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STRATEGIC INTERACTION IN THE MARKET FOR PHYSICIAN SERVICES: THE TREADMILL EFFECT IN A FIXED BUDGET SYSTEM*

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Abstract

We examine the strategic interaction in the market for physician services when the total budget for reimbursement is fixed. We show that this prospective payment system involves – compared to a fee-for-service remuneration system – a severe coordination problem, which potentially leads to the "treadmill effect". For the institutional setting of German primary physician service we provide evidence for decreasing reimbursement per treatment, which is consistent with theoretical predictions. When market entry is possible, a budget can be efficiency enhancing, if in addition a price floor is used.

Keywords: Health economics, supplier-induced demand, remuneration systems, coodination device

JEL Classification: D21, I11, I18, L11

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1 Introduction

The German health care system currently undergoes a new round of restructuring by the proposed introduction of the *global budget*. To stabilize the share of health care expenditure on the gross national product the total expenditures to all suppliers in the health care market will be fixed. Already in 1993 in the German physician market there was a switch from the cost reimbursement system to a remuneration system with a fixed budget to stop rising health care expenditures.[1] In this prospective payment system with a fixed total budget the individual physician learns only retroactively how much he has actually earned: He faces the strategic uncertainty how his professional colleagues act.

Looking at the German outpatient market the following interesting observations can be made: Since the 90's the average income of physicians has decreased substantially. Furthermore, since the introduction of the budget system, the point value has fallen.

In this paper we suggest one possible explanation for these observations, and argue how they may be related to each other. For this purpose we investigate the interaction in the market for physician service when the budget is fixed. By analyzing the strategic uncertainty of a single doctor we show that the market for physician service can - due to a coordination problem - be stuck in an equilibrium which involves bankruptcy and therefore market exit. This equilibrium can arise, because - given a certain total budget - physicians have to augment their number of treatments to avoid bankruptcy. As a consequence a downward spiral of prices finally forces some physicians to exit the market. Our analysis suggests that the introduction of a specific

[1]Some other countries have also gathered experience with total budgets. Fixed budget systems for example are used in the physician remuneration system of France, the United Kingdom and are also partially used in the U.S.A., i.e. in the Medicare services. Although the federal government in the United States have proposed the option of a fixed budget within the Clinton health plan, global budgets have been introduced only within a small percentage in the health industry in the U.S.A. In Canada since 1990 payment for physician services in the fee-for-service sector has shifted from an open-ended system to fixed global budgets (Hurley and Card, 1996).

mechanism of a price floor into the German market for physician services could solve this coordination problem.

Our model belongs to the field of research where alternative reimbursement schemes are investigated and compared.[2] Many theoretical papers consider physician response to the form of reimbursement rule, generally focusing on fee-for-service versus capitation reimbursement.[3] Consequently many of the empirical papers have examined the effects of exogenous changes in physician remuneration programs.[4] However, strategic aspects (in our case induced through a fixed budget) have not been investigated so far.

We compare the remuneration system of fee-for-service, which we call price system, with the prospective payment system of a fixed total budget, which we call point system. In this payment system the individual physician receives a certain number of points per treatment which depends on the kind of service he renders. At the end of each quarter the fixed budget for all physicians is divided by the sum of points submitted by all physicians for reimbursement, which determines the (ex-post) point value. Therefore from the point of view of an individual physician the amount he receives from the reimbursement center does not only depend on the sum of points of his treatments but also on the number of treatments of all other doctors in the market. We investigate how physicians act when they are able to control the number of treatments.

In a general model of physician behaviour with a price system we show that physicians maximize their utility, taking into account monetary and effort cost, if prices are high. However, if prices are low, physicians forgo their effort costs to avoid bankruptcy. They expand their treatments to the target where monetary costs will be covered. If prices are getting too low, some physicians are forced to declare bankruptcy.

In contrast to this price system we find that in the budget system there

[2]For an overview see Gaynor (1994), who summarizes industrial organizational aspects in the market for physician services.

[3]See Newhouse (1992) and Ellis and McGuire (1993) for reviews.

[4]For summaries see Rice and Labelle (1989), Dranove and Wehner (1994) and Scott and Hall (1995).

exists a coordination problem. Depending on the size of the budget, the possible equilibria have one of three different structures. If the budget is very high, there exists a unique equilibrium in pure strategies where the individual physician behaves as a profit maximizer. If the budget is very low, there exists a unique equilibrium where a proportion of physicians exit the market and the others work very hard to avoid bankruptcy. In the scenario with an intermediate budget there exist the two equilibrium outcomes as described above and one additional equilibrium with an intermediate point value, where all physicians work hard[5], but there is no market exit. We argue that this last equilibrium is unstable.

Physicians do not seem to coordinate themselves on an equilibrium with high point values. However there exist two possible coordination devices. First, the physicians are guaranteed that the budget will be augmented if the point-value drops by more than a predetermined percentage. This point value guarantee will not be used in equilibrium and the budget target will be met. Second, alternatively a prospective maximal number of treatments per physician can be implemented into the budget. However, this second coordination device involves high information and administration effort.

In the paper we also analyze the equilibrium when entry into the market is possible. Physician will enter the market only if the budget is large enough and if their utility by entering the market exceeds their outside option. In this case we show that a fixed budget can lead to a desired allocation of human capital.

The paper is organized as follows. In Section 2 we describe the German outpatient medical care system. In Section 3 a basic model of physician choice where physicians can induce demand is presented. In Section 4 we introduce the fixed budget phenomenon into our framework and compare the two different approaches of reimbursement. We study how strategic interaction of physicians leads to a coordination problem. In Section 5 evidence for the predictions derived in Section 4 is given. In Section 6 we derive ways

[5]This phenomenon, where physicians increase their treatments is commonly referred to the term“treadmill effect”, see e.g. Breyer (2000).

how to solve the coordination problem. Then, in Section 7 market entry of physicians is included into the model. Finally, Section 8 concludes.

2 Reimbursement scheme in Germany

Until the '90s in the public health system, which covers 90 percent of the German health market, physicians were paid on a fee-for-service basis.[6] Since the health care reform in 1993 we find administered caps on the total budget for outpatient care.[7] Right now the costs may not rise faster than labor's share in national income. In 1998, outpatient care for physicians[8] accounted for about 17,4 percent (more than 40 billion Deutsch Marks) of the total healthcare bill paid by the statutory funds in Germany (see Federal Association of Panel Doctors (1999), Table $G3$). The segment outpatient care is largely made up of the services provided by doctors and dentists with their own practices. At the end of 1998, there were about 125,000 practicing physicians in various fields in outpatient care and about 60,000 dentists in Germany.[9]

In the current German debate the question arises whether a point system with a fixed budget, where each treatment has a certain amount of points serves as the adequate reimbursement scheme for physicians.[10] Currently, at the end of each accounting period a fixed budget for all physicians will be divided by the sum of the points of all physicians. Therefore the value of a treatment is determined ex post. For example, if the physicians submit a

[6] The other ten percent are financed by private health insurers. See Federal Association of Panel Doctors (1999), table $G1$.

[7] This outpatient medical care is provided primarily by physicians in independent practices. The term "outpatient care" refers to medical services that can be provided outside of the inpatient wards of a hospital.

[8] Outpatient care for dentists accounted for about 10 percent of the total health care bill.

[9] See Federal Association of Panel Doctors (1999), Table A1 and HypoVereinsbank (1999) for dentists.

[10] Alternative reimbursement systems are among others the price-system, where each treatment is reimbursed by a fixed price - our benchmark case fee-for-service - and the capitation system, where each doctor receives a fixed amount per capita.

high number of points at the end of a quarter, the value per point drops. In Germany associations of panel doctors or dentists run the reimbursement center in accordance with a uniform evaluation standard[11], that allocates a specific number of points to some 2,000 outpatient services.[12] The regional associations that administer the reimbursement can exert some influence via separate individual budgets by applying fee distribution criteria. While the number of points assigned to a particular service is uniformly negotiated by the Federal-level association and the statutory funds (insurances), the value assigned to the points can differ from region to region.

3 The basic model

We present a simple model to capture the relevant aspects of the strategic uncertainty in the market for physician service. Especially we draw attention to the different equilibrium outcomes of the two methods of reimbursement, the fee-for-service system, what we call price system, and the prospective payment system with a fixed total budget, which will be called point system. We start by developing a model of the behaviour of the physician in the price system. To do so, the following assumptions are made:

Assumption 1

1. *A physician finances his practice by taking out a loan of size F, which has to be paid back at the end of the period.*

2. *Running costs consist of monetary costs $c_1(n)$ and effort costs $c_2(n)$, with $c_i' > 0$ and $c_i'' > 0$ for $i = 1, 2$. n is the number of treatments.*

3. *If a physician cannot repay his loan, he faces bankruptcy costs of BK.*

At the beginning of the period a physician is confronted with fix costs and other liquidity problems. Physicians require equipment, have to pay rents,

[11]In Germany known as the "EBM" (Einheitlicher Bewertungsmaßstab).

[12]In Germany the primary physician service is assured by this institution which is called 'Kassenärztliche Vereinigung'(KV), and which acts as a representative for all physicians by dealing with the interest group of the health insurer.

pay for their employees, etc. Therefore, as implied by Assumption 1.1, a bank loan of size F is needed to finance his expenditures.[13] For instance, a dentist, who decided to open his own practice in 1998 had to finance an average volume of 548,000 D-Mark.[14] Assumption 1.2 introduces two sorts of variable costs. The monetary costs $c_1(n)$ have to be paid by the physician, while costs $c_2(n)$ describe the disutility he has from providing the service. This might refer to the time spent on work, the effort he has to put in, etc. For simplicity we only consider a single kind of treatment. In addition the physician is confronted by bankruptcy costs BK (Assumption 1.3), which only occur if he cannot pay back his bank loan F. These costs should also be interpreted as private, monetary and non-monetary costs. In the German system, for example, the license fee will be foregone when the practice of a physician is closed and of course, the physician bears a reputational cost for future working possibilities.[15]

Following Assumption 1, if p is the price per treatment, the utility of a physician who provides n treatments is given by:

$$\Pi(n) = \begin{cases} pn - c_1(n) - c_2(n) - F & \text{if} \quad pn - c_1(n) \geq F \\ -c_2(n) - BK & \text{if} \quad pn - c_1(n) < F \end{cases} \tag{1}$$

If the physician does not go bankrupt, his utility (profit) is income minus costs. However, in case of bankruptcy all monetary income accrues to the bank, so the physician is left with his effort costs and his private bankruptcy costs.

We now turn to the question of how n, the number of treatments is determined. As an empirical fact we observe that physicians act differently under different reimbursement systems. For instance in Germany the number

[13] Allowing for different F_i for different physicians does not change the basic results, as shown in Section 4.

[14] HypoVereinsbank (1999)

[15] Modelling bankruptcy costs as private costs is a standard tool in the principal-agent analysis, see e.g. Schmidt (1997).

of treatments without proper medical justification seems to have increased in the last decade. An interesting example are the operations of gall bladders. Between 1990 and 1996 their number had risen by 150 percent through the introduction of outpatient endoscopic operation techniques. However, for the same indication, physicians show a rate of operation which is 84% lower than the rate of the average population.[16] Even the German Society of Radiology claims that in 1998 every second out of 100 million x-rays was not necessary.

The way to model this phenomena, which is commonly called Supplier-induced Demand, is however very heterogeneous (for an overview, see e.g. Gaynor (1994)). In one strand of the literature physicians can induce demand directly. They just choose the number of treatments. Here, limits to inducement are given either via target incomes (Evans, 1974) or because the degree of inducement enters utility negatively (e.g. McGuire and Pauly, 1992). Another approach models informational differences explicitly by comparing medical services to credence goods. Examples are Emons (1997), Wolinsky (1993) and Dranove (1988). We are in line with the first strand. However we do not assume that inducement is limited via an exogenous target income or via a possible negative utility, but by cost of treatment instead.[17] Therefore, in our model physicians have complete control over the number of treatments.

Assumption 2

The choice variable of a physician is n, the number of treatments. The overall supply in the market determines the demand for medical services.

In a more elaborate model one would like to constrain the possibilities to induce demand by informational asymmetries between physician and patient. However, for the purpose of the present paper, it is only required that the physician can induce demand to some degree, so the proposed form of

[16]Speech of the state secretary of the health ministry Christa Nickels at the health care congress on May, 11, 1999 in Heidelberg/Germany.

[17]Adding that the degree of inducement influences utility negatively would not change the results.

modeling seems appropriate. Under Assumptions 1 and 2 we can now solve the maximization problem of the physician. Depending on the price p, three regions for the optimal number of treatments are obtained.

Proposition (Fee for service) *There exists a lower bound $\underline{p}$ and an upper bound $\bar{p}$ with $0 < \underline{p} < \bar{p}$, such that:*

If $p \geq \bar{p}$ the optimal number of treatments $n^*(p)$ is such that the individual physician equates price with marginal costs: $p = c_1'(n^*) + c_2'(n^*)$. An increase in price will lead to an increase in n: $\frac{dn^*(p)}{dp} > 0$.

If $\underline{p} \leq p < \bar{p}$ the optimal number of treatments $n^{**}(p)$ is such that bankruptcy is just avoided: $pn^{**} - c_1(n^{**}) = F$. An increase in price will lead to a decrease in n: $\frac{dn^{**}(p)}{dp} < 0$

If $p < \underline{p}$ the optimal number of treatments $\hat{n}$ is 0 and the individual physician exits the market.

Proof Assume that the bankruptcy constraint of equation (1) is not binding. Then maximizing this expression with respect to n yields $p - c_1'(n) - c_2'(n) = 0$. This defines n^* as a function of p. Using the implicit function theorem it follows that $n^{*\prime}(p) = \frac{1}{c_1''(n^*) + c_2''(n^*)}$ which is positive as costs are convex. Therefore, if p is large enough it will hold that $pn^*(p) - c_1(n^*(p)) > F$. This proves the first part of the Proposition.

Define $\bar{p}$ such that $\bar{p}n^*(\bar{p}) - c_1(n^*(\bar{p})) = F$. As $c_1'(n^*(p)) < p$, it follows that for all $p < \bar{p}$, $pn^*(p) - c_1(n^*(p)) < F$. Therefore, as long as p is not too small, the bankruptcy constraint becomes exactly binding and the physician chooses the optimal $n^{**}(p)$ such that $pn^{**}(p) - c_1(n^{**}(p)) = F$. Again, using the implicit function theorem gives $n^{**\prime}(p) = -\frac{n^{**}(p)}{p - c_1'(n^{**}(p))}$. In the region of interest this expression is negative: The physician would never provide so many treatments that the marginal monetary costs exceed the price. Therefore $c_1'(n^{**}(p)) < p$. This proves the second part of the Proposition.

Now define $\underline{p}$ as the largest $p < \bar{p}$ such that either $c_2(n^{**}(\underline{p})) = BK$ or $c_1'(n^{**}(\underline{p})) = \underline{p}$. In the first case, effort costs equal the private bankruptcy costs. Therefore at this price the physician is indifferent between going bankrupt or providing n^{**} treatments. In the latter case, marginal costs equal price. In both cases, if prices fall below $\underline{p}$, the physician will exit the market.[18] Due to the fact that n^{**} increases if the price falls, the physician will exit the market for all $p < \underline{p}$. Q.E.D.

The implications of Proposition 1 can most easily be illustrated by Figure 1, which shows the supply curve of the physician.

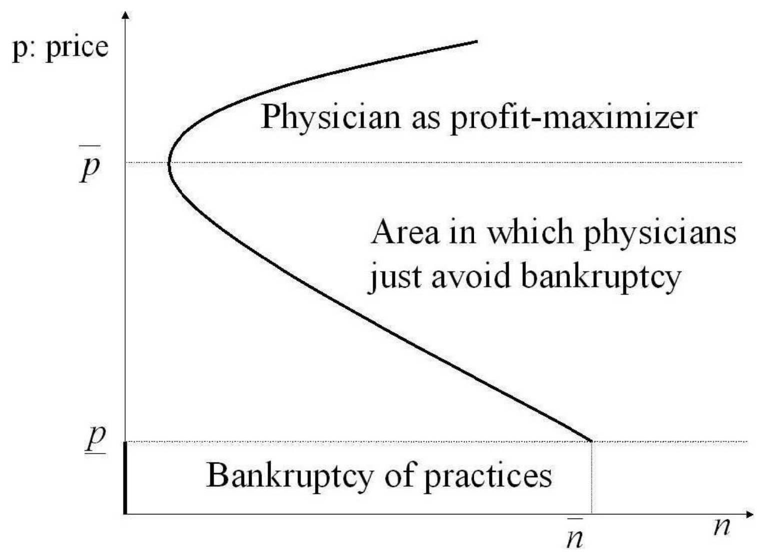

Figure 1: The price system

For high prices, the supply curve is upward sloping. We call this region *Profit maximization*, as the physician behaves here like a standard profit maximizer, equating price with marginal costs. For intermediate prices, the supply curve is downward sloping. To avoid bankruptcy the physician is working harder, even if the price is declining. We call this region *Target income*, as the physician works exactly so much that he covers his bank loan. There is a long debate in the literature whether the so-called target-income-hypothesis holds. This hypothesis usually augments the supplier-

[18] We regard the former scenario, where exit occurs due to large effort costs, as more plausible than the latter one. In general, monetary variable costs are relatively low, see HypoVereinsbank (1998).

induced demand theory, by noting that physicians will induce exactly so much demand that some target level in income (or utility) is reached. One of the main criticisms with this approach is that the target is not derived, but just postulated. In our model, we obtain for some prices a target-income, with an explicit explanation for the target: For intermediate prices physicians work so much that they cover their costs. Note that one result of this model is that the target is in income, and not in utility. Due to effort costs, the physician would prefer to supply less at higher prices.[19] If the price is very low, the physician exits the market and supplies nothing. This is indicated with the bold part of the vertical axis in the graph. We can now turn to the analysis of strategic interaction between physicians under a fixed budget.

4 The budget system: Strategic uncertainty

In this section we investigate the strategic interaction in the market for physician services when the budget is fixed. As described above, in a point system with a global expenditure cap, the value of a point is determined ex-post. It is given by the budget divided by the number of points all physicians accumulate together. We want to capture the strategic element which arises in such a setting. To do so, assume that a continuum of physicians exist. The physicians are indexed by a parameter x which is distributed uniformly on the line $[0, 1]$.[20]

Given a budget of size B, the structure of the game is the following: Each individual physician x decides either to exit the market, which implies that he sets $n(x) = 0$, or he stays in the market and chooses to provide the number of treatments $n(x) > 0$. Depending on the number of treatments chosen by the other physicians $(n(y), y \neq x)$, the pay-offs to physician x are

[19] For the debate about the target income hypothesis see e.g. Labelle, Stoddart, and Rice (1994).

[20] Using a continuum rather than a discrete number of physicians implies that the individual supply of any physician has no consequence for the resulting point-value. This seems to be a sensible assumption to make, given that e.g. in Germany more than 110.000 physicians are reimbursed by the German reimbursement centers.

given by:

$$\Pi(n(x)) = \begin{cases} \frac{B}{\int_0^1 n(y)dy} n(x) - c_1(n(x)) - c_2(n(x)) - F \\ \qquad \text{if } \frac{B}{\int_0^1 n(y)dy} n(x) - c_1(n(x)) \geq F \\ -c_2(n(x)) - BK \\ \qquad \text{if } \frac{B}{\int_0^1 n(y)dy} n(x) - c_1(n(x)) < F \end{cases} \tag{2}$$

The first line of the payoff-function is clear: If the expected price per treatment, given by the expression $\frac{B}{\int_0^1 n(y)dy}$, is such that by working $n(x)$ the physician earns enough revenue not to go bankrupt, he obtains his profit minus the effort costs of work. If he goes bankrupt (the second line), all his monetary return is used to pay for the outstanding loan. So the individual physician is left over with his effort costs and the bankruptcy costs. For the following proposition, we define $\bar{n}$ as the number of treatments a physician supplies if the price is $\underline{p}$ (see Figure 1). Recall that $\underline{p}$ was the minimum price at which an individual physician would be willing to stay in the market. Depending on the size of the budget, the possible equilibria have one of three different structures.

Proposition *There exists a lower bound $\underline{B}$ and an upper bound $\bar{B}$ for the budget, such that*

If $\underline{B} < B < \bar{B}$ there exist three equilibrium outcomes:

- $E_1 : \forall x \in [0,1] \;\; n(x) = \arg\max_n [\frac{B}{n(x)} n - c_1(n) - c_2(n)]$
- $E_2 : \forall x \in [0,1] \;\; n(x) \;\; \text{solves} \;\; \frac{B}{n(x)} n(x) - c_1(n(x)) = F$
- E_3*: A proportion α of physicians exits the market, and the other physicians provide $\bar{n}$ treatments each. α is determined such that $B = (1-\alpha)\bar{n}\underline{p}$.*

If $B > \bar{B}$ the unique equilibrium is of type E_1.

If $B < \underline{B}$ the equilibrium outcome is of type E_3.

Proof See section A.1 in the appendix.

Here we outline the proof. This is done in 5 steps.
First: No physician influences the overall point-value by his own treatments. Therefore, given the strategies of the others, the response function of the physician is identical to the supply function we calculated in the previous section, if we identify the price $\tilde{p}$ on the y-axis with the point-value $\frac{B}{\int_0^1 n(y)dy}$. This supply function is displayed again in Figure 2.

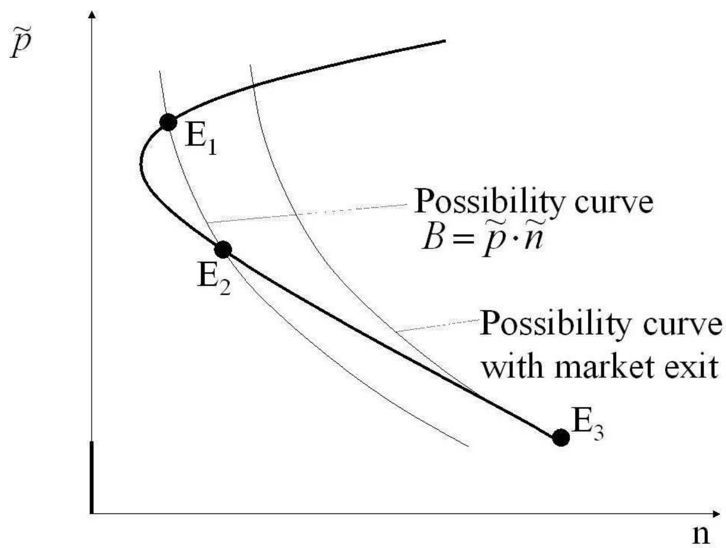

Figure 2: The point-system with an intermediate budget

Second: Assume that $\frac{B}{\int_0^1 n(y)dy} \neq \underline{p}$. Then Figure 2 shows that the best response of physician x is uniquely determined. Let this be some $\tilde{n}$. Now it cannot be the case that any other physician supplies a different number of treatments, because if $\tilde{n}$ is the optimal response for physician x, it must be the optimal response for any other physician. Thus, as long as we are not at the point of indifference between bankruptcy and working hard, the equilibrium strategies must be the same for everyone.
Third: Assume that $\frac{B}{\int_0^1 n(y)dy} = \underline{p}$. In that case physician x is indifferent between working $\bar{n}$ or exiting the market. As this holds for any physician, in equilibrium there might be some physicians who exit the market and some

others who supply $\bar{n}$.[21]

Fourth: Now consider the budget. For Figure 2 we have chosen the budget such that the line B/n cuts the supply curve twice, at points E_1 and E_2 (the possibility curve to the left). This corresponds to the scenario with an intermediate budget. These two points are two equilibria; if everyone supplies the number of treatments given at these points, then the ex-post price will be such that this number of treatments was individually optimal in the first place. As can be seen from Figure 2, either all physicians work less hard and enjoy a large point value (E_1), or all physicians supply more at a lower point value (E_2) and just avoid bankruptcy. If some physicians exit the market the budget line per active physician moves to the right. This is shown by the possibility curve to the right in Figure 2 which has the functional form $p = B/((1-\alpha)n)$. If α is chosen such that this line cuts the point $E_3 = (\bar{n}, \underline{p})$, the third equilibrium is obtained. Some physicians work very hard, the others exit the market, and they are all indifferent between the two alternatives.

Fifth: If the budget is so large that B/n cuts the supply curve only once, then the only possible equilibrium is the one where all physicians work little and where the price per treatment is very high. This is displayed in Figure 3 by the intersection with the line to the right.[22]

If on the other hand the budget is so small that B/n does not even cut the supply curve, (the budget line to the left in Figure 3), then the unique equilibrium is the one where some physicians go bankrupt.

For the following discussion we concentrate on the case of an intermediate budget, where all three forms of equilibria exist. The equilibrium at point E_1 in Figure 2 is, from the point of view of the physicians, the optimal outcome. Everyone supplies treatment exactly to the point that (expected) price equals marginal costs. There is no danger of going bankrupt. The equilibria in points E_2 and E_3 differ from the first equilibrium in that the physicians are supplying more treatments: They just avoid bankruptcy while

[21] In general, every physician could mix between exiting or supplying $\bar{n}$.

[22] Formally, $\bar{B}$ is determined by $\frac{\bar{B}}{\bar{n}} = \underline{p}$.

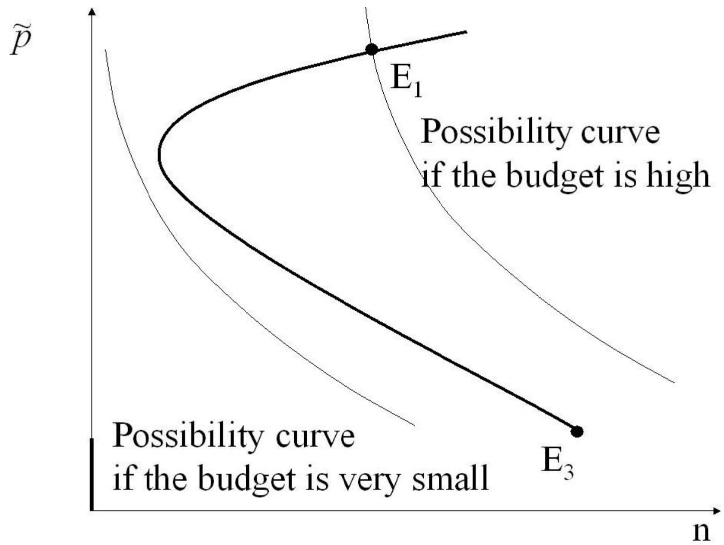

Figure 3: The point-system with a high and with a very small budget

at equilibrium point E_3 some even exit the market.

These latter two equilibria are however, hard to distinguish empirically. Remember that we modelled all physicians to have equal cost-functions, and equal debts to be paid back. If we heterogenize the model, one would also at equilibrium E_2 expect some of the physicians, namely those with high costs, to go bankrupt. The main difference between E_2 and E_3 is the nature of the interaction between the supply of the physicians. By investigating the sign of the slope of a single physician's reaction function, it is easy to see that at the intermediate equilibrium the actions of the physicians are strategic complements. That is, if any other physician increases his number of treatments, the point value falls, which makes the individual physician increase his treatments as well. In contrast, in equilibrium E_3, if someone increases the number of treatments, the price falls below the threshold $\underline{p}$ which makes another physician exit the market, which implies a reduction in the number of treatments.[23] The strategic complementarity makes the intermediate equilibrium unstable from a phenomenological point of view.

[23]It is easy to see that also in equilibrium outcome E_1 the number of treatments are strategic substitutes.

Consider the case of a "price shock", where everyone believes that the end-of-year point value is lower. This makes everyone work harder, which results in even lower prices, and thus finally in some physicians exiting the market. Thus the intermediate equilibrium would move towards the lower equilibrium. As mentioned above, we do not think that from an empirical point of view equilibria E_2 and E_3 differ very much. And, as we will show later on, also in terms of policy implication it does not matter which of the two equilibria we consider. Still, due to the instability of the intermediate equilibrium, we will concentrate in the following only on equilibria E_1 and E_3. We call these the "upper" (coordinated) and "lower" (non-coordinated) equilibrium outcomes, as the physicians strictly prefer to end up in the upper one. Given the anecdotal evidence we reported in the introduction, it seems to be the case that the German physicians opted for the lower equilibrium. In some sense this choice is understandable: If someone believes that the equilibrium is the upper one, and he supplies less treatments, however the outcome turns out to be the lower one, then he goes bankrupt, which comes with very high costs. On the other hand, if the single physician works hard in the belief to be in the lower equilibrium, then, if the outcome is the upper one, he earns more per point than expected and surely does not go bankrupt.[24]

Until now we have assumed that all physicians are the same, so that the model cannot predict who exits the market. However, the model is easily modified to capture some heterogeneity on the side of the physicians. Assume that physicians differ with respect to the size of loans they have to repay. In a price system, for any price p there exists a $\bar{F}(p) > \underline{F}(p)$, such that a physician with an F larger than $\bar{F}(p)$ would exit the market. A physician with an intermediate F, i.e. $\underline{F}(p) < F < \bar{F}(p)$, would work to finance his loan. Finally, those with very small values of F, i.e. if $F < \underline{F}(p)$ would equate price with marginal costs.

[24] This argumentation is similar to the one used by Harsanyi and Selten (1988) in the discussion of a risk-dominated equilibrium. However, the generalization from a two player game to one with infinitely many players has to be considered as pure analogy, not as theoretically well-defined concept.

The market supply curve now depends on the distribution of F. In Appendix 2 we provide an explicit example where the market supply curve is decreasing for some range of prices. In that case, if a shift from a price to a point system occurs, more than two equilibria can exist.

Comparing the analogue of the upper and lower equilibrium, the following holds:

Statement 1 (Heterogeneous Physicians) *Let p_1 (p_2) be the point value at the upper (lower) equilibrium. Then:*

Physicians with $F \leq \underline{F}(p_2)$ supply less in the lower equilibrium.

Physicians with $\underline{F}(p_2) \leq F \leq \underline{F}(p_1)$ work harder in the lower equilibrium.

Physicians with $\bar{F}(p_2) < F < \bar{F}(p_1)$ stay in the market in the upper equilibrium, but exit in the lower equilibrium.

This result gives rise to an interpretation if we assume that younger physicians have larger debts to repay. Then if a shift from the upper to the lower equilibrium occurs, one would expect that young physicians exit the market or supply more treatments, while more elderly physicians will supply less treatments. The result is similar if the heterogeneity is in bankruptcy costs, and if the elder physicians have lower bankruptcy costs. Then the elderly physicians will work less in the lower equilibrium. In this case, they might even exit in the lower equilibrium, where prices are low.

Based on the analysis in this section, the following testable predictions about the behaviour of physicians can be made: Assume that in a price system physicians equate price and marginal costs, and that the budget is large enough to cover the expenses of the price system. Then, if the system changes from a price system to a system with a fixed budget, and if the physicians coordinate on the lower equilibrium, we expect that

1. the price per treatment, i.e. the point value, declines,
2. the net income per physician decreases,

3. some physicians will exit the market and others just avoid bankruptcy,
4. young physicians work harder or exit the market, while more elderly physicians will work less hard.

We now proceed by providing some empirical evidence for these conclusions.

5 Evidence

Using data from the German outpatient market we present empirical evidence for our model of the previous section.

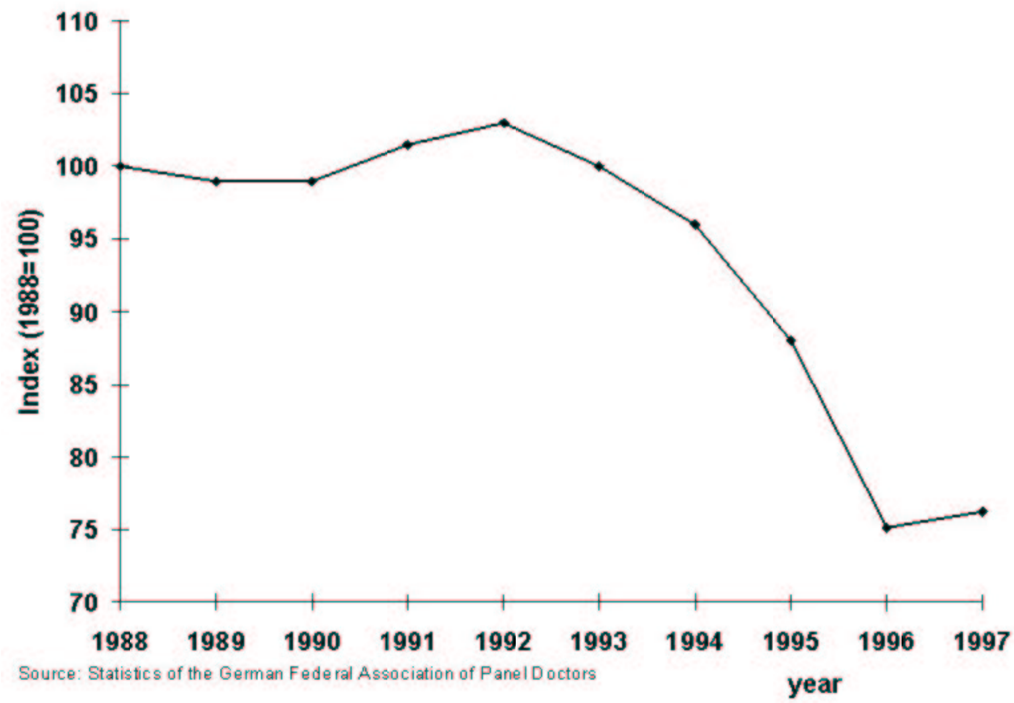

Figure 4: Point value development 1988-1997

The first prediction of the model is strongly supported by data from the German Federal Association of Panel Doctors. The graph in Figure 4 shows that with the switch from the fee-for-service system to the budget system on January 1, 1993, the point value (without prevention, laboratory and outpatient surgery) went on a negative trend. The data is provided by the Bavarian Association of Panel Doctors. Until the end of 1992 the point value was relatively stable because the price was determined ex ante in the fee-for-service system. In 1993 however the point value began to decline rapidly. The point value for all associations of panel doctors fell by about 25% between 1993 and 1997 for the general health insurance funds (Allgemeine Ortskrankenkassen).[25] The introduction of a maximal number of points per practice in 1997, on which we comment below, achieved a partial stabilization of the point value.

Also the second hypothesis is supported by the data. This is shown in Figure 5 on the basis of the data provided by the Bavarian Association of Panel Doctors. Nominal income peaks in 1992 and real income is more or less constant between 1988 and end of 1992.[26] During the period between 1993 and 1997 the physicians' average nominal income dropped by about 8% and their income in real terms declined by about 16%.

This can also be seen in Table 1, which summarizes the analysis of cost and income structure, data collected by the Central Research Institute of Ambulatory Health Care in Germany (related to the German Federal Association of Panel Doctors) and by the consulting firm GEBERA.[27] Each year 2000-2500 physicians respond to an annual survey sent out to about 20% of all physicians, chosen randomly. The survey contains data on the income situation and cost structure of the German outpatient market.[28]

The table compares revenue and cost figures in a three year period before the reform with a three year period after the reform. The first lines of the

[25]The point value for the substitute health insurance funds (Ersatzkassen) dropped by the same amount. Both groups, general and substitute health insurance funds counted together for more than 80% of the funding of the German public market for ambulatory physicians. To see how the population is distributed on the various insurance funds see Federal Association of Panel Doctors (1999, Table G17).

[26]To adjust for inflation the consumer price index for families with higher income was used.

[27]See also Deutsches Ärzteblatt (1997).

[28]See Zentralinstitut (1988-1998).

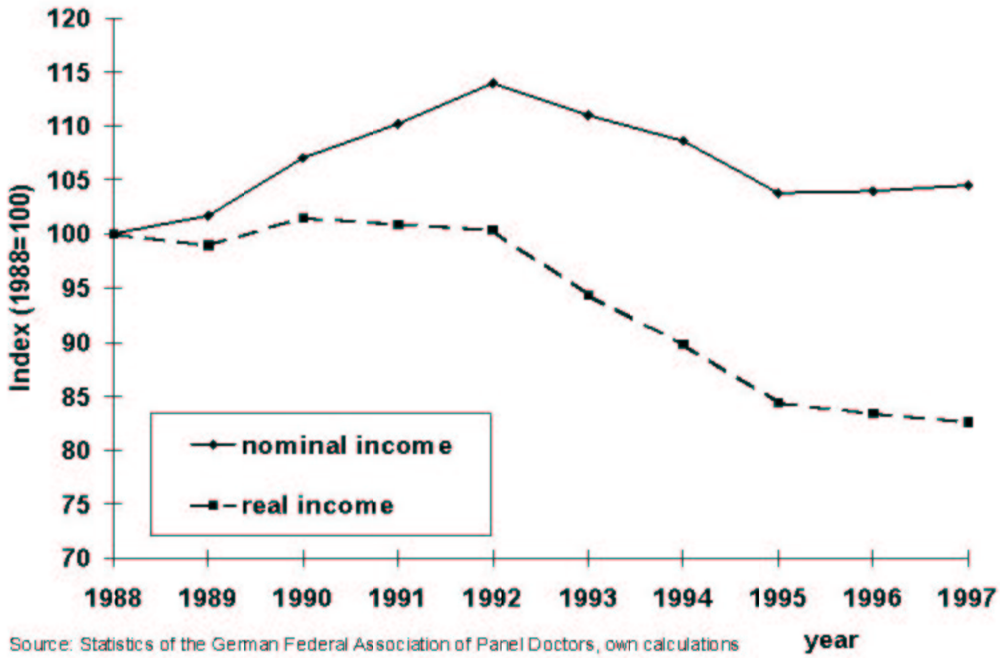

Figure 5: Real and nominal physicians' income 1988-1997

table show that the reform did not lead to declining revenues. The revenue from outpatient care rose by 1.9% and other revenues rose by 4.9%, leading to an increase in total revenues by 2.5%. Other revenues have been mainly made up by treatments of privately insured patients (with a fee-for-service system) and by treatments which are not listed in the uniform evaluation standard, which describes the outpatient services reimbursed by the reimbursement center in the budget system.

However, at the same time, total monetary expenditures went up rapidly. On average they increased by about 8.9% between these two periods. The driving force being labor expenditures which rose by 11.3%. As a result, the ratio of total expenditures to revenues rose from 56.7% to 60.3%. In terms of surplus, defined as revenue minus costs, this amounts to a decline of about 6% between the average of 1990-1992 and the average of 1993-1995 .

The third hypothesis is by nature hard to test. Although bankruptcies

Table 1: Changes in physicians' income in West Germany

	mean 1990 to 1992		mean 1993 to 1995		value change	
	mean/DM	%	mean/DM	%	% △	% △ p.a.
revenue from						
outpatient care	368,418	80.7	375,512	80,2	1.9	0.6
other revenues	87,945	19.3	92,240	19.8	4.9	1.6
total revenue	**456,363**	**100.0**	**467,752**	**100.0**	**2.5**	**0.8**
costs						
labor costs	112,740	43.6	125,480	44.5	11.3	3.6
other costs	146,110	56.4	156,484	55.4	7.1	2.3
total costs	**258,850**	**100.0**	**281,964**	**100.0**	**8.9**	**2.9**
total costs in % of revenue		**56.7**		**60.3**	**6.3**	**2.1**
surplus	**197,513**		**185,788**		**-6.0**	**-2,0**

Source: Statistics of the ZI, own calculations

can be detected - and there are not very many -, surviving at the margin of bankruptcy is hard to find out. Still, there is anecdotical evidence for an increasing number of practices which seem to exist at the margin to survive: This "critical frontier" with a turnover of less than 120,000 Deutsch Marks confronts 6,600 physicians out of 110,000 in outpatient care (Handelsblatt, 1999).[29]

6 Coordination Mechanisms

To avoid the from the physician's prospective undesired consequences, namely the lower outcome, there are two possibilities: First, consider a system where a budget is given, but physicians are guaranteed that the point value will not fall below some prespecified value. If it does, then the budget will be augmented so that every physician obtains this value. Then, for particular values

[29]Concerning the fourths hypothesis, we were unfortunately unable to obtain data on the behaviour of different groups of physicians (young/old). This will be left to future research. Nevertheless, there is anecdotical evidence that young physicians with own practices are more likely to live at the "critical frontier". (Handelsblatt, 1999)

of the size of the budget and the lower point value, the outcome of the game above can be unique:

Lemma 1 (Point value guarantee) *In a remuneration system with a fixed budget and a point value guarantee, such that the budget is augmented if the point value falls below the guaranteed level physicians will coordinate on the upper equilibrium and the budget will be met.*

Proof The proof is done by noting that if the point value guarantee lies above the two lower equilibria of the previous game, then these two can not be equilibrium outcomes anymore. However, the upper, coordinated equilibrium can still be the outcome (and is the unique equilibrium), as here the point value guarantee does not bind. Q.E.D.

This can be seen in Figure 6 : Due to the point value guarantee the budget line has a kink at the level $\breve{p}$. If the value of $\breve{p}$ is large enough, there is only one intersection of the budget line with the supply-curve. Therefore only the upper equilibrium E_1 exists.

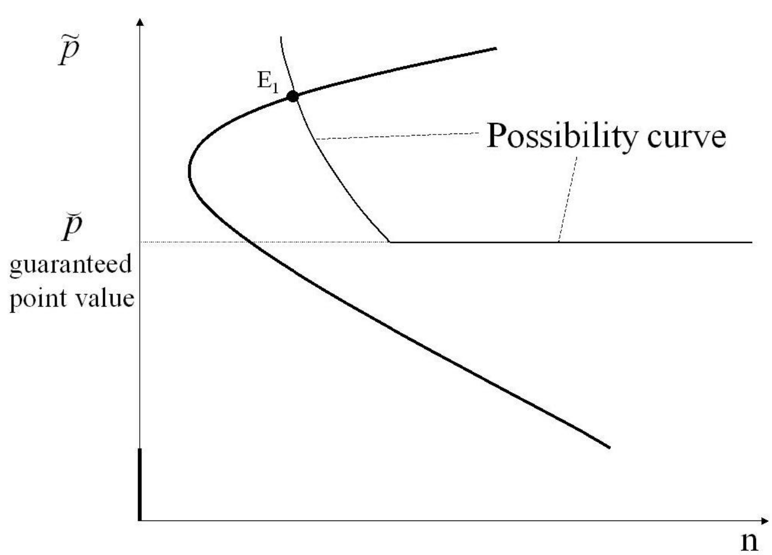

Figure 6: The point-system, modified by a point value guarantee

A second possibility to avoid the coordination problem is given by prospectively implementing a maximal number of treatments per physician into the budget system. The number of treatments beyond this predetermined number of treatments per individual physician will not be remunerated by the reimbursement centers:

Lemma 2 (Maximal number of treatments) *In a remuneration system with a fixed budget and a maximal number of treatments per physician, physicians will coordinate on the upper equilibrium and the budget will be met.*

Proof To avoid the not desired treadmill effect, this maximal number of treatments per physician ($\check{n}$) has to lie above the two lower equilibria. Like in the case of a point value guarantee, the upper (coordinated) equilibrium can still be the outcome, because in this case the maximal number of treatments does not bind. Q.E.D.

This can be seen in Figure 7 : Due to the maximal number of treatments for each individual physician, the budget line stops exactly at the level of $\check{n}$. If, given the previous upper equilibrium, the maximal number of treatments is relatively small, there is again only one intersection of the budget line with the supply-curve, the unique equilibrium E_1.

The consequences of either a guaranteed point value or a maximal number of treatments per physician are the same in this model: The undesired treadmill effect can be avoided.

However, if we go beyond the model these two methods of solving the coordination problem become very different. We discuss three effects.
First, consider the consequences of a health shock, like e.g. an unanticipated wave of influenza. In the case of a predetermined maximal number of treatments per physician there will not be enough supply to treat all patients. In the other case, where a minimal point value is guaranteed, the budget will be augmented and all patients with influenza will be treated.[30]

[30] In this context it is often argued that a pure budget system (without a point value guarantee) will shift risk from the sickness funds to the physicians. In a companion paper, where we relax the assumption of pure Supplier Induced Demand, we show that this statement does not hold if fixed costs are much larger than variable costs. See Benstetter and Wambach (2000)

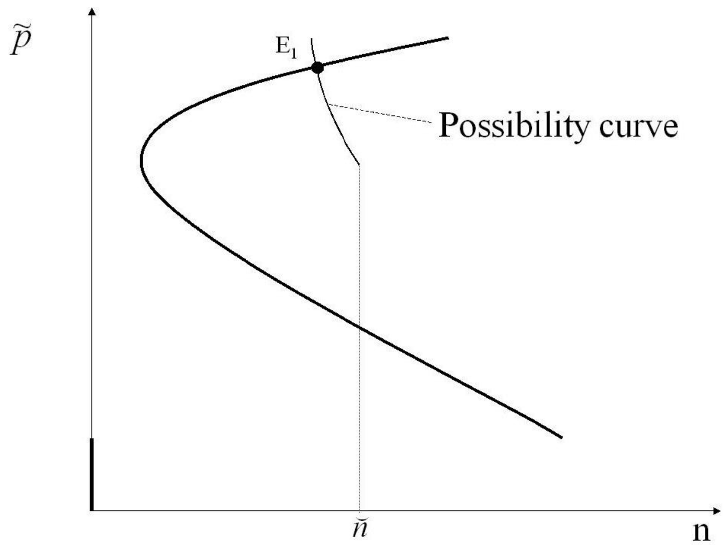

Figure 7: The point-system, modified by a maximal number of treatments per physician

Second, we also have to take into account that practices vary by size and by the distribution of their patients. Thus implementing a maximal number of treatments per physician requires detailed knowledge of each practices, while a point value guarantee does not need much further information.
A third issue arises if we allow for a dynamic setting. In the system with a guaranteed lower bound on the point value, it might be the case that if physicians fear falling point values and therefore falling income levels in future periods, they will expand their treatments in the present period to cash in today. Thus the budget needs to be augmented. On the other hand, such an effect is not possible in a budget system with a maximal number of treatments per physician and period.

In June 1997 the reimbursement system in Germany shifted from a pure budget to the so-called "Practice-budget", which includes a maximal number of treatments per physician (and which is a budget on points rather than on money). This maximal number depends on the calculated average treatments per group of physicians and on age of the patients. Although this comes close to the system proposed here, it differs in that the point-value is fixed as long as physicians do not reach their limit on the number of treatments. The introduction of this system with a maximal number of treatment came - as discussed before - with huge administrative effort. However, the alternative instrument of a minimum point value would have been more difficult to implement: The German associations for panel doctors would have not only required the agreement by the public sickness fund, they also needed a different legal framework to be provided by the government.[31]

7 Market Entry

In this section we extend the model and allow for market entry. The market entry decision is influenced by the payment regime in the (regulated) physicians market and with that by the well-being of the active physicians. As a matter of fact, due to the declining income of physicians more and more young physicians in Germany decide nowadays to work in alternative jobs like in business consulting, hospitals, pharmaceutical industry etc (compare Berliner Morgenpost (1999)). We model market entry by introducing a stage 0, in which new physicians (those finishing their "probationary period") can decide to enter the market. For simplicity we assume that if they enter, they also have to repay the debt F in the following period. If they do not enter, they take an alternative job which comes with utility $\hat{U}$, which is assumed to be positive. The stock of possible entrants is given by S^E. We denote the number of entrants in equilibrium by δ. Then, in stage 1, $1 + \delta$ physicians decide simultaneously how many treatments, if any, they supply. Compared to the game in Section 4 the payoff-function has to be redefined, because the

[31] As discussed before, the guarantee of a minimal point value makes the coordination of the physicians possible. In 1998 the Bavarian association of panel doctors together with the primary sickness fund implemented the so-called "Regelleistungsvolumen", a modification of the point system in which few parts could be interpreted as a point value guarantee: Also here a point value was guaranteed, however only for a limited predetermined number of treatments. Treatments above this predetermined number had been reimbursed only by a downward graduated point value. Because of a new law in the German health system ("Vorschaltgesetz") in January 1999, this system could not be tested further.

number of physicians in stage 1 has now changed to $1 + \delta$.[32] The pay-off for physician x who is in the market in stage 1 and assuming that he does not go bankrupt is given by:

$$\Pi(n(x)) = \frac{B}{\int_0^{1+\delta} n(y)dy} n(x) - c_1(n(x)) - c_2(n(x)) - F \tag{3}$$

In a regulated system like e.g. the German health market (but also many other health systems) the regulating authority faces two main problems: First, to provide the right incentives for the supply of treatments. Second, to find the right overall reimbursement level for physicians.[33] In contract theory terms: Even if the structure of the second best contracts induced by the incentive constraint is clear, it still needs to be determined how the overall level of the reimbursement per physician, as spelled out by the participation constraint, is set. In contract theory, it is usually just assumed that a participation constraint exists.[34] In the health sector, there is no obvious level for the size of the participation constraint: How much should a physician earn? What reimbursement induces the right level of entry? Using competitive analysis, one would expect that wage equal to marginal product would be the appropriate payment. Paying more induces excessive entry, while paying less will lead to a reduction in entry (or a shift towards lower quality physicians). One possible indicator for the right payment could be the outside option physicians have. If that market (consulting, pharmaceutical industry) is much less regulated than the health care market, the payment there should be close to productivity. We therefore interpret $\hat{U}$ as the correct overall level of reimbursement for physicians with the following implication: If physicians expect to earn $\hat{U}$ in the market for physician services, the desired number of entry to this market will be induced.[35]

[32] We index the physicians who are in the market at stage 1 by $x \in [0, 1 + \delta]$.

[33] While the first question is addressed excessively in the literature (for summary see Gaynor (1994)), the second problem has received very little attention.

[34] E.g. Ma and McGuire (1997) assume a reservation utility for the physician.

[35] In our homogeneous model the following holds: If expected earnings are larger (lower) than $\hat{U}$, all (no) physicians will enter. Both alternatives are suboptimal. Only for expected

With these preliminaries, the following observation can be made:

Lemma 3 *If the equilibrium of the subgame at stage 1 is not the upper one, then no additional physician will enter the market.*

If the equilibrium of the subgame at stage 1 is the upper one, then depending on the size of the budget, either all new physicians or no new physician enter at stage zero, or exactly so many that the expected profit equals the outside option, i.e.

$$\hat{U} = \frac{B}{(1+\delta)n^*}n^* - c_1(n^*) - c_2(n^*) - F \tag{4}$$

where n^* is the equilibrium number of treatments at stage 1.

The reasoning is obvious. Physicians will only enter the market if they expect to obtain more or as much as by staying away. This can only be the case in the upper equilibrium. If the expected profit there without any entry is less than the outside option, no one will enter. If it is larger, then so many physicians will enter until the stock of entrants is exhausted or the expected profit is equal to the outside option. The most interesting case is the latter scenario, where exactly so many physicians enter that their outside option equals the expected profit they obtain in the market itself. Given the remarks above on the interpretation of $\hat{U}$ this implies that market entry is optimal. So, if physicians coordinate on the upper outcome, a fixed budget will lead to an improved allocation of human capital.

This can be seen in Figure 8: Market entry will shift the budget line to the left until the expected profit of the marginal physician, who wants to enter the market, is equal to his outside-option.

This last result points towards the potential a fixed budget has: It might be a useful tool to appropriately regulate market entry. If, as can be assumed, the right size of reimbursement is not known to the government and to the reimbursement center, introducing a budget can be a self-sustaining method

earnings equal to $\hat{U}$, optimal entry can be expected.

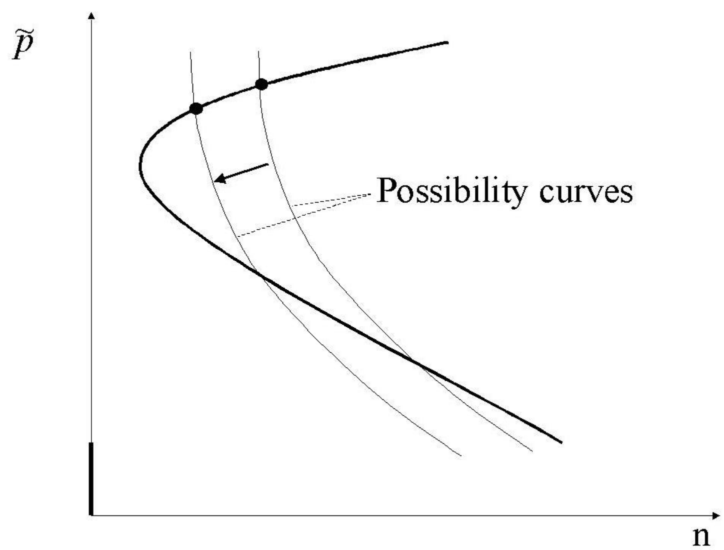

Figure 8: The point system can regulate market entry

to elicit this level of compensation. But, as argued previously, the proposed (improved) budget system can only work properly if sufficient measures are in place to avoid the lower, uncoordinated outcome, in which physicians face the "treadmill effect".

8 Conclusion

We have presented a model of demand inducing physicians which has the property that if prices are high, physicians behave like profit maximizers, while for low prices they behave like satisficers, inducing demand to reach a target income. This target income is given by the monetary costs of the practice. With this model a reimbursement system where the budget is fixed is investigated. Due to a coordination problem physicians may end up in an equilibrium where they have to endure the treadmill effect. The point value falls, the number of treatments increases, and some physicians are forced to exit the market. We provide evidence for these predictions in the German physicians market. However, if physicians succeed to avoid the coordination problem, then a fixed budget has the positive effect that it leads to desired market entry. A possible coordination device could be that to a fixed budget a point value guarantee is added, which in equilibrium will not be used. In our model this coordination device leads to the same result as implementing a prospective maximal number of treatments into the budget system. However, a lower bound on the point-value will establish sufficient health service in case of health shocks and will be much easier to administer. When implementing this measure, however, the government needs to assure to the physician community that it will not cut the budget in future years.

A Appendix

A.1 Proof of Proposition 2

Let $n(y), y \neq x$ be the equilibrium strategies of the physicians apart from physician x. Define p as $p = \frac{B}{\int_0^1 n(y)dy}$ where we set some finite $n = n(x)$. Note that p is independent of $n(x)$ as long as it is finite. Then the pay-offs for physician x as a function of $n(x)$ is given by:

$$\Pi(x) = \begin{cases} pn(x) - c_1(n(x)) - c_2(n(x) - F & \text{if} \quad pn(x) - c_1(n(x)) \geq F \\ -c_2(n(x)) - BK & \text{if} \quad pn(x) - c_1(n(x)) < F \end{cases} \tag{5}$$

But this is exactly the same profit function as was derived in the section on the price system. The optimal $n(x)$ is the chosen analogue to the derivation in the proof of Proposition 1. Thus we can interpret the supply function as the response function of the individual physician. The next steps are straightforward: Note that for any 'price' $p = \frac{B}{\int_0^1 n(y)dy}$ there is a unique best response of physician x as long as $p \neq \underline{p}$. We call this $n(p)$. The same argument applies for the other physicians. Therefore in the equilibrium all physicians supply the same number of treatments. An equilibrium of such a form exists if and only if one can find a value for p such that $p = \frac{B}{n(p)}$. We return to the issue of existence below.

Now consider the case where the 'price' $p = \frac{B}{\int_0^1 n(y)dy}$ is equal to $\underline{p}$. Then the best response of physician x is either to work very hard, i.e. to choose $n = \bar{n}$, or to exit the market, i.e. to choose $n = 0$. The same reasoning applies for all physicians, so such an equilibrium price exists if one can find an α with $0 \leq \alpha < 1$ such that $\underline{p} = \frac{B}{(1-\alpha)\bar{n}}$. If α is strictly larger than zero, then some physicians go bankrupt in equilibrium.[36] Having shown the form of the possible equilibria, we now turn to existence.

[36] There are several possible equilibrium strategies which would lead to this result: Either all physicians mix between exiting the market and working hard with probability $(\alpha : 1 - \alpha)$, or a proportion α of physicians with say $x \leq \alpha$ exit the market, the others work hard, etc. The equilibrium outcome, however, has always the same structure.

Consider first the case where all physicians supply the same number of treatments. This can only be an equilibrium if $p = \frac{B}{n(p)}$, or, in other words, if the line B/n cuts the supply line for the individual doctor (see Figure 2 and Figure 3). It is obvious that if B is very small such a crossing will not occur (the possibility curve to the left in Figure 3). Therefore $\underline{B}$ is defined such that the line $\underline{B}/n$ just touches the supply curve. On the other hand, if B is very large (the possibility curve to the right in Figure 3), it crosses the supply curve only once in the region where supply is increasing in p. Accordingly, $\bar{B}$ is defined such that $\bar{B}/\bar{n} = \underline{p}$, i.e. the two curves touch at the point where the physicians just avoid bankruptcy. For all intermediate levels of B there are at least two crossing points (as shown in Figure 2). We now proof that there are at most two crossing points:

It is obvious that in the region of the supply curve where n increases in p the two curves can cross at most once, as B/n is decreasing in n. It remains to show that also in the region where n decreases with p at most one crossing occurs. Suppose the two curves cross at a point $p = B/n = (F + c_1(n))/n$. The slopes of the two curves at this point are given by $-B/n^2 = -p/n$ versus $-(F + c_1(n))/n^2 + c_1'(n)/n = -p/n + c_1'/n$. Therefore the budget curve will always decrease more than the supply curve, which in turn implies that there is at most one crossing in this region. Finally, it remains to show that an equilibrium, where some α physicians go bankrupt, exist. By the definition of $\bar{B}$ it is clear that for all $B \leq \bar{B}$ one can always find a $0 < \alpha < 1$ such that $\underline{p} = \frac{B}{1-\alpha}\bar{n}$ holds.

Q.E.D.

A.2 Downward curving supply with heterogeneous physicians

Physicians differ with respect to the size of the loan F they have to repay. Denote by $G(F)$ the distribution function. To derive an explicit example of a supply function, we simplify by assuming that monetary costs are quadratic, i.e. $c_1(n) = \frac{1}{2}\alpha n^2$ and effort costs are linear, i.e. $c_2(n) = \beta n$.

Now we are in a position to derive the explicit values of $\underline{F}(p)$ and $\bar{F}(p)$. For small F, the physician sets price equal to marginal cost. Therefore $p = \alpha n + \beta$ and consequently

$$n^*(p) = \frac{p-\beta}{\alpha}. \tag{6}$$

He can do so as long as his monetary income covers his loan. Therefore, $\underline{F}(p)$ is defined by $pn^*(p) - \frac{1}{2}\alpha(n^*(p))^2 = \underline{F}$, which implies

$$\underline{F} = \frac{p^2-\beta^2}{2\alpha} \tag{7}$$

For values of F larger than $\underline{F}$ but not too large, the physician will work to avoid bankruptcy. This implies for the number of treatments $pn - \frac{1}{2}\alpha n^2 - F = 0$ and therefore

$$n(p,F) = \frac{1}{\alpha}[p - \sqrt{p^2 - 2\alpha F}] \tag{8}$$

It directly follows that $n(p,F)$ decreases in p and increases in F. $\bar{F}$ can now be derived. As discussed in Section 3, there are two possible reasons why a physician might declare bankruptcy: Either the price exceeds monetary marginal costs or effort costs exceed bankruptcy costs.

1.) In the first case, $p = \alpha n(p;\bar{F})$, which gives $\sqrt{p^2 - 2\alpha\bar{F}} = 0$.Therefore

$$\bar{F} = \frac{p^2}{2\alpha} \tag{9}$$

2.) In the second case, $BK = \beta n(p,\bar{F})$, which gives $BK = \beta\frac{p}{\alpha} - \frac{\beta}{\alpha}\sqrt{p^2 - 2\alpha F}$ and therefore:

$$\bar{F} = \frac{1}{2}\alpha[p^2 - (p - \frac{\alpha}{\beta}BK)^2] = \frac{BK}{\beta}[p - \frac{\alpha}{2\beta}] \tag{10}$$

Note that the second case is relevant if $\frac{p}{\alpha} > \frac{BK}{\beta}$.

Now we are able to derive the aggregate supply $N(p)$:

$$N(p) = \int_0^\infty n^*(p,F)dG(F) = G(\underline{F}) \cdot \frac{p-\beta}{\alpha} + \frac{1}{\alpha}\int_{\underline{F}}^{\bar{F}} (p - \sqrt{p^2 - 2\alpha F})dG(F) \tag{11}$$

For our numerical example, we assume in addition that F is distributed uniformly on $[0, \hat{F}]$. By using the following values: $\alpha = 1$, $\beta = 8$, $\hat{F} = 8,5$ and BK large enough, a supply curve is obtained which is partly downward sloping. The curve is shown in Figure 9.

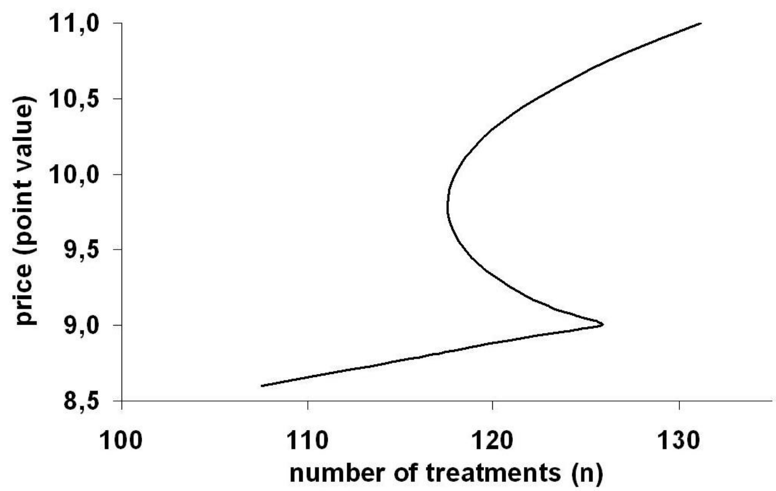

Figure 9: Market Supply Curve

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