Preventive health care and payment systems to providers*

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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 present, both the normative and the positive analyses of the change from independent providers to integrated services. We show the evaluation of that change to depend on the particular way payment to providers is done.

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.

Keywords: Preventive health care, payment systems to providers.

JEL classification: I12, I18.

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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.

The WHO (1986), in the letter of Ottawa to promote health over all the population, proposed three courses of action: (i) development of healthy habits among children and youngsters, (ii) education in the self-care as well as encouragement of groups of mutual help, and (iii) application of preventive activities to the population in general and to the high-risk groups in particular.

There are several notions of prevention. Kenkel (2000) distinguishes three categories of prevention. *Primary prevention* relates to activities reducing the occurrence or incidence of disease. *Secondary prevention* considers "actions that reduce or eliminate the health consequences of a disease given its occurrence" (p. 1677). Finally, *tertiary prevention* comprises activities aiming at reducing the disabilities associated with chronic illness.

The American Board of Preventive Medicine, as quoted by Dranove (1998), proposes a global definition of preventive medicine as "that speciality of medical practice which focusses on the health of individuals and defined populations in order to protect, promote, and maintain health and well-being and prevent disease, disability and premature death."

In a somewhat more individualistic fashion, Oliver and Berger (1979), quoting Kasl and Cobb (1996), define preventive health care behavior as "any activity undertaken by a person who believes himself to be healthy for the purpose of preventing disease in an asymptomatic stage." In this context, Duraisamy and Duraisamy (1995) study the allocation of resources within the family unit according to the sex of the children in a rural community in India. From the perspective of the firm, Boxx and Chambless (1975) examine the benefits (cost savings) that an organization may obtain with a proper behavior scheme and regular medical check-ups to the employees, from the top executives until the workers in the simplest tasks.

Our focus differs from the above. We are interested in the industrial organi-

zation 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. In part this is because there is not an identifiable industry that produces prevention, viewed broadly; (...) Separate analysis of the supply of preventive medical care could be more fruitful, depending upon the extent to which this supply differs in important ways from the supply of physician services more generally. (...) 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."

Closer to this spirit is Encinosa and Sappington (1997). These authors present a model of competition among HMOs where the level of provision of preventive health services is used as an instrument to induce individuals to declare their true health state. However, the model was not intended for analysis of other aspects that are of relevance, like integration, or not, of primary and acute care within the same provider or the definition of a bundled payment (joint for both providers). In a recent paper, Banks, Parker and Wendel (2001) look at the strategic interaction among providers of acute care and of nursing facilities, and how payment systems interact with incentives for vertical integration. They also address the normative question of whether the first-best can be achieved. Though with a different aim, our main questions are close to theirs.

A general problem health authorities face is to provide the proper incentives both to patients to be willing to accept the increase in premia associated to the widening with preventive services of their insurance contracts, and to the insurance companies so that they are willing to include preventive care services in their insurance contracts (see, for instance, Kenkel (2000 pp. 1685-1693) and Zweifel and Breyer (1997, ch. 6). This is an important issue because the traditional analyses on provision of preventive health care services foresee an insufficient level of investment even though the total benefits of the provision of these services exceed their costs. In this sense Barigozzi (2001) reports on the lack of general agree-

ment in the cost-containment value of measures of secondary prevention such as diagnostic screening that usually do not do well in the cost-benefit analyses. The reason behind is that these analyses do not consider simultaneously the two sources of demand of preventive health services. On the one hand, patients lose income and utility when falling sick. On the other hand, insurance companies bear the costs associated to the appearance of the sickness (hospital, medicines, visits to doctors, etc.). Without the adequate incentives, neither the patients nor the private insurers are willing to pay for services of preventive medicine. A first effort in considering these effects together is Helwege (1996).

In this paper, 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 WHO in its World Health Report 2000, devotes part of chapter 3 to the description of service delivery configurations, and to the incentives according to the organizations structure of service provision. We rather investigate the structure of the relationships between primary and secondary care providers in relation with the activities (what in the model we refer to as efforts) linked to prevention. These relationships have been studied in different contexts. We can group them in four (broad) categories: (i) the synergies between hospital and primary care center (see Chatziarsenis et al. (1998)). Especially interesting is a recent experience in Portugal where the management of a stated-owned hospital was concessioned to private management. An evaluation, conducted for the Regional Health Authority, comparing the privately managed hospital with a similar size NHS hospital, suggested that links between primary care centers and hospitals were, in both cases, below the desired level (INA (1999)). The private management has stated several times their willingness to manage the primary care centers in the geographical area of influence. This desire is so far unmet (see also Hospital São Sebastião (2000)). Instead, another recent experiment in the Portuguese health system was the creation of local health systems, which put under the same management hospitals and primary care centers within a small, well-defined geographical area; (ii) the substitution between primary care and emergency departments in re-

lation with the provision of preventive care (see Hull et al. (2000), O'Brien et al. (1999), and Robertson-Steel (1998)). The basic objective of these studies is to identify the difficulties patients encounter in accessing the primary care services. By correcting them, the possibility arises of referring emergency department users to primary care; (iii) primary care clinicians as providers both of primary care and preventive services (see Keim et al. (1999) and Rafferty (1998)). Here, we find attempts to estimate the proportion of time primary care physician spend on prevention during routine care of patients; (iv) on referral rates, hospital admissions and quality of primary care (see Coulter (1998), Giuffrida et al. (1999), and Jankowski (1999)).

The question of centralization vs. decentralization of the provision of services is also relevant in relation with the managed care literature. Glied (2000) proposes a "broad definition" of managed care including (i) fully integrated insurance and service delivery; (ii) insured people restricted to a defined set of providers; and (iii) unrestricted choice of providers with insurers providing incentives to select providers. In this sense, managed care provides further instruments as the selection and organization of providers, the methods used to pay providers, and the methods of utilization review. It is also known that different levels of provider integration originates distinct preventive levels (Weiner and de Lissovoy (1993)). Other justifications have been proposed. Back to Pauly (1970) we find 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.

Curiously enough, the early HMOs were, on average, more vertically integrated than the present ones. An interpretation provided by Glied (2000, p. 713) is that "the advantages of formal vertical integration have declined over time or that consumer preferences for choice have increased". In any case, the integration aspect remained true whether in one-to-one relations or in group relations. Independent practice associations seem to dominate, namely the preferred provider organizations.

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. In fully vertically integrated plans, physicians are paid by salary; under decentralization, groups of physicians are paid on a capitation basis. Within the group, both capitation and salaries can exist; the individual physician contracts use capitation, discounted fee-for-service or incentive schemes. There are also less integrated arrangements, such as discounted fee-for-service that can be combined with bonuses or other incentive mechanisms.

The substitution of primary care for more expensive hospital services has been present in a number of cost strategies, as well as the use of payment incentives to treat patients in primary care. 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 this paper.

Glied (2000) discusses four sources of market failure and how management care arrangements cope with them: (i) asymmetric information about health risks: managed care plans are able to better segment consumers according to risk and utilization preferences; (ii) moral hazard: managed care adds supply-side cost sharing to the demand-side cost sharing typical of insurance contracts; (iii) information about health care quality: managed care plans may perform the role of providing information to consumers about the quality of care due to the way managed care is organized and its information requirements; (iv) industry competitiveness: man-

aged care plans may be a way to overcome the lack of competition in some areas and to countervail the market power of providers of health care. We add a fifth element. This is referral externalities. As our model shows, either a centralized structure or a decentralized one, combined with an appropriate payment system, can achieve the same outcome. This outcome is superior to a decentralized structure with simple payment rules (fee-for-service). 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 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. Here we introduce two different types of management (independent or joint) for the primary care center and the hospital. Then we compare the equilibrium effort levels between these two scenarios. This is done through a series of examples where the payment rule for both the primary care center and the hospital is fixed and the efficient (net-revenue maximizing) efforts are obtained. 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 derives the optimal (welfare maximizing) payment schemes. Section 5 concludes.

2 The model.

Consider a population of N individuals contracting a health insurance providing preventive care services. Such services can be obtained from first or second level providers whose managements can be independent or joint. When an individual gets sick suffers a utility loss L. While healthy enjoys a utility level B.

At the primary care center two activities take place: (i) The primary care cen-

[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.

ter puts effort e_1 to promote prevention. We can think of this effort as activities population-oriented such as vaccination campaigns and clinician-oriented such as the use of disposable injections. These actions are oriented to have an impact on the probability of an individual falling sick, $p(e_1)$. The cost of such effort is $\phi_1(e_1)$; (ii) Patients are visited. Let c denote the cost of visiting a patient at the primary care center, irrespective of whether (s)he is treated there or referred to the hospital. Let e_2 be the effort done by the primary care center to avoid referring a patient to the hospital. This effort can thus be interpreted also as the effort of the primary care center to treat patients. Activities related to this effort e_2 can be information campaigns addressed to the population encouraging the use of the primary care center rather than the specialized care services or the emergency units of hospitals to avoid e.g. congestion and limit waiting lists. Also lobbying activities to the health authority to set the primary care center as gatekeepers or to have facilities installed such as X-ray machines or minor surgery premises allowing for treatment of easy patients in the primary care center fall in this category. The cost of the treatment is c_p. The cost of the effort is $\phi_2(e_2)$. Finally, we denote by $W(e_1, e_2)$ the revenues to the primary care center, by $\theta(e_2)$ the probability that a sick person is treated at the primary care center, and by $1 - \theta(e_2)$ the probability of referral to the hospital.

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 cost. 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 primare care centers. We stylize this role by neglecting it. The cost of treating a patient at the hospital is $c_h(e_3)$. Finally the revenues to the hospital are $R(e_1, e_2, e_3)$.

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 embebded in e_2 but would not add any particular insight to the analysis.

We assume $c < c_p < c_h$; we also assume that all functions are twice continuously differentiable and usual regularity properties of the different functions

hold: convexity of illness probability function, of hospital-treatment cost-reduction function and of cost of effort; concavity of payment functions, and of the referral function; zero efforts implies absence of effort costs, no hospital-cost reductions and strictly positive probabilities of referral and referral rates. Summarizing,

$$
\begin{aligned}
&p'(e_1) < 0,\ p''(e_1) > 0;\\
&c_h'(e_3) < 0,\ c_h'(0) = 0,\ c_h''(e_3) > 0;\\
&\phi_i'(e_i) > 0,\ \phi_i'(0) = 0,\ \phi_i''(e_i) > 0,\ i = 1,2,3;\\
&R^3(e_3,\cdot) < 0,\ R^{ii}(e_i,\cdot) < 0,\ i = 2,3,\ R^2(e_2,\cdot) > 0;\\
&W^i(e_i,\cdot) < 0,\ W^{ii}(e_i,\cdot) < 0,\ i = 1,2;\\
&\theta'(e_2) > 0,\ \theta''(e_2) < 0.
\end{aligned}
$$

where superindices denote partial derivatives with respect to the specified argument, e.g. $R^i(e_i,\cdot) \equiv \dfrac{\partial R(e_i,\cdot)}{\partial e_i}$. In a similar fashion $p'(e_1) \equiv \dfrac{dp(e_1)}{de_1}$ or $c_h''(e_3) \equiv \dfrac{d^2c_h(e_3)}{de_3^2}$.

2.1 Objective functions.

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.

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

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

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

$$\Pi^H = \max_{e_3} R(e_1,e_2,e_3) - \phi_3(e_3) - Np(e_1)c_h(e_3)[1 - \theta(e_2)]. \qquad (2)$$

The health authority chooses effort levels e_1, e_2, e_3 to maximize social welfare:

$$\max_{e_1,e_2,e_3} V = BN - Np(e_1)[L + c_p\theta(e_2) + c + c_h(e_3)(1 - \theta(e_2))] - \\ - [\phi_1(e_1) + \phi_2(e_2) + \phi_3(e_3)]. \quad (3)$$

The effort in the referral function can be interpreted 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) and Mair and Whitten (2000)), and the development of electronic networks involving primary care (Willmot and Sullivan (2000)).

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 reimbursements schemes.

3.1 Independent management of primary care center and hospital.

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

$$\frac{\partial \Pi^P}{\partial e_1} = W^1(e_1, \cdot) - Np'(e_1)[c_p\theta(e_2) + c] - \phi_1'(e_1) = 0, \quad (4)$$

$$\frac{\partial \Pi^P}{\partial e_2} = W^2(e_2, \cdot) - Np(e_1)c_p\theta'(e_2) - \phi_2'(e_2) = 0. \quad (5)$$

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,

$$\frac{\partial \Pi^H}{\partial e_3} = R^3(e_3, \cdot) - Np(e_1)c_h'(e_3)[1 - \theta(e_2)] - \phi_3'(e_3) = 0. \quad (6)$$

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

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,

$$\begin{aligned}\Pi = \max_{e_1,e_2,e_3} & W(e_1,e_2) + R(e_1,e_2,e_3) \\ & - [\phi_1(e_1) + \phi_2(e_2) + \phi_3(e_3)] \\ & - Np(e_1)[c_p\theta(e_2) + c + c_h(e_3)(1-\theta(e_2))]\end{aligned}$$

Accordingly, the system of first order conditions is,

$$\begin{aligned}& W^1(e_1,\cdot) + R^1(e_1,\cdot) - Np'(e_1)\left[c_p\theta(e_2) + c + c_h(e_3)\left(1-\theta(e_2)\right)\right] \\ & \qquad - \phi_1^{'}(e_1) = 0, \qquad (7)\end{aligned}$$

$$W^2(e_2,\cdot) + R^2(e_2,\cdot) - Np(e_1)\theta^{'}(e_2)[c_p - c_h(e_3)] - \phi_2^{'}(e_2) = 0, \qquad (8)$$

$$R^3(e_3,\cdot) - Np(e_1)c_h'(e_3)[1-\theta(e_2)] - \phi_3^{'}(e_3) = 0. \qquad (9)$$

3.3 Social Welfare.

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

The set of first order conditions is,

$$- Np'(e_1)[c_p\theta(e_2) + c + c_h(e_3)(1-\theta(e_2)) + L] - \phi_1^{'}(e_1) = 0, \qquad (10)$$

$$- Np(e_1)\theta^{'}(e_2)[c_p - c_h(e_3)] - \phi_2^{'}(e_2) = 0, \qquad (11)$$

$$- Np(e_1)c_h'(e_3)[1-\theta(e_2)] - \phi_3^{'}(e_3) = 0. \qquad (12)$$

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,

$$\phi_1^{'}(e_1) = \alpha W^1(e_1,\cdot) + \beta R^1(e_1,\cdot) \\ - Np'(e_1)[c_p\theta(e_2) + c + \gamma c_h(e_3)(1-\theta(e_2)) + \delta L]. \quad (13)$$

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,

$$\phi_2^{'}(e_2) = \alpha W^2(e_2,\cdot) + \beta R^2(e_2,\cdot) - Np(e_1)\theta^{'}(e_2)[c_p - \gamma c_h(e_3)]. \quad (14)$$

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,

$$\phi_3^{'}(e_3) = \alpha R^3(e_3,\cdot) - Np(e_1)c_h'(e_3)[1-\theta(e_2)], \quad (15)$$

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.

	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.

3.5 Joint vs. Independent Management

We can now address the following 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?

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 do the comparative statics on β.

The system of first order conditions (13)-(15) characterizes the equilibrium effort levels, that is

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

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 prospective budget rule, that is, $R(e_1, e_2, e_3) = a_0$. According to Mossialos and Le Grand (1999) prospective budgets is the most common type of payment of hospital care (even if the global budget is built on the basis of expected activity).[2]

3.5.1 Capitation payment for primary care service

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

$$W(e_1, e_2) = b_1 N + b_2 N p(e_1) + b_3 N p(e_1) c_p \theta(e_2), \tag{16}$$

where $b_2 < 1$ and $b_3 < 1$ capture per capita value per visit and per treatment.

[2]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).

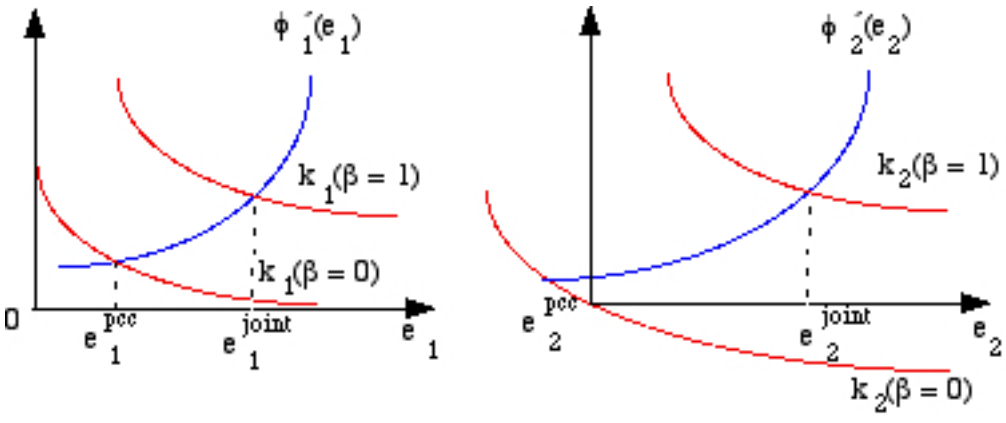

Figure 1: Impact of integration on e_1 and e_2.

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

$$k_1(\beta) \equiv -Np'(e_1)\Big[c_p\theta(e_2)(1-b_3)+c-b_2 + \beta(1-\theta(e_2))c_h(e_3)\Big] \tag{17}$$

$$k_2(\beta) \equiv -Np(e_1)\theta'(e_2)\Big[c_p(1-b_3)-\beta c_h(e_3))\Big] \tag{18}$$

$$k_3(\beta) \equiv -Np(e_1)c_h'(e_3))(1-\theta(e_2)) \geq 0. \tag{19}$$

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, it is required that (from (17), (18), and (19)):

$$c_p\theta(e_2)(1-b_3)+c-b_2+\beta(1-\theta(e_2))c_h(e_3) > 0, \tag{20}$$

$$c_p(1-b_3)-\beta c_h(e_3) < 0. \tag{21}$$

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.

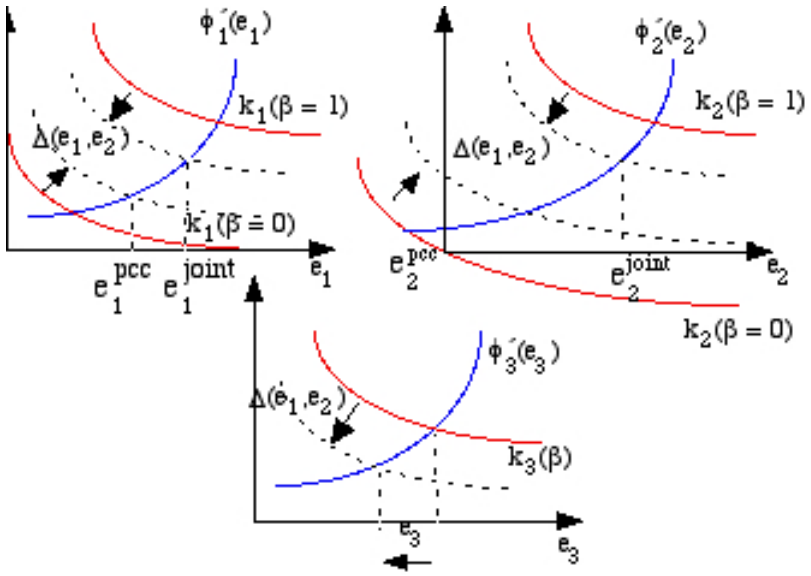

Figure 2: Efforts under prospective payment for hospitals and capitation for primary care centers.

Holding constant other effort levels, 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 $k_i(\beta = 0)$ shifts when we allow for all efforts to vary. Straightforward derivations establish that

$$\begin{aligned}
\frac{\partial k_1}{\partial e_2} &= -Np'(e_1)\theta'(e_2)\Big[c_p(1-b_3) - \beta c_h(e_3)\Big] \\
\frac{\partial k_1}{\partial e_3} &= -Np'(e_1)(1-\theta(e_2))\beta c_h'(e_3) < 0 \\
\frac{\partial k_2}{\partial e_1} &= -Np'(e_1)\theta'(e_2)\Big[c_p(1-b_3) - \beta c_h(e_3)\Big] \\
\frac{\partial k_2}{\partial e_3} &= Np(e_1)\theta'(e_2)\beta c_h'(e_3) \leq 0 \\
\frac{\partial k_3}{\partial e_1} &= -Np'(e_1)c_h'(e_3)(1-\theta(e_2)) \leq 0 \\
\frac{\partial k_3}{\partial e_2} &= Np(e_1)\theta'(e_2)c_h'(e_3) \leq 0
\end{aligned}$$

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.

We summarize this discussion, in the following lemma:

Lemma 1. *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, lemma 1 says that 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. Thus, $b_3 > 1$. 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, $\partial k_1/\partial e_2 = \partial k_2/\partial e_1 < 0$ 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 $b_3 > 1$, 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 $R(e_1, e_2, e_3) = Np(e_1)c_h(e_3)[1 - \theta(e_2)]$. It is straightforward to see that there is no incentive to perform hospital cost-reduction effort (a well-known result). In addition, whether we have fee-for-service in primary care ($b_3 > 1$) or a (partial) prospective system ($b_3 < 1$) is again crucial.

Under a prospective payment system to primary care, even if it is a partial one, no effort to reduce referral rates is done by both the hospital and the primary care center. Prevention effort, if done at all, is insensitive to the organizational design. The intuition runs as follows. Under a partial capitation, it is always profitable to the primary care center to divert patients to the hospital. Furthermore, as the latter is fully reimbursed of its costs, it has no incentive to do effort to avoid such referrals. Therefore, these efforts are at a minimum level.

Consider in turn the fee-for-service system, $b_3 > 1$. Under this condition, $c - b_2$ 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.[3]

The last subcase occurs when prevention is not sufficiently rewarded, and e_1 is set at its minimum value. Under fee-for-service, integration leads the hospital management to recognize the financial gain associated with treating patients at the primary care level. Thus, both referral rates efforts will increase, as the marginal value of effort done at the primary care center is increasing in the level of effort done at the hospital.

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. It is not generally true that integration promotes less referrals to hospitals. It is more likely to be so, under cost reimbursement as the main financing environment for hospitals, whenever primary care treatments are paid under fee-for-service (price above marginal cost of treatment).

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. Then, the relevant first-order conditions are:

$$k_2(\beta) = - Np(\bar{e}_1)\theta^{'}(e_2)[c_p(1 - b_3) - \beta c_h(e_3)]$$
$$k_3(\beta) = - Np(\bar{e}_1)c_h^{\prime}(e_3)(1 - \theta(e_2)) \geq 0$$

[3]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.

Totally differentiating with respect to e_2, e_3 and β allows to establish that:

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

(without any ambiguity, as we assumed $a_2 = 0$). 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 ($b_3 > 1$), 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

Expressions (13) to (15) summarize the difference among the different first order conditions under independent management, joint management and the social welfare. We now want to study the payment systems under both independent and joint management allowing to achieve the first best.

We already know that we can characterize these payments systems since no informational difficulties appear in the model. Nevertheless, we want to assess the optimality properties (if any) of the reimbursement schedules proposed in the previous illustrations.

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 $W(e_1, e_2, \cdot)$ for the primary care center such that

$$W^1 = - Np'(e_1)[c_h(e_3)(1 - \theta(e_2)) + L], \tag{23}$$

$$W^2 = Np(e_1)\theta'(e_2)c_h(e_3). \tag{24}$$

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 referral rate to the hospital. At the margin, the last term equals the change in the referral rate times 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 $W(e_1, e_2, \cdot)$ 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 full prospective payment 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.

5 Conclusions

A main finding of our analysis is that due to internalization of referral rate impact of hospital and primary care center efforts, under joint management the payment rules are considerably simpler than under independent management. This 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 prospective payment envisaged for such health entities is not optimal, according to our analysis. The reason is that a fully prospective 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 incentives 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).

Although a full discussion of implementation issues is beyond the scope of the paper, some comments on it are deserved. The major difficulties are (a) the definition of $p'(e_1)$ – the marginal effect of prevention effort, and (b) $\theta^{'}(e_2)$ – the marginal effects upon the referral rate.

The joint management case faces only problem (a), as it internalizes completely in the decision-making process of the health entity all the relevant marginal impacts.

To define $p'(e_1)$ there are, basically, two options. One is to econometrically estimate it. The second one is to approximate it by a linear function, which can be specified on the basis of actual visits to the primary care center and on expected number of visits. This expected number of visits can be set in a variety of ways

(value of last year, mean value from a sample, adjusted for covered population differences in characteristics, etc.). It is also worthwhile pointing out that the payment rule can be applied either in the case of "captive population" of the primary care center (that is, whenever the primary care center cannot dump patients to other primary care centers), or in the case of competition among primary care centers, in which case dumping of patients could be a concern. In the latter situation, the expected number of patients must be based on the population enrolled at that primary care center and not on the population of the (presumed) geographical area of influence. Naturally, other elements may dictate the choice of one architecture over the other.

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.

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