under managed care.

Banks, Parker and Wendel (2001) examine the strategic interaction among providers of acute care and of nursing facilities, and how payment systems interact with incentives for vertical integration. They find that the transition from a variable to a fixed payment hospital reimbursement system created incentives for vertical integration and inefficient production. Though with a different aim, our main questions are close to theirs.

Weiner and de Lissovoy (1993) show that different levels of provider integration originates distinct preventive levels. Pauly (1970) finds a positive relation between financial means and prevention effort. Frank, Glazer and McGuire (2000) relate the prevention effort with the attraction of healthier than average population. To these arguments, we add the internalization of the referral decisions.

Our model shows that the referral externality induced by the referral of patients from the primary care center to the hospital constitutes an important element in the provision of preventive health care services. In particular, it changes in unexpected ways the assessment of likely effects of moving from independent to joint management of different levels of health care providers. The analysis is performed through a series of examples combining capitation vs fee-for-service at the primary care center with prospective vs cost-based payment at the hospital. We find that the referral externality has an impact on the prevention efforts exerted at the primary care center according to the payment schemes and management organization. In particular, we will argue that when hospitals are reimbursed according to costs, prevention efforts are unlikely to occur. However, under a capitation payment for the primary care center and prospective budget for the hospital, prevention efforts increase when shifting from an independent to an integrated management. Also, from a normative standpoint, we obtain that optimal payment schemes are simpler under joint management. Thus, the referral externalities argument can be a potential explanation for the growth of both types of managed care vis-a-vis the decline of traditional insurance agreements.[1]

The institutional setting of the model corresponds to a relatively centralized health care system as is common in most EU countries. We assume a compulsory health care insurance on the population provided publicly, privately (regulated) or both. This makes demand price-insensitive at the point of consumption. Therefore, a reduced form for demand is used. Our focus is on the supply side. Thus, in this setting there is not much room for the players to integrate. Rather this is a decision

[1]The qualification "potential" is due to the absence of a formal empirical test of this effect, which is beyond the scope of the paper.

left to the Health authority according to some welfare analysis.

The paper is organized in the following way. Section 2 presents the model and introduces the behavioral assumptions on the players. Section 3 is devoted to the analysis of the equilibrium. We introduce two different types of management (independent or joint) for the primary care center and the hospital and compare the equilibrium effort levels. Our analysis of integration is limited. Most of the literature on vertical integration considers more than two firms. Accordingly, there is room for strategic effects such as dumping of patients among hospitals (see e.g. Ellis and Ruhm (1988)). We abstract from these effects to stress the relevance of the externality produced by the referral of patients from the primary care center to the hospital. Section 4 illustrates the optimal (welfare maximizing) payment schemes. Section 5 concludes.

2 The model.

Consider a population of N individuals fully covered with a compulsory health insurance providing preventive care services and treatment services when necessary.[2] Such services can be obtained from first or second level providers whose managements can be independent or joint. A healthy individual enjoys a utility level B. Patients suffers a health loss $\widetilde{L} = L + \eta$, where L is a non-recoverable utility loss, and η is a random term reflecting illness severity. Utility loss η can be recovered by adequate treatment. We assume illness severity to be distributed according to a probability distribution function $F(\eta)$ with support $[\underline{\eta}, \overline{\eta}], \underline{\eta} > 0$.

Implicitly we are considering a "minor" sickness in the sense that its treatment does not require sophisticated technology and where the life of the patient is not at stake. Nevertheless, these cases are important in economic terms as they involve a very significant share of the working time lost. Examples of the type of sickness we consider are stress, flu, depression, small accidents leading to broken arms or legs, etc. We are not considering situations where diagnosis occurs at the hospital although treatment can take place at either facility, such as some cancer treatments, dialysis, etc. neither do we consider emergency services like stroke or failure of vital organs.

At the primary care center two activities take place. First, the primary care center puts effort e_1 to promote prevention. We can think of this effort as primary prevention, that is, as activities population-oriented such as vaccination campaigns and clinician-oriented such as the use of disposable injections. These actions have an impact on the probability of an individual falling sick, $p(e_1)$. We assume this illness probability function to be decreasing and convex in effort, that

[2]The insurance decision is not under consideration in this paper.

is, $p'(e_1) < 0$, $p''(e_1) > 0$. The cost of such effort is represented by a convex function $\phi_1(e_1)$ satisfying $\phi_1'(e_1) > 0$, $\phi_1'(0) = 0$, $\phi_1''(e_1) > 0$. Second, once a patient arrives at the primary care facility a first evaluation, with cost v, is performed to assess η. We assume no error is made in this assessment. The primary care center defines a rule of referral stating that all patients with $\eta < \hat{\eta}$ are treated at the primary care center. The value $\hat{\eta}$ depends positively on the effort e_2 made by the primary care center, that is, $\hat{\eta} = \hat{\eta}(e_2), \hat{\eta}'(e_2) > 0, \hat{\eta}''(e_2) < 0$. The choice of $\hat{\eta}$ is conceivably constrained by clinical protocols establishing that for low enough severities, the primary care center has the obligation to treat the patient, while for high enough severities, the patient must be referred to the hospital. The probability of not referring a patient is then $F(\hat{\eta}(e_2))$.

Effort e_2 can thus be interpreted also as the effort of the primary care center to treat patients (secondary prevention). Also, e_2 can be thought of as the effort to "triage" patients.[3] In a different fashion, it can also be understood as actions to improve communication between hospital specialists and primary care center general practitioners, as well as actual behavior of both GPs and specialists. A good example is the use of telemedicine (Harrison, Clayton and Wallace 1996; Mair and Whitten 2000), and the development of electronic networks involving primary care (Willmot and Sullivan 2000). The cost of effort e_2 is $\phi_2(e_2)$ assumed convex whenever effort is positive: $\phi_2'(e_2) > 0$, $\phi_2'(0) = 0$, $\phi_2''(e_2) > 0$.

Let $\tilde{c}(\eta)$ be the cost of treating a patient with severity η at the primary care center. We assume $\tilde{c}'(\eta) > 0$ and $\tilde{c}'(\eta) > 0$. Define $c(e_2)$ as the average cost of treatment per patient treated in the primary care facility:

$$c(e_2) = \int_{\underline{\eta}}^{\hat{\eta}(e_2)} \tilde{c}(\eta) dF(\eta).$$

We have $c'(e_2) > 0$ and $c''(e_2) > 0$. The first part follows directly from $\hat{\eta}$ being an increasing function of effort and cost of treatment being increasing in patients' severity. The second part assumes the direct effect of increasing expected cost due to an increase in severity of patients treated at the primary care center to dominate the (eventually) decreasing marginal effect of effort on $\hat{\eta}$ and the (possible) smaller density of patients at high severity levels (which also slows down the rate of growth of costs).[4]

We denote by $W(e_1, e_2)$ the revenues to the primary care center, where W is defined by $W\big(Np(e_1), c(e_2), N, Np(e_1)F(\hat{\eta}(e_2))\big)$. That is, the payment function is (potentially) defined over the number of people visiting the primary care center,

[3] We acknowledge an anonymous referee for this suggestion.

[4] This last assumption is not strictly necessary. The expected cost of treatment can be concave, as long as it is not too concave. See below.

$Np(e_1)$, the average cost of treatment in the primary care center, $c(e_2)$, the population covered, N, and the number of people treated at the primary care center, $Np(e_1)F(\hat{\eta}(e_2))$. For simplicity, we use the reduced form $W(e_1, e_2)$. We assume W to be concave, $W_1(e_1, \cdot) < 0$, $W_2(e_2, \cdot) > 0$, $W_{ii}(e_i, \cdot) < 0$, $i = 1, 2$.. Furthermore, it is decreasing in e_1 as the more effort to promote prevention leads to less activity and thus, to less revenue. Also, we assume it increasing in e_2 as the less referring of patients involves more activity at the primary care center.

The hospital only action consists in doing some effort to lower treatment costs. Let e_3 denote such effort, and $\phi_3(e_3)$ its convex cost.[5] Note that this is a different type of activity. In particular, the hospital does not take preventive activities. Rather, it only seeks ways to become more efficient from a technological point of view. Thus the cost of providing treatment at the hospital is directly linked to this effort. The cost of treating a patient at the hospital is $\tilde{h}(\hat{\eta}(e_2), e_3)$, with $\tilde{h}_2(\hat{\eta}(e_2), e_3) < 0$ and $\tilde{h}_{22}(\hat{\eta}(e_2), e_3) > 0$. The expected cost is given by

$$h(e_2, e_3) = \int_{\hat{\eta}(e_2)}^{\overline{\eta}} \tilde{h}(\eta, e_3) f(\eta) d\eta,$$

satisfying $h_1(e_2, e_3) < 0, h_{11}(e_2, e_3) < 0$.[6]

The revenues to the hospital are denoted by $R(e_1, e_2, e_3)$, where $R(e_1, e_2, e_3) = R\Big(h(e_2, e_3), Np(e_1)(1 - F(\hat{\eta}(e_2))\Big)$. That is, the payment schedule to the hospital depends on the (average) cost per patient and on the total number of patients treated within the hospital. We assume R to be concave. Moreover it is decreasing in all its arguments: the more effort to lower treatment costs, the less revenue is required; the higher the primary care center efforts e_1 and e_2 the less activity at the hospital level: $R_i(e_i, \cdot) < 0$, $R_{ii}(e_i, \cdot) < 0$, $i = 1, 2, 3$.

We assume $v < c(e_2) < h(e_2, e_3)$. This is in accordance with conventional wisdom. In other words, we assume that the infrastructure at the hospital is more expensive than at the primary care center. Also, more qualified medical staff is to be found at the hospital, also adding to the (average) cost.

We perform our analysis through a series of examples combining different payment rules both at the primary care center and at the hospital. In particular we will consider an (extended) capitation scheme or a fee-for-service at the level of the

[5] One can discuss about the contribution of the hospital to improve referral patterns. In particular, it is sometimes argued that hospitals have a relatively minor role in influencing referral rates from primary care centers. We stylize this role by neglecting it. We can include another effort on the part of the hospital consisting in actions to avoid referrals from the primary care center. These actions would complement those embedded in e_2 but would not add any particular insight to the analysis.

[6] Again, we assume the direct effect on cost to be stronger than the density effect and the (eventually) decreasing marginal effect of effort on $\hat{\eta}$.

primary care center to be combined with a prospective budget or a cost reimbursement rule for the hospital. In these different set-ups we will study the impact on the different efforts of a centralized or independent management of first and second level providers. To do so, first we will define the objective functions of the players. Also, we will introduce the a health authority (social planner) to be able, later, to examine the optimality properties of the reimbursement schemes.

We can certainly discuss extensively the appropriate objective functions for primary care centers and hospitals. We take here the (narrow) view that they want to generate the higher possible surplus. We do not specify which use is given to such surplus.[7]

The primary care center chooses effort levels e_1 and e_2 to maximize its net revenues, that is,

$$\Pi^P = \max_{e_1,e_2} W(e_1,e_2) - \phi_1(e_1) - \phi_2(e_2) - Np(e_1)[c(e_2) + v]. \qquad (1)$$

The problem of the hospital is to select effort level e_3 to maximize its net revenues. Formally,

$$\Pi^H = \max_{e_3} R(e_1,e_2,e_3) - \phi_3(e_3) - Np(e_1)h(e_2,e_3). \qquad (2)$$

In the normative analysis, the benchmark is provided by the choice of the health authority. It chooses effort levels e_1, e_2, e_3 to maximize social welfare:

$$\max_{e_1,e_2,e_3} V = BN - Np(e_1)[L + c(e_2) + v + h(e_2,e_3)] - \\ - [\phi_1(e_1) + \phi_2(e_2) + \phi_3(e_3)]. \qquad (3)$$

3 Equilibrium Analysis

We aim at comparing the net revenue-maximizing efforts of the primary care center and the hospital under two different management regimes, namely a decentralized (independent) management and a centralized (joint) management. To do it, we propose a series of examples defined by particular combinations of reimbursement schemes.

[7]There is no change in the analysis if providers care only about recoverable utility loss due to sickness, as patients are assumed to fully recover η after treatment.

3.1 Independent management of primary care center and hospital.

Primary care center. From (1) we derive the first-order conditions. They are,

$$\frac{\partial \Pi^P}{\partial e_1} = W_1(e_1, \cdot) - Np'(e_1)[c(e_2) + v] - \phi_1^{'}(e_1) = 0, \tag{4}$$

$$\frac{\partial \Pi^P}{\partial e_2} = W_2(\cdot, e_2) - Np(e_1)c^{'}(e_2) - \phi_2^{'}(e_2) = 0. \tag{5}$$

As usual, these conditions equate the marginal cost of the respective efforts to the marginal revenues of the primary care center.

Hospital. From (2) the first-order condition is,

$$\frac{\partial \Pi^H}{\partial e_3} = R_3(e_3, \cdot) - Np(e_1)h_2(\cdot, e_3) - \phi_3^{'}(e_3) = 0. \tag{6}$$

As usual, this condition equates the marginal cost of the effort to the marginal revenue of the hospital.[8]

3.2 Joint management of primary care center and hospital.

Under joint management of the primary care center and the hospital, the selection of efforts are derived from the following objective function,

$$\Pi = \max_{e_1,e_2,e_3} W(e_1, e_2) + R(e_1, e_2, e_3) - Np(e_1)[c(e_2) + v + h(e_2, e_3)] - [\phi_1(e_1) + \phi_2(e_2) + \phi_3(e_3)]$$

Accordingly, the system of first-order conditions is,

$$W_1(e_1, \cdot) + R_1(e_1, \cdot) - Np'(e_1)[c(e_2) + v + h(e_2, e_3)] - \phi_1^{'}(e_1) = 0, \tag{7}$$

$$W_2(e_2, \cdot) + R_2(e_2, \cdot) - Np(e_1)[c^{'}(e_2) + h_1(e_2, \cdot)] - \phi_2^{'}(e_2) = 0, \tag{8}$$

$$R_3(e_3, \cdot) - Np(e_1)h_2(\cdot, e_3) - \phi_3^{'}(e_3) = 0. \tag{9}$$

3.3 Social Welfare.

The problem to solve from the social welfare point of view is to find a vector of efforts to maximize the function given by (3).

[8]Hereafter, we assume second-order conditions of all maximization problems to be satisfied. This is equivalent to assume effort costs to be sufficiently convex.

The set of first-order conditions is,

$$-Np'(e_1)[c(e_2)+v+h(e_2,e_3)+L]-\phi_1^{'}(e_1)=0, \tag{10}$$
$$-Np(e_1)[c'(e_2)+h_1(e_2,\cdot)]-\phi_2^{'}(e_2)=0, \tag{11}$$
$$-Np(e_1)h_2(\cdot,e_3)-\phi_3^{'}(e_3)=0. \tag{12}$$

3.4 Joint management, independent management and welfare.

Let β and γ be parameters to allow the comparison of the joint and independent management for the different efforts. Let also α and δ be parameters allowing this comparison w.r.t. social welfare.

Looking now at the first-order conditions (4), (7), (10) we can summarize them as,

$$\phi_1^{'}(e_1)=\alpha W_1(e_1,\cdot)+\beta R_1(e_1,\cdot) - Np'(e_1)[c(e_2)+v+\gamma h(e_2,e_3)+\delta L]. \tag{13}$$

Note that for $\alpha=1$ and $\beta=\gamma=\delta=0$ we recover (4); for $\delta=0$ and $\alpha=\beta=\gamma=1$ we recover (7). Also for $\gamma=\delta=1$ and $\alpha=\beta=0$ we recover (10).

Regarding effort e_2, the first order conditions (5), (8) and (11) can be summarized as,

$$\phi_2^{'}(e_2)=\alpha W_2(\cdot,e_2)+\beta R_2(e_2,\cdot)-Np(e_1)[c'(e_2)+\gamma h_1(e_2,\cdot)]. \tag{14}$$

For $\alpha=1$ and $\beta=\gamma=0$ we recover (5); for $\alpha=\beta=\gamma=1$ we recover (8). Finally, for $\gamma=1$ and $\alpha=\beta=0$ we obtain (11).

The first-order conditions with respect effort e_3 in the independent and joint management cases coincide. Therefore, we can summarize all the first order conditions as,

$$\phi_3^{'}(e_3)=\alpha R_3(e_3,\cdot)-Np(e_1)h_2(\cdot,e_3), \tag{15}$$

where $\alpha=1$ lets us recover (6) and (9), while for $\alpha=0$ we recover (12).

To ease the comparisons between the different scenarios we summarize in Table 1 the values of the transition parameters.

3.5 Joint vs. Independent Management

We can now address the following positive question: what is the effect of moving from a decentralized organization of primary and acute care to an integrated-services view, conditional on the proposed payment rules?

	Joint	Independent	Social Welfare
α	1	1	0
β	1	0	0
γ	1	0	1
δ	0	0	1

Table 1: Values of the transition parameters.

We know, from our normative analysis, that under the assumptions of the model, the first-best can be achieved under both structures, provided payment schedules are appropriately defined. Since the optimal rules derived (see section 4 below) are not observed in practice (up to our knowledge), then it is relevant to ask what are the effort implications of alternative architectures for the health system.

To compare the joint management and the independent management, note that looking at the two first columns of Table 1, $\alpha = 1$ and $\delta = 0$. Finally, $\beta = \gamma$ go from 1 to 0 when considering the transition from a joint to an independent management. Hence, we can set $\beta = \gamma$ and do the comparative statics on β.

The system of first-order conditions (13)-(15) characterizes the equilibrium effort levels. Generically, these first-order confitions can be summarized as

$$\phi_i^{'}(e_i) = k^i(\beta),\ i = 1, 2, 3,$$

where k^i stands for the difference between marginal revenue and marginal cost associated to effort e_i.

To provide a positive view on the implication of our model, we have to define a specific payment schedule. Thus, assume the hospital is reimbursed according to a global budget rule set in a prospective manner, that is, $R(e_1, e_2, e_3) \equiv a_0$. According to Mossialos and Le Grand (1999) global budget is the most common type of payment of hospital care (even if the global budget is built on the basis of expected activity).[9]

3.5.1 Capitation payment for primary care service

Regarding the primary care center, let us assume that it is reimbursed on an extended capitation basis, that is

$$W(e_1, e_2) = b_1 N + b_2 N p(e_1) + b_3 N p(e_1) F(\hat{\eta}(e_2)), \tag{16}$$

[9]See Mossialos and Le Grand (1999) tables 1.4 and 1.5 for an overview of different systems present in the European Union. This formulation has also been used extensively in the literature. See, for example, Chalkley and Malcomson (2000).

where $b_2 < v$ and $b_3 < \tilde{c}(\hat{\eta}(e_2))$. Parameters b_2 and b_3 capture per capita value per visit and per treatment respectively. We assume here that these values are below their associated costs. The pure capitation system with no relation to actual activity performed would pay only on the basis of population covered. This corresponds to the first term ($b_1 N$). We allow for partial payment on the basis of visits ($b_2 N p(e_1)$) and treatments ($b_3 N p(e_1) F(\hat{\eta}(e_2))$). To still describe some form of capitation payment, these two last payments cannot be sufficient to sustain activity in an economically viable way as the marginal costs overcome the corresponding marginal revenues for every patient. The case $b_3 > \tilde{c}(\hat{\eta}(e_2))$ and $b_2 > v$ will be treated below as they take us to fee-for-service schemes.

Now the system of first-order conditions, taking into account (16), reduces to

$$k^1(\beta) \equiv -Np'(e_1)\Big[c(e_2) - b_3 F(\hat{\eta}(e_2))) + v - b_2 + \beta h(e_2, e_3)\Big], \tag{17}$$

$$k^2(\beta) \equiv -Np(e_1)\Big[c'(e_2) - b_3 f(\hat{\eta}(e_2))\hat{\eta}'(e_2) + \beta h_1(e_2, \cdot)\Big], \tag{18}$$

$$k^3(\beta) \equiv -Np(e_1)h_2(\cdot, e_3)) \geq 0, \tag{19}$$

where $c'(e_2) = \tilde{c}(\hat{\eta}) f(\hat{\eta})\hat{\eta}'(e_2)$, and $h_1(e_2, \cdot) = -f(\hat{\eta})\hat{\eta}'(e_2)\tilde{h}(\hat{\eta}(e_2), e_3)$.

As a first step, note that $k^1(\beta = 0) < k^1(\beta = 1)$ for all e_2 and e_3; $k^2(\beta = 0) < k^2(\beta = 1)$ for all e_1 and e_3; and $k^3(\beta = 0) = k^3(\beta = 1)$ for all e_1 and e_2. Thus, when changing from $\beta = 0$ to $\beta = 1$, the curve $k^i(\beta = 0)$, evaluated at the new effort levels, is a lower bound to the true $k^i(\beta = 1)$, also evaluated at the new equilibrium effort levels.

To have an interior equilibrium, at all effort levels, from the first-order conditions (17) - (19), it is required that

$$c(e_2) - b_3 F(\hat{\eta}(e_2)) + v - b_2 + \beta h(e_2, e_3) > 0, \tag{20}$$

$$(\tilde{c}(\hat{\eta}(e_2)) - b_3) - \beta h(e_3, \hat{\eta}(e_2)) < 0. \tag{21}$$

Expression (21) does not hold for $\beta = 0$ and it is likely to hold for $\beta = 1$. Thus, for $\beta = 0$ effort e_2 will be at its minimum value. The other expression is satisfied for all values of β as long as $b_2 < c$. This is a sufficient condition relating the marginal cost of a visit in the primary care center with its marginal revenue. At the margin the payment received associated with a consultation must be lower than its cost.

Holding constant e_3, it is easy to check that changing to an integrated-services model will increase both e_1 and e_2. Figure 1 illustrates this argument.

Let us now study how $k^i(\beta)$ shifts when we allow for all efforts to vary.

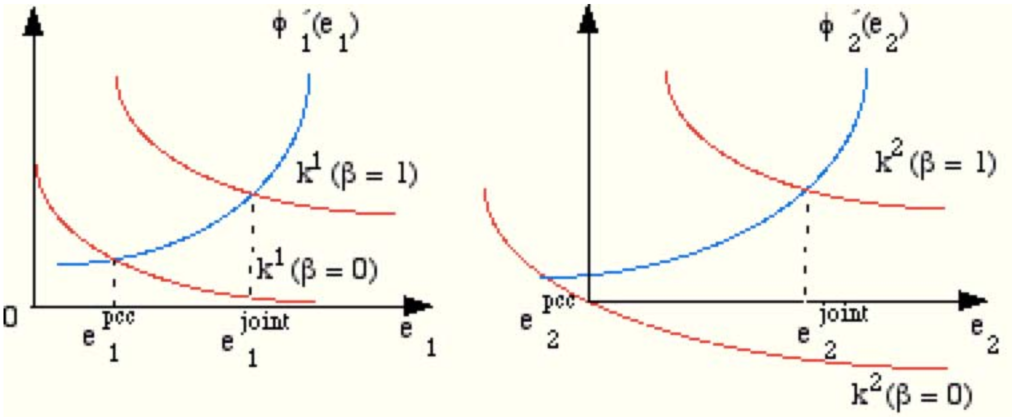

Figure 1: Impact of integration on e_1 and e_2.

Straightforward derivations establish that

$$\frac{\partial k^1}{\partial e_2} = -Np'(e_1)\hat{\eta}' f(\hat{\eta})[\tilde{c}(\hat{\eta}) - b_3 - \beta\tilde{h}(\hat{\eta}(e_2), e_3)] = \frac{\partial k^2}{\partial e_1}$$
$$\frac{\partial k^1}{\partial e_3} = -Np'(e_1)\beta h_2(e_2, e_3) < 0$$
$$\frac{\partial k^2}{\partial e_3} = Np(e_1)\beta f(\hat{\eta})\hat{\eta}\tilde{h}_2(\hat{\eta}(e_2), e_3) \leq 0$$
$$\frac{\partial k^3}{\partial e_1} = -Np'(e_1)h_2(e_2, e_3) \leq 0$$
$$\frac{\partial k^3}{\partial e_2} = Np(e_1)\tilde{h}_1(\hat{\eta}(e_2), e_3)f(\hat{\eta})\hat{\eta}' \leq 0$$

From (21), we find that $\partial k^1/\partial e_2 = \partial k^2/\partial e_1$ is negative for $\beta = 1$ and positive for $\beta = 0$.

Therefore, in equilibrium, both e_1 and e_2 increase with the move from independent management to integrated services. It is also the case that e_3 decreases. The intuition runs as follows. With integration, decisions on the effort levels of prevention and of treating patients in primary care take into account the costs of hospital treatment if a patient reaches that stage. Thus, prevention efforts increase as well as the effort to treat patients. This, in turn, reduces the incentive to invest in cost reduction at the hospital level (as less patients reach the hospital). Since a lower effort for cost reduction leads to higher unit hospital costs, it reinforces the incentive to have higher efforts at the primary care level, ensuring internal consistency of the comparative statics exercise. Figure 2 illustrates this discussion.

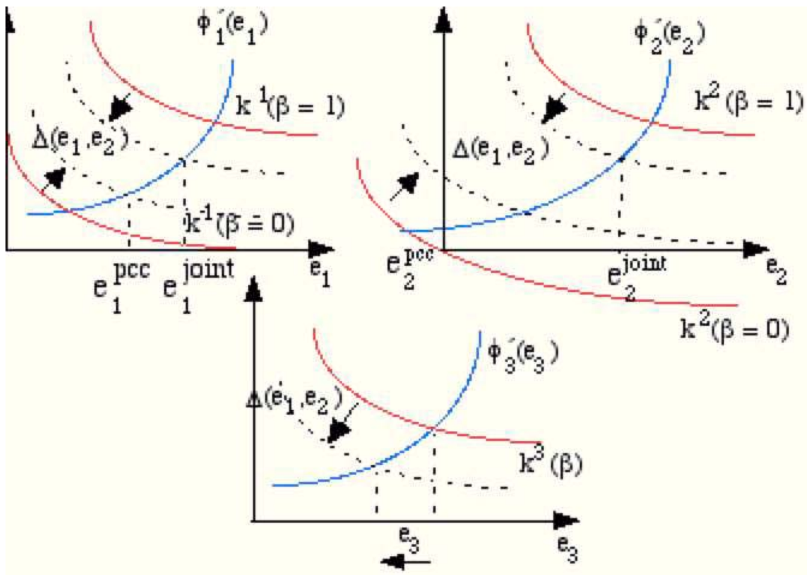

Figure 2: Efforts under prospective payment for hospitals and capitation for primary care centers.

We summarize this discussion, in the following result:

Under a prospective payment rule for hospital care and capitation for primary care services, in equilibrium both e_1 and e_2 efforts increase and e_3 decreases when moving from independent management to integrated services.

In other words, the change in the management structure of the two providers of preventive health care services induces an increased effort to diminish the population of patients and also as many of those patients as possible are treated at the primary care center. Consistently with this induced behavior on the part of the primary care center, the hospital faces a lower incentive to control its treatment costs.

3.5.2 Fee-for-service payment for primary care service

Consider again the payment schedule for the primary care center given by (16). For treatments paid under fee-for-service, one would expect that marginal benefit to the provider must exceed its marginal cost as all payments are linked to activity. Thus, $b_3 > \tilde{c}(\hat{\eta}(e_2))$ and $b_1 = 0$. As in the previous case, $k^1(0) < k^1(1)$ and $k^2(0) < k^2(1)$. Accordingly, when changing from $\beta = 0$ to $\beta = 1$, the curve $k^i(0)$, evaluated at the new effort levels, is a lower bound to the true $k^i(1)$.

To have interior solutions, we need as before $k^1(\beta) > 0$ and $k^2(\beta) < 0$. Now, the latter expression always holds while the former will generally not hold for $\beta = 0$ and effort e_1 will be at its minimum, and may hold for $\beta = 1$.

Now when we consider a simultaneous variation of e_1 and e_2 we find that, $k^1/e_2 = k^2/e_1 < 0$ for all values of β.

Given the properties of this case, it is not possible to predict the final outcome of the change to integrated services. In a first moment, both e_1 and e_2 increase. This triggers a decrease in e_3, but also a decrease in e_2 and a further increase in e_1. However, due to cross-effects, there are conflicting forces affecting effort levels. In particular, given that $b_3 > \tilde{c}(\hat{\eta}(e_2))$, there is always advantage to the primary care center in treating the patient. If integration increases the prevention effort, it also means that the net benefit from treating people at the primary care level will be smaller, as there is a smaller probability that someone will need treatment. Thus, incentives to increase the probability of treatment in primary care are smaller. All in all, the composite effect is ambiguous, à priori.

This means that integration in health systems that pay primary care providers on a fee-for-service basis may lead to quite distinct, and to a certain extent unexpected, outcomes.

3.6 Hospitals under cost reimbursement

Consider now the other limiting case, that is, full cost reimbursement where $R(e_1, e_2, e_3) = Np(e_1)h(e_2, e_3)$. It is straightforward to see that there is no incentive to perform hospital cost-reduction effort (a well-known result).[10] In addition, whether we have fee-for-service in primary care ($b_3 > \tilde{c}(\hat{\eta}(e_2))$ and $b_2 < v$) or a (partial) capitation system ($b_3 < \tilde{c}(\hat{\eta}(e_2))$) is again crucial.

Under a capitation payment system to primary care, even if it is a partial one, no effort to reduce referral rates is done by the primary care center. Prevention effort, if done at all, is insensitive to the organizational design. This is so because under a partial capitation, it is always profitable to the primary care center to divert patients to the hospital. To see this, substitute the expression for $W(e_1, e_2)$ in (1) to obtain

$$\Pi^P = b_1 N + b_2 Np(e_1) - vNp(e_1) + b_3 Np(e_1)F(\hat{\eta}(e_2)) - Np(e_1)c(e_2) - \phi_1(e_1) - \phi_2(e_2).$$

Take the first-order derivative associated with the effort decision,

$$\frac{\partial \Pi^P}{\partial e_2} = Np(e_1)\Big[b_3 f(\hat{\eta})\hat{\eta}'(e_2) - f(\hat{\eta})\hat{\eta}'(e_2)\tilde{c}(\hat{\eta}(e_2))\Big] - \phi_2'(e_2).$$

[10] To see this, take the profit of the hospital, given by expression (2) and substitute $R(e_1, e_2, e_3)$. Then, $\Pi^H = -\theta_3(e_3)$, which yields minimum effort.

Clearly, for $b_3 < \tilde{c}(\hat{\eta}(e_2))$, which we identify with the capitation system, $\dfrac{\partial \Pi^P}{\partial e_2} < 0$ yielding zero effort. Taking now the first-order derivative in prevention effort,

$$\frac{\partial \Pi^P}{\partial e_1} = Np'(e_1)\Big[(b_2 - v) + \int_{\underline{\eta}}^{\hat{\eta}} (b_3 - \tilde{c}(\eta)) f(\eta) d\eta\Big] - \phi'(e_1) < 0.$$

From which we obtain zero prevention effort.

Consider in turn the fee-for-service system, $b_3 > \tilde{c}(\hat{\eta}(e_2))$ and $v > b_2$. Under this condition, $v - b_2$ must be sufficiently high for prevention effort to be done at positive levels. Whenever prevention effort is above its minimum level, integration increases prevention and decreases the incentive for referral rate reductions. Again, the full-cost reimbursement effect is at work. There is no cost in shifting patients to the hospital. There is only the financial loss of not treating them at the primary care center.[11] Again we should expect an increase in the overall cost of the system.

The last subcase occurs when prevention is not sufficiently rewarded, and e_1 is set at its minimum value.[12] Under fee-for-service, integration leads the hospital management to recognize the financial gain associated with treating patients at the primary care level. Thus, the effort to avoid referral to the hospital will increase.

We find again that optimal efforts will evolve in different directions, after integration of primary care and hospital management, depending on the way treatment at primary care centers is paid. Regarding referral rates, they are also contingent on the scenario considered. Table 2 summarizes all effects.

Hospital/PCC	Capitation	Fee-for-service
Global Budget	Prevention level increases Referral rate decreases Hosp. average cost decreases	Prevention level ambiguous Referral rate ambiguous Hosp. average cost ambiguous
Cost-Based	Prevention level unchanged Referral rate constant No hosp. average cost effect	Prev. level unchanged or increasing Referral rate decreases No hosp. average cost effect

Table 2: Effects due to a switch from independent to integrated management.

[11] This can be verified analytically by total differentiation of first-order conditions and computation of comparative statics effects. To sign expressions, one appeals to second-order sufficient conditions: principal minors alternate in sign, starting negative, for a maximum value of the objective function to be achieved.

[12] This corresponds to expression (17) for $v - b_2$ negative or small enough.

3.7 Absence of prevention effort

Our analysis illustrates that vertical integration of different layers of provision in the health care market and prevention issues cannot be seen in isolation. The economic incentives are interdependent in a non-obvious way. To make the point clear, suppose that prevention effort done by the primary care center is constant.[13] Then,

$$
\begin{aligned}
k^2(\beta) &= -\,Np(\bar{e}_1)f(\hat{\eta})\hat{\eta}'(e_2)\left[\tilde{c}(\hat{\eta}) - b_3 - \beta\tilde{h}(\hat{\eta}(e_2), e_3)\right] \\
k^3(\beta) &= -\,Np(\bar{e}_1)h_2(e_2, e_3) \geq 0
\end{aligned}
$$

Totally differentiating the relevant first-order conditions with respect to e_2, e_3 and β allows to establish that:

$$
\frac{de_2}{d\beta} > 0 \qquad \text{and} \qquad \frac{de_3}{d\beta} < 0 \tag{22}
$$

Thus, in the absence of prevention, the move from independent to joint management leads to an increase in efforts to avoid referrals (consequently, the primary care center treats more patients) and a decrease in hospital cost-reduction effort (as fewer patients reach the hospital and higher hospital costs reinforce the incentive to treat at primary care whenever feasible).

When prevention effort (and incentives) is accounted for and treatments at primary care are paid, at the margin, below cost, the same intuition and effects carry through. However, if treatment at primary care is paid under fee for service, with "price" above marginal cost ($b_3 > \tilde{c}(\hat{\eta}(e_2))$), then comparative statics differ from the case without prevention. This is so because prevention efforts change both the marginal benefit of effort to avoid referrals to the hospital and the marginal benefit of hospital cost reductions (decreasing on prevention effort). Any increase in prevention dampens the incentive to do effort at the primary care center to avoid referral to hospital, as described above. Thus, incentives for cost reduction, for prevention and payments systems/providers organization interact in complex ways. They cannot be treated in a simple additive way.

4 Implementing the first-best allocation of efforts

Given that our model assumes perfect information, the solution of the social welfare problem must yield the first-best allocation of efforts. Thus, we can study the design of the reimbursement schemes for the primary care center and the hospital allowing for the achievement of the first-best allocation of efforts both under

[13] The same argument can be done making any of the efforts constant in turn.

joint and independent management. We can do this exercise without explicitly computing the first-best effort levels simply by comparing the system of first-order conditions (13) to (15) after applying the corresponding values of the transition parameters given in Table 1. The aim of the exercise is not to show that under either regime there is always a reimbursement scheme allowing to achieve the first-best allocation of efforts, but rather to illustrate the properties that such schemes should have, so that the private marginal benefit of prevention equates the social one. For that purpose we assume that the health authority chooses effort levels (e_1, e_2, e_3) to maximize a social welfare function given by expression (3).

4.1 Independent management

In terms of efforts e_1 and e_2 we can implement the first-best efforts if we can design a reimbursement $W(e_1, e_2)$ for the primary care center such that

$$W_1 = -Np'(e_1)h(e_2, e_3), \tag{23}$$
$$W_2 = -Np(e_1)h_1(e_2, e_3). \tag{24}$$

The reimbursement condition (23) establishes that, on the margin, the system should reward on the basis of people treated and on the social value of prevention, while condition (24) sets up a reimbursement component associated with the marginal costs resulting from referral to the hospital. At the margin, the last term equals the change in the savings from avoiding hospital treatment. That is, the reference benchmark is not the the cost of treating people in the primary care center but the cost saving of avoiding their treatment in the hospital (the true economic opportunity cost of primary care treatment). Regarding the hospital, effort e_3 is set at its optimal level.

4.2 Joint management

In the case of joint management, we can implement the first-best efforts if we can design reimbursements $W(e_1, e_2)$ and $R(\cdot, e_3)$ for the primary care center and the hospital respectively such that,

$$\begin{aligned} W_1 + R_1 =& -Np'(e_1)L, \\ W_2 + R_2 =& 0, \\ R_3 =& 0. \end{aligned}$$

Under joint management, there is internalization of efforts affecting referral rates, allowing for a global budget of the hospital part. As to the primary care center, the payment system only needs to correct for the marginal social value of prevention.

Under adequate mixed payment rules, the first-best allocation of resources is achieved under both system architectures. This is not surprising given the full information context of the model. Note that under the absence of a non-recoverable health loss ($L = 0$), a fixed budget scheme would be optimal.

5 Conclusions

We propose a model to examine the effects of providing preventive health care services introducing a new effect linked to the externality generated by the referral of patients from the primary care center to the hospital. A series of examples where different payment schemes for the primary and acute care facility are combined illustrates the main points. In particular, we consider capitation vs fee-for-service at the primary care center with prospective vs cost-based payment at the hospital, under centralized or decentralized management of the provision of health care. We find that the referral externality has an impact on the prevention efforts exerted at the primary care center according to the payment schemes and management organization. In particular, we argued that when hospitals are reimbursed according to costs, prevention efforts are unlikely to occur and the overall costs of the system tend to increase. However, under a capitation payment for the primary care center and prospective budget for the hospital, prevention efforts increase when shifting from an independent to an integrated management. Also, from a normative standpoint, we obtain that optimal payment schemes are simpler under joint management.

This last point constitutes an argument for joint management, as it is being attempted in the Portuguese NHS, with the creation of the ”local health systems”. However, the full capitation payment envisaged for such health entities is not optimal, according to our analysis. The reason is that a fully capitation payment for the joint management still entails too few incentives for prevention efforts. Thus, the payment rule must be such that the private marginal benefit of prevention equals the social one.

Of course, under the independent management architecture, the payment rule must also align the incentives for efforts that decrease referral rates. These adjustments are somewhat involved, as different referral rates also lead to different efforts for prevention (by the primary care center) and cost reduction (by the hospital). Still, in either case, the variables to be included in the payment rules are in general observed, or can be presumably estimated from existing data (this is the case of referral rates behavior and of the probability of being sick).

In this paper we have identified a different motive to set a mixed reimbursement system, which has a simple interpretation in our context. Moreover, unlike other motives, the calibration of the weight parameters is prone to be measured. This is in sharp contrast to other motives presented in the economics literature: (i) the asymmetric information motive (Laffont and Tirole (1993)) requires knowledge of the managers utility function for effort; (ii) the unobserved heterogeneity motive (Pope (1990)) demands information on patient factors that drive health care costs; (iii) the agency motive (Ellis and McGuire (1986)) requires knowledge of the physicians utility function; (iv) the measurement error motive (Newhouse (1991)) needs information on error variance of the prices.

The driving force behind our results is the referral externality. This makes our analysis complementary to most works reported in the literature. It also addresses in a more direct way the issue of preventive health care.

Our analysis is based on a very simple model that abstracts from many other issues. Thus, for a complete view of actual payment systems and for a more complete discussion of organizational design (integrated services vs. independent providers), one must add other relevant aspects, treated in the literature. We conjecture, nonetheless, that the externality effect highlighted here will remain. Moreover, the type of payment system required to internalize the referral externality is likely to survive in more complex settings.

Colophon

Acknowledgments

The authors wish to express their gratitude to David Li, Randall Ellis, Albert Ma, Matilde Machado, participants in the International Health Conference held in Hong Kong, an anonymous referee, and the editor Kyle Bagwell for their useful comments. Financial support of 2001SGR-00162 and BEC2000-0172 and CREA (Xavier Martinez-Giralt) and Praxis XXI 13132/1998 (Pedro Pita Barros) is gratefully acknowledged. The usual disclaimer applies.

Correspondence addresses:

Pedro Pita Barros	Xavier Martinez-Giralt
Departamento de Economia	CODE and Departament d'Economia
Universidade Nova de Lisboa	Universitat Autònoma de Barcelona
Travessa Estêvão Pinto	Edifici B
P-1099-032 Lisboa	08193 Bellaterra
Portugal	Spain
Fax: +351-21-388 60 73	Fax: +34-93-581 24 61
ppbarros@fe.unl.pt	xavier.martinez.giralt@uab.es

References

Banks, D., Parker, E. and Wendel, J., 2001, Strategic interaction among hospitals and nursing facilities: the efficiency effects of payment systems and vertical integration, *Health Economics*, **10**(2): 119–134.

Barigozzi, F., 2001, Reimbursing Preventing care, mimeo.

Boxx, W.R. and Chambless, J.R., 1975, Preventive Health Maintenance for Executives, *California Management Review*, **18**(1), 49-56.

Chalkley, M. and Malcomson, J., 2000, Government purchasing of health services, in *Handbook of Health Economics*, vol 1, edited by A. J. Culyer and J. P. Newhouse, Amsterdam, Elsevier Science B.V., chapter 15.

Dranove, D., 1998, Is there underinvestment in prevention research?, *Journal of Health Economics* 17(1): 117 – 127.

Ellis, R.P., and McGuire, T.G., 1986, Provider behavior under prospective reimbursement: cost sharing and supply, *Journal of Health Economics*, **5**(2): 129-151.

Ellis, R.P. and Ruhm, C.J., 1988, Incentives to Transfer Patients under Alternative Reimbursement Mechanisms, *Journal of Public Economics*, **37**(3): 381-94

Fournier, G.M. and McInnes, M.M., 2002, The Effects of Managed Care on Medical Referrals and the Quality of Specialty Care, *The Journal of Industrial Economics*, **50**(4): 457-473.

Frank, R., Glazer, J. and McGuire, T.G., 2000, Measuring adverse selection in managed health care, *Journal of Health Economics*, **19**(6): 829-854.

Harrison, R., Clayton, W. and Wallace, P., 1996, Can telemedicine be used to improve communication between primary and secondary care?, *British Medical Journal*, **313**: 1377-1380.

Kasl, S. and Cobb, S., 1996, Health Behavior, Illness Behavior and Sick Role Behavior, *Archives of Environmental Health*, **12**: 246-266.

Kenkel, D. S., 2000, Prevention, in *Handbook of Health Economics*, vol 1b, edited by A. J. Culyer and J. P. Newhouse, Amsterdam, Elsevier Science B.V., chapter 31.

Laffont, J.-J. and Tirole, J., 1993, *A Theory of Incentives in Procurement and Regulation*, Cambridge, MIT Press.

Mair, F. and Whitten, P., 2000, Systematic review of studies of patient satisfaction with telemedicine, *British Medical Journal*, **320**: 1517-1520.

Mossialos, E. and Le Grand, J., 1999, Cost containment in the EU: an overview, in *Health Care and Cost Containment in the European Union*, edited by E. Mossialos and J. Le Grand, Aldershot, Ashgate, chapter 1.

Newhouse, J.P., 1991, Pricing and imperfections in the medical care market place, in *Health Economics Worldwide*, edited by P. Zweifel and H.E. Frech, Amsterdam, Kluwer.

Oliver, R.L. and Berger, P.K., 1979, A Path Analysis of Preventive Health Care Decision Models, *Journal of Consumer Research*, **6**(2): 131-122.

Pauly, M., 1970, Efficiency incentives and reimbursement for health care, *Inquiry*, **7**(1): 115-131.

Pope, G., 1990, Using hospital-specific costs to improve the fairness of prospective reimbursement, *Journal of Health Economics*, **9**(3): 237-251.

Weiner, J. and de Lissovoy, G., 1993, Razing a tower of Babel: a taxonomy for managed care and health insurance plans, *Journal of Health Politics, Policy and Law*, **18**(1): 75-103.

Willmot, M. and Sullivan, F., 2000, NHSnet in Scottish primary care: lessons for the future, *British Medical Journal*, **321**: 878-881.

World Health Organization/Europe [WHO], 1998, *European Health Care Reform: Analysis of Current Strategies*, European Series no. 72, Denmark.