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The Physician-Patient Relationship Revisited - the Patient's View

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Abstract

The physician-patient-relationship: the patient’s view

The importance of the physician-patient relationship for the health care market is beyond controversy. Most theoretical work is done in a principal-agent framework, dealing with moral hazard problems. Recent work emphasizes a two-sided asymmetric information relationship between physician and patient (double moral hazard). In contrast to most work looking only at the physician's perspectives, our paper concentrates on the patient's view. Estimation results using panel data support the hypotheses that physician consultation and health-relevant behavior are not stochastically independent. This means that health care demand is determined by the patient and not only by the physician. In the recursive bivariate probit model, the patient’s health-relevant behavior has a significant positive influence on the probability of a physician visit. This should be taken into account in the discussion that primary care physicians should function as gatekeepers.

Keywords: physician-patient relationship, health behavior, bivariate probit

JEL-classification: I 12, C 33, D82

1 Introduction

In the political discussion about reforming the health care sector in Germany and especially the Statutory Health Insurance (SHI) the focus is on health expenditures and financing health care. In detail, this corresponds to questions concerning the dynamics of expenditures and the slackness of revenues. Proposals that focus on the relationship between physician and patient play an underpart in the debate about the future design of the health care system. In the last years, regulation has taken place in the benefits catalogue and levels of coinsurance but not in the physician-patient relationship. In contrast to health politics, the advisory council for the health care system has described the fields of patient's personal responsibility (cf. Sachverständigenrat für die Konzertierte Aktion im Gesundheitswesen (1994)). In fact, the responsibility is often misconceived as financial participation of the patient on his health care expenditures.

The patient's special attitude in his relation to the physician can be described by the keyword patient orientation (cf. Sachverständigenrat für die Konzertierte Aktion im Gesundheitswesen (2003), 38). Compared to other parts of the service sector the health care sector has some characteristics that prevent a better patient orientation (cf. Sachverständigenrat für die Konzertierte Aktion im Gesundheitswesen (2003), p. 182). On the one hand, 99 % of the patients demand for medical services is based on their status as an insured person. Therefore, it is not possible to speak of free consumption because of the regulations in this market.[1] On the other hand, asymmetric information is prevalent in the physician-patient relationship (cf. Wille / Ulrich (1991)). Moreover, the medical services can be classified as experience goods, so that the patient's function in the health production is one of a "co-producer of health care" (Sachverständigenrat für die Konzertierte Aktion im Gesundheitswesen (2003), p. 182). [2]

From a theoretical point of view, patient's influence in the physician-patient relationship can be analyzed from the perspective of economics of information. Most of the theoretical models in this field are based on the physician's behavior whereas the patient's health related behavior is neglected. Our paper emphasizes the patient's view of the physician-patient relationship. Therefore, we focus on models that incorporate explicitly the patient's health

[1] The German Council of Economic Experts (cf. Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (2002), p. 273) describes the relationship between physician and patient as a double rationality trap because it is individually rational for the patients to demand health care services independently of the related costs. This emerges because of the compulsory contribution rates to the SHI. On the physician's side a fee-for-service remuneration has an incentive to increase the quantity of services.

[2] In many cases, the services supplied can be denoted as confidence goods because the patient is not able to monitor their quality ex post.

related behavior. It is important to keep in mind that the term health related behavior has a broader meaning than the term compliance, which indicates the patient's complimentary treatment behavior.

Part of the patient's health relevant behavior is his consumption pattern, sports, or patient's subjective measure of his health status. From an empirical perspective, especially the analysis of the determinants of patient's behavior as well as the determination of factors influencing the relationship of a patient and his physician are in the center of interest.

The paper is organized as follows: The second chapter presents some theoretical models of the physician-patient relationship that deal explicitly with the patient's behavior. With the results of these models in mind testable hypotheses about patient's behavior are developed. The empirical analysis is presented in the third part of the paper. The determinants of individual health relevant behavior and physician consultation are investigated using a bivariate probit model for panel data. The paper ends with a conclusion.

2 The relationship between physician and patient and the market for health care services

The physician-patient relationship in the market for health care services is characterized by the following stylized facts. In contrast to other economic markets, asymmetric information is prevalent in the health care sector. Especially the patient suffers an informational disadvantage and there is a lack of consumer sovereignty (cf. Ryan (1994) and Gaynor (1994)). The quality of the credence good medical services is not verifiable for the patient neither before medical treatment nor after (cf. Arrow (1963), p. 949 and Richard (1996), p. 201).[3] This applies to the situation whether the patient is not informed about the medical process. Therefore, he cannot infer the adequate therapy from the disease symptoms (cf. Richard (1993), p. 2). Like in other service industries, production and consumption of the good are not separable (uno-actu principle). Moreover, as the physician usually does diagnosis and therapy, he has a discretionary scope concerning his decisions (cf. Arrow (1963), p. 949). As a result, it is possible that the physician is able to use medical services and his therapeutic advice to maximize his resulting profit (cf. Gaynor (1994), p. 299ff. and Richard (1993), p. 2).

The physician's scope for profit maximizing activities depends crucially on the remuneration system and the possibility of a kind of treatment monopoly even if this is temporary limited

[3] For a theoretical analysis about credence goods cf. Emons (1997).

(cf. Kortendieck (1993), p. 186). The treatment success is not solely determined by physician's actions but is also influenced by the patient's treatment accompanying behavior, his compliance because in most cases the treatment would not result in a satisfactory outcome without patient's cooperation (cf. Wille / Ulrich (1991), p. 27ff.). From the perspective of the economics of information, there exists mutual asymmetric information between physician and patient. The physician provides the medical services that he is going to demand due to his informational advantage over the patient. The latter is the source of the original demand but at the same time is a productive input and therefore an integral component of the supply side. Thus, health outcome can be described as joint production between physician's medical services and patient's behavior (cf. Wille / Ulrich (1991), 27). Consequently, each actor has a discretionary scope concerning the actions he can make use of for his own advantage (cf. Wille / Ulrich (1991), 27).[4]

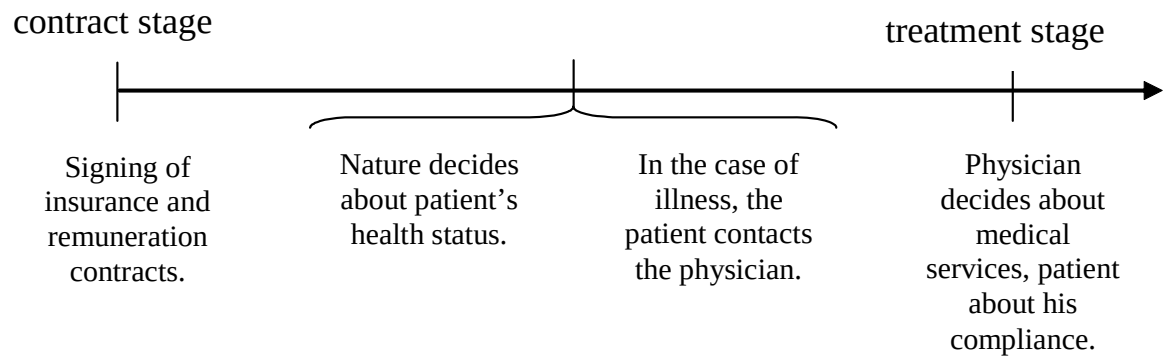
The adequate theoretical background for investigating the information relation between physician and patient is the so-called principal-agent theory (cf. Arrow (1985) and Zweifel (1994)).[5] By means of his specialized knowledge, the physician gains advantages he can use to influence the patient's demand. This informational advantage goes hand in hand with incentives to control the treatment the patient is going to choose in order to receive the maximum net revenue (cf. Evans (1974), p. 163). It is possible to manipulate the demand by varying the contact frequency, treatment intensity, and treatment costs (cf. Kortendieck (1993), p. 234). The physician acts in two matters: first as the provider of medical services and second as the patient's advisor concerning the decision about demanded services (cf. Breyer / Zweifel / Kifmann (2005)).

Most of the principal-agent models in health economics focus solely on the physician's behavior. Some newer approaches explicitly integrate the health relevant behavior of the patient and its influence on physician activities and health outcome into the analysis (cf. Ma / McGuire (1997), Leonard / Zivin (2001) and Schneider (2004)). Core of the following analysis is the so-called double moral hazard approach that is fundamental to the model of Schneider (2002a). The basic structure of the model is presented in Figure 1.

[4] Moreover, there exists uncertainty in the market for medical service concerning the demand as well as on the supply side. „Patients are uncertain about their condition, the accuracy of the physician's diagnosis, his honesty, and the amount of effort or quality he has expected on their case. [...] Physicians do not know the patient's condition, they are uncertain about the technology of proceeding health from health care, and they do not (generally) know the patient's reservation price" (Gaynor (1994), p. 225).

[5] An agency relationship is illustrated by preferences of principal and agent that fall apart and the informational advantage of the agent (cf. Gaynor (1994)). Besides the physician-patient relationship, there exist other principal-agent relations in the health care sector, e. g. between insurer and physician or between patient and insurer (cf. Pfaff / Zweifel (1998)).

Figure 1: Model structure of the double moral hazard problem



Source: Cf. Schneider (2002a), p. 107.

The model incorporates a contract and a treatment stage. At the first stage, the insurer signs the insurance contract with the patient and the remuneration contract with the physician or the physicians association. It is worth mentioning that these contracts are dependent from the insurer's point of view. After contracting, nature decides about the health status of the patient. If he is ill he visits the physician (contact decision); in the other case, the game ends. The physician plays the central part at the treatment stage. He chooses the adequate therapy that depends on patient's health status as well as on the remuneration, coinsurance, and insurance premium. Moreover, the health outcome is also determined by the patient's health related behavior.

One central element of the treatment stage of the model is the strategically interaction of physician's medical services and patient's compliance. In detail, one has to distinguish three cases of interaction: first, medical services and compliance are strategic independent. This means that a higher level of medical services has no effect on the marginal productivity of the compliance and vice versa. Second, in the case of strategic complements the marginal productivity of one input factor in the medical process increases as the level of the other factor rises. Third, given strategic substitutes, a decrease of the marginal productivity of one input is the result of an increase in the other input. As a consequence, the probability of a recovery depends not only on the level of medical services and compliance but also on the kind of strategic interaction. Furthermore, when introducing a demand-side coinsurance, health outcome depends crucially on the strategic interactions.

Within this model structure, it is possible to analyze the determinants of physician visits and the health relevant behavior of the patient. It is important to note that the results of the treatment stage cannot be adopted straightforwardly for an empirical model. First, it is necessary

to look at the entire health production process i.e. that besides the compliance of the patient his health relevant behavior without a physician visit is important, too. The second point corresponds to the first. The contracts for health insurance have an influence on the behavior of physician and patient especially if we look at a demand-side coinsurance that influences the contact decision. It follows that it seems necessary to extent the analysis to the entire health production instead of focusing on the treatment process.

3 Empirical analysis of the physician-patient relationship

3.1 Basic considerations

The following hypotheses that depend on the structure of information between physician and patient are used as starting point for the empirical analysis. First, the decision whether a discomfort can be regarded as an illness or not depends on each person's own discretionary power (*hypothesis 1*).[6] The more liberally the choice of the physician is organized and the lower the costs the patient has to bear the higher is the probability of a consultation of the physician even in the case of a small discomfort. Second, in case of a consultation, the physician determines not only the illness diagnosis but also because of his medical knowledge the relevant therapy and therefore the patient's demand for medical services (*hypothesis* 2).[7] The tendency for a supply-side increase of the treatment frequency intensifies by a fee-for-service remuneration system. Third, this excessive supply behavior facilitates because the possibility to control the supplied medical services as well as the treatment quality is limited (*hypothesis 3*). Fourth, the excessive demand behavior of the patient benefits from the lack of cost transparency concerning the level and the distribution of the treatment costs (*hypothesis 4*). Fifth, the non-constrained and non-coordinated choice of the physician leads to duplicate or multiple examinations and results in a rise in health care expenditure because of not coordinated parallel treatments (*hypothesis* 5).

One remaining question for the empirical analysis is the measurement of health relevant behavior and medical services. Both variables are multidimensional constructs. Therefore, it is necessary to develop appropriate indicators for the empirical analysis because both, health relevant behavior and medical services are difficult to measure. Concerning the medical services, the treatment expenditures or the number of physician visits are possible indicators. For

[6] More than 18 % of ambulatory patients indicated that their discomforts that let them visit the physician were only of minor importance. The treating physicians argued that 30 % of the discomforts could be regarded as negligible (cf. Sachverständigenrat zur Begutachtung der gesamtwirtschaftlichen Entwicklung (2000), p. 252).

[7] The structure of the decision process can be empirically tested by separating the contact from the frequency decision (cf. Pohlmeier / Ulrich (1995), Jones (2000)).

the health relevant behavior, the situation is more complex. We construct an indicator that may include patient's attitude towards health, his consumption behavior, or sports.

Besides these aspects that deal with the topic of choosing variables the choice of the estimation method is of relevance. Here, it is necessary to decide if the actions of physician and patient occur simultaneously or sequentially. This distinction is important if the sequence of actions has an impact on the result. If the health outcome does not depend on the timing structure or if it is not possible to sort the data with respect to the sequence of actions the simultaneous structure fits better. Moreover, besides this simultaneity it is necessary for the estimation method to account for the interdependency of the actions of physician and patient.

3.2 Data

The data we use are three waves from the German Socio-Economic Panel Study (GSOEP), the years 1998, 1999, and 2001.[8] Together with these data, we use the physician density in each of the German states. Our variables of interest are the health relevant behavior of the patient and the physician's medical services.

Patient's health relevant behavior is a multidimensional variable that is problematic to observe directly. It is therefore necessary to construct an adequate indicator that covers various aspects of the health relevant behavior. Two different kinds of aspects are of relevance: on the one hand direct patterns of individual behavior and on the other hand health perception.[9] First, the direct behavioral patterns are consumption and sports. Second, health perception includes the subjective perception of the patient's health status. While the relevance of a harmful consumption for the health status is clear it is possible for the sports to identify two effects that point in the opposite direction. First, the individual health status might improve due to sports and second, there exist a higher risk of injuries. Especially because of the second possibility, we reject the option of including the sports variable in the index of health relevant behavior.

With respect to the health relevant consumption only data about tobacco consumption are included in the SOEP. For the year 1998 it is asked if the respondent smoked cigarettes, cigars

[8] The data used in this publication were made available to us by the German Socio-Economic Panel Study (SOEP) at the German Institute for Economic Research (DIW), Berlin. For the year 2000 no information about tobacco consumption is available.

[9] A principle components analysis is used for the determination of the influencing factors of the health care behaviour including variables referring to health like smoking and sports. The result of this analysis is that for all variables high loadings are found at least for one of the principle components. Therefore, besides the statistical techniques also economic and socio-scientific criteria are used for the choice of variables describing the health relevant behaviour.

or a pipe or if he is a non-smoker. In contrast to this, for the years 1999 and 2001 it is generally requested if the respondent smokes or not. Therefore, we transform the 1998 data to use a binary variable (smoker yes-no) in analogy to the years 1999 and 2001. Other consumption patterns like alcohol drinking and consumption expenditures are not included in the questionnaire. Instead, many variables concerned with the subjective perception of the respondent towards his health status are included in the data, e.g. the satisfaction with health, the current state of health, the importance of health, and worries about health. Unfortunately, only the first two variables are available for all waves in our dataset. For the indicator of health relevant behavior, we use tobacco consumption and satisfaction with health. The latter is a variable is a subjective appreciation of the health status consisting of eleven categories, scaled from poor health (zero) to healthy (ten). Our indicator will take the value one (high health relevant behavior) if he does not smoke and if the variable satisfaction with health takes the value seven or higher.

The second endogenous variable is medical services. This variable is not included in the SOEP dataset. Only some indicators for the utilization of health services are available, e.g. the number of physician visits in the last quarter, the number of overnight stays in hospital or the number of rehabilitations, both in the last year. Because these two variables are date back too far and the number of rehabilitations is not available for the wave 2001, we use the number of physician visits in the current year.[10] In analogy to the indicator of the health relevant behavior it is possible to create a binary variable that takes the value one if there was one or more physician visit in the last quarter. Moreover, the independent variables are predisposing variables like age, age squared, gender, nationality, family status, and an interaction term. For the latter, age is multiplied with the dummy variable gender. The group of socioeconomic variables consists of income and educational variables, a variable concerning the unemployment status as well as the respondent's sporting and religious activities. Furthermore, we include health and insurance variables like hospital stay in the previous year, physician density per state, a measure of health, and the insurance status. An overview over the variables in the dataset is given in Table 1.

[10] This variable does not make any distinction between treatment and prevention.

Table 1: Description of variables in the dataset

dependent variables	
physician	physician visit in the last quarter yes/no
health behavior	non-smoker and current health status at least good yes/no
predisposing variables	
age	age in years
age²	age squared
gender	1 = female, 0 = male
interaction	age*gender
single	not living together with a partner yes/no
foreign	nationality not German yes/no
socioeconomic variables	
unemployed	unemployed yes/no
Eastern Germany	living in Eastern Germany yes/no
income	household net income per month in 1000 DM
university	university degree yes/no
high school	general qualification for university entrance yes/no
O-level	first public examination in secondary school yes/no
religious	go to church every week yes/no
sports	go in for sports every week yes/no
health and insurance variables	
hospital	hospital stay in last year yes/no
health status	health status 1= very good, … , 5= bad
physician density	physicians per 10.000 inhabitants per state
supplemental insurance	private supplemental insurance yes/no
private health insurance	fully private insured yes/no

3.3 Estimation techniques

Because of the simultaneity of health relevant behavior and medical services in the double moral hazard approach presented in chapter 2 we use an empirical model for simultaneous equations. The advantage of this procedure is that we are able to estimate two equations that seem to be independent at first view. Instead, there exists a correlation between them due to the structure of the errors.

Starting with the dependent variables, we are in need of an estimation technique for qualitative dependent variables.[11] Two estimation techniques are of special interest for the underlying theoretical model. First, a bivariate probit model and second, a bivariate probit model with recursive effect (cf. Maddala (1983) or Greene (2003)).[12] To start with the simple bivariate

[11] In contrast to the work of Schellhorn (2004) who uses a count data model combined with an instrumental variables approach, we emphasize the simultaneity with our proceeding. Moreover, we are not interested in the dependency of the error term upon the independent variables but in the correlation between the two equations due to the error terms.

[12] There exist other models using a binary dependent variable for the first equation and a continuous dependent variable for the second equation (cf. Maddala (1983)). Our indicator for the utilization of health care, the number

probit model for cross-section data, we can write the specification using a two-equation model: [13]

$$
\begin{aligned}
&y_1^* = \mathbf{x}_1' \boldsymbol{\beta}_1 + \varepsilon_1 , \quad y_1 = 1 \quad \text{für } y_1^* > 0 , \\
&y_2^* = \mathbf{x}_2' \boldsymbol{\beta}_2 + \varepsilon_2 , \quad y_2 = 1 \quad \text{für } y_2^* > 0 , \\
&E\left[\varepsilon_1 \,|\mathbf{x}_1 , \mathbf{x}_2\right] = E\left[\varepsilon_2 \,|\mathbf{x}_1 , \mathbf{x}_2\right] = 0 , \\
&\text{Var}\left[\varepsilon_1 \,|\mathbf{x}_1 , \mathbf{x}_2\right] = \text{Var}\left[\varepsilon_2 \,|\mathbf{x}_1 , \mathbf{x}_2\right] = 1 , \\
&\text{Cov}\left[\varepsilon_1 , \varepsilon_2 \,|\mathbf{x}_1 , \mathbf{x}_2\right] = \rho .
\end{aligned}
\tag{3.1}
$$

Here, the parameter ρ is the covariance between the error terms.[14] Both equations in (3.1) can be estimated separately as single probit models but the estimated coefficients are inefficient because the correlation between the error terms is neglected. Only in the case where the covariance parameter ρ is not significantly different from zero it is possible to deal with the above model as two independent equations.

The underlying bivariate normal conditional distribution function can be written as:

$$
\text{Prob}\left(X_1 < x_1 , X_2 < x_2\right) = \int_{-\infty}^{x_1} \int_{-\infty}^{x_2} \phi_2\left(z_1 , z_2 , \rho\right) d z_1 \, d z_2 = \Phi_2\left(x_1 , x_2 , \rho\right) . \tag{3.2}
$$

In equation (3.2), ϕ_2 denotes the density of the bivariate normal distribution. To derive the log-likelihood function it is necessary to define $q_{i1}=2y_{i1}-1$ and $q_{i2}=2y_{i2}-1$. The variable takes the value 1 if $y_{ij}=1$ holds and the value -1 for $y_{ij}=0$, for $j=1, 2$. Furthermore, we assume that $z_{ij}=\boldsymbol{x}'_{ij}\boldsymbol{\beta}_j$ and $w_{ij}=q_{ij}z_{ij,}$ for $j=1, 2$ and $\rho_{i*}=q_{i1}q_{i2}\rho$. The probabilities that enter the log-likelihood function are given by the following expression:

$$
\text{Prob}\left(Y_1 = y_{i1} , Y_2 = y_{i2}\right) = \Phi_2\left(w_{i1} , w_{i2} , \rho_i^*\right) \tag{3.3}
$$

and the resulting log-likelihood function is:

$$
\log L = \sum_{i=1}^{n} \ln \Phi_2\left(w_{i1} , w_{i2} , \rho_i^*\right) . \tag{3.4}
$$

---

of physician visits, is a count variable. Applying the estimation method described can result in inefficient, inconsistent, and biased estimates (cf. Long (1997), p. 217).

[13] A model in which the vector of explaining variables is different in both equations can be characterized as a seemingly unrelated bivariate probit model (cf. StataCorp (2001), p. 139).

[14] The estimation is carried out using maximum likelihood techniques.

The second estimation approach considers a potential endogeneity of the dependent variables. If one emanates from a mutual influence of both dependent variables the structural equations of the model are given by (cf. Maddala (1983), p. 242ff.):[15]

$$\begin{aligned} y_1^* &= \gamma_1 \, y_2^* + \mathbf{x}_1' \, \boldsymbol{\beta}_1 + \varepsilon_1 \, , \\ y_2^* &= \gamma_2 \, y_1^* + \mathbf{x}_2' \, \boldsymbol{\beta}_2 + \varepsilon_2 \, . \end{aligned} \tag{3.5}$$

If both dependent variables appear to be binary, we are able to write Maddala's approach alternatively as:

$$\text{Prob}\left[y_1 = 1 \, , y_2 = 1\right] = \Phi_2 \left(\gamma_1 \, y_2 + \mathbf{x}_1' \, \boldsymbol{\beta}_1 \, , \gamma_2 \, y_1 + \mathbf{x}_2' \, \boldsymbol{\beta}_2 \, , \rho\right) . \tag{3.6}$$

Here, y_1 and y_2 are binary dependent variables. Equation (3.6) gives the probability if both variables take the value one. The probabilities for the other cases are calculated in the same manner. Again, Φ_2 is the bivariate normal conditional distribution function. Unfortunately, the above model is not consistent and not estimable in the presented form. One possible modification of the approach is to calculate the probabilities for two binary dependent variables if γ_1=0 holds. Thereby, the following model results:

$$\begin{aligned} y_1^* &= \mathbf{x}_1' \, \boldsymbol{\beta}_1 + \varepsilon_1 \, , \quad y_1 = 1 \quad \text{for } y_1^* > 0 \, , \\ y_2^* &= \mathbf{x}_2' \, \boldsymbol{\beta}_2 + \gamma_2 \, y_1 + \varepsilon_2 \, , \quad y_2 = 1 \quad \text{for } y_2^* > 0 \, , \end{aligned} \tag{3.7}$$

The equations in (3.7) form a recursive, simultaneous equation system (cf. Maddala (1983)). The problem of endogeneity in the first equation is not relevant for the calculation of the log-likelihood function. Therefore, in contrast to a linear regression model, the simultaneity can be neglected (cf. Greene (2003), p. 715).

With respect to the panel structure of the data, the above model has to be adjusted. We use the random parameters approach suggested in Greene (2001) to implement a random effects

[15] There exist different alternatives of the dependent variables for the presented model, e.g. latent, observed or censored Variables. Maddala suggests a two-step estimation procedure (cf. Maddala (1983), p. 243).

bivariate probit model for panel data.[16] The basic structure of a random parameters model for binary choice is based on the following conditional probability:

$$\text{Prob}\left[y_{it} = 1 \mid \mathbf{x}_{it}, \boldsymbol{\beta}_i\right] = F\left(\boldsymbol{\beta}_i' \mathbf{x}_{it}\right), \qquad i = 1, \ldots, N, \; t = 1, \ldots, T, \tag{3.8}$$

with $F(\cdot)$ as the normal distribution. In the general model, it is assumed that parameters are randomly distributed with possible heterogeneous mean across individuals. Moreover, the mean and the variance for the coefficients β_i are:

$$\mathrm{E}\left[\boldsymbol{\beta}_i \mid \mathbf{z}_i\right] = \boldsymbol{\beta} + \Delta \mathbf{z}_i,$$
$$\mathrm{Var}\left[\boldsymbol{\beta}_i \mid \mathbf{z}_i\right] = \Sigma.$$

The underlying specification of the coefficients vector is:

$$\boldsymbol{\beta}_i = \boldsymbol{\beta} + \Delta \mathbf{z}_i + \Gamma \mathbf{v}_i,$$

where β is the vector of unconditional means. Furthermore, Δ is a matrix of unknown location parameters, z_i is a vector of individual characteristics (heterogeneity term), Γ a matrix of unknown variance parameters and v_i the vector of random latent individual effects, with a mean of zero. If the mean of the coefficient β_i is constant, the parameter in view is non-random. In our estimation of a bivariate probit model, we assume that all parameters are non-random except for the constant terms in both equations.[17] In this formulation, the random parameters model is equivalent to a random effects model:

$$\begin{aligned} y_{it}^1 &= x_{it}^1 \beta^1 + \alpha_i^1 + \varepsilon_{it}^1 \qquad \forall\, i, t, \\ y_{it}^2 &= x_{it}^2 \beta^2 + \alpha_i^2 + \varepsilon_{it}^2 \qquad \forall\, i, t. \end{aligned} \tag{3.9}$$

Here, y^j_{it} is the binary dependent variable of equation j. The vector β^j is the coefficient vector that is constant over individuals and time. The heterogeneity between individuals is represented by the parameter α^j_i that is random over individuals and ε^j_{it} is the true disturbance.[18] The parameters α^j_i are binormally distributed with a zero mean and a standard deviation equal to $\sigma_{\alpha j}$ and the correlation coefficient is θ. For the true error terms, the same assumptions are

[16] For an application of a random parameters approach see Greene (2002), Greene (2004) and Björnsen (2004).
[17] This means that the parameter matrix Δ=0.
[18] The recursive effect of y^1 and y^2 in the second equation of (3.9) is neglected here.

made as in equation (3.1): the standard deviation is equal to 1 and the covariance or correlation between these error terms is ρ. Moreover, there exists no correlation between the true errors and the individual heterogeneity parameters. The estimation is carried out using LIMDEP Version 8.0. For the random effects bivariate probit model, we use the random parameter specification with only constant terms as random.[19]

3.4 Estimation results

First, if one takes a look at the descriptive statistics of the data used it is obvious that 59.5 % of the respondents have visited their physician in the last quarter on average (cf. Table 2). Overall, the dataset consists of 7856 individuals for three years (23568 observations). 39.1 % of the individuals claim to have a good health related behavior.

Table 2: Descriptive statistics (n=7856, T=3, N=23568)

dependent variables	**mean**	**standard deviation**
physician	0,595	0,491
health behavior	0.391	0.488
predisposing variables		
age	45,428	16,264
age²	2328,197	1598,539
gender	0,519	0,500
interaction	23,764	25,867
single	0,257	0,437
foreign	0,127	0,329
socioeconomic variables		
unemployed	0,073	0,260
Eastern Germany	0,314	0,464
income	4,072	2,277
university	0,120	0,325
high school	0,163	0,370
O-level	0,234	0,424
religious	0,090	0,286
sports	0,254	0,435
health and insurance variables		
hospital	0,121	0,326
health status	2.611	0.922
physician density	34,691	4,811
supplemental insurance	0,059	0,235
private health insurance	0,074	0,262

The average age of the sample is 45.4 years whereas only adults are included in our dataset. Overall, 51.9 % are female, 26,8 % do not live together with a partner and 12.7 % are not

[19] Moreover, instead of the random draws we use the Halton sequence for the simulated maximum likelihood to reduce the number of draws and the computation time.

German. Concerning the socioeconomic variables, it is obvious that 7.3 % are unemployed at the time the survey was conducted. About 31 % have their living residence in Eastern Germany (including the former East Berlin). The average net income of a household is about 4000 DM. Regarding the education of the individuals, 12 % tell a university or comparable degree as their highest certificate, 16.3 % have a high-school graduation and 23.4 % a first public examination in secondary school. The remaining 48.7 % of the respondents possess another kind of certificate or they did not graduate from any kind of school. Only 9.0 % of our sample said that they frequently attend church and about 25 % carry out sports regularly.

For the health and insurance variables, it follows that about 12 % of the respondents stayed at least once in hospital the year before. The measure of health status is a categorical indicator. If it takes the value 1 the individual assesses his health status as very good and if it takes the value 5 his health status is very poor. The average value for the health status is 2.6 and lies in the middle of the scale. The physician density in Germany in the years 1998, 1999, and 2001 has an average of 34.7 that means that there are about 35 physicians per 10,000 residents. Only 7.4 % of the respondents in the sample are fully privately insured and only 5.9 % have a supplemental insurance. These low values correspond with the actual level in Germany. This is a result of the dominance of the Statutory Health Insurance with covers more than 90 % of the population.

For the subsequent estimation results, there are 23568 observations available; the number of individuals is 7856 in a three-year panel. We only look at adults both employed and not working. For the two estimation equations for the health relevant behavior and the physician visits, we use different sets of independent variables. For both regressions, all of the predisposing variables are included. For the health behavior regression, all of the socioeconomic variables are integrated. Moreover, we include the subjective health status and the insurance variables in the first equation.

In the estimation of the physician visit equation, the unemployment variable and the one concerning sports are used. The unemployment serves as a measure for the opportunity costs of a physician visit. We do not include the household income because in a health care system like in Germany where over 90 % of the population is insured in the SHI with contribution rates as a share of earned income and low co-payments. Furthermore, we assume that for all other socioeconomic variables the effect on the probability of a physician visit is only indirect via the health relevant behavior.

First, we estimate a bivariate probit model without a recursive effect as it is presented in section 3.3. The results are obtainable from Table 3. In addition to the variables described, we introduced two yearly dummies for 1998 and 1999, which should measure the individual invariant effect over time. Both coefficients are negative but only that one for 1999 is significant. This means that compared to the year 2001 in 1999 the probability for a good health related behavior was lower. In addition, it is obvious that the health relevant behavior depends negatively on the individual's age. The effect is significant on the 1 % level. The quadratic age term is significant positive. Overall, it follows that we have a u-shaped relationship between health related behavior and age. If we look at the gender variable, the significant positive effect indicates that women's health related behavior is better than that of men. The interaction variable is not significant. Therefore, it follows that the health related behavior reaches its minimum at about the age of 43 years independent of the gender of the respondent. Foreigners and singles show a lower health related behavior. Possible explanations are that for the first group we observe different living habits and that for the second group there is no partner to monitor the behavior.

The significant negative coefficient of the unemployment variable indicates that people without a job have a lower probability for a good health related behavior independent of their financial situation. Other socioeconomic factors show the expected signs and are significant on the 1 % level. People living in Eastern Germany have a minor health related behavior. The household income has a positive effect as well as a better education does.[20] All of the three education dummies show a positive effect with respect to the reference case, i.e. a lower school graduation certificate. An individual that goes to church every week exhibits a better health related behavior and the coefficient of the sport dummy also is positive. This means that the effect of a better health status dominates the adverse effect of a higher risk of injury.

In the group of the health and insurance variables, the health status has a significant negative impact on the probability for a good health related behavior. Health status is a categorical variable with the value one indicating that the health status is very good. A higher value goes along with a poorer health status. In the first equation, a reduction of the health status leads to a worse health related behavior. One possible interpretation for this result is that people are ill and seek medical care from a physician, which can be seen through the significant positive coefficient for the health status in the estimation of a physician visit. The consumption of

[20] This corresponds with the effect of the income in the Grossman model where a higher income leads to a higher consumption of medical services (cf. Grossman (1972), p. 243).

medical services leads to a reduction in their own effort. This indicates that there exists a substitutive relation between medical services and health related behavior. A supplemental of full private insurance has no significant effect on the probability of a good health related behavior.

Table 3: Estimation results bivariate probit model

	health behavior		**physician**	
	coefficient	**z-value**	**coefficient**	**z-value**
predisposing variables				
1998	-0.0093	-0.57	1.5013	46.81***
1999	-0.0428	-2.56***	0.2259	11.56***
age	-0.0341	-12.31***	-0.1049	-26.86***
age²	0.0004	15.29***	0,0015	38.25***
gender	0.3075	7.45***	1.7109	28.67***
interaction	-0.0012	-1.41	-0.0152	-12.01***
single	-0.2238	-12.06***	-0.2407	-9.68***
foreign	-0.1768	-7.77***	-0.1932	-6.55*
socioeconomic variables				
unemployed	-0.1745	-6.21***	0.0890	2.47**
Eastern Germany	-0.1420	-7.87***	-	-
income	0.0379	11.51***	-	-
university	0.2065	7.74***	-	-
high school	0.2960	12.40***	-	-
O-level	0.1286	6.73***	-	-
religious	0.3473	14.03***	-	-
sports	0.3411	21.12***	0.2142	9.79***
health and insurance variables				
hospital	-	-	0.3640	11.58***
health status	-1.0311	-100.56***	0.7154	53.31***
physician density	-	-	0.0089	4.29**
supplemental insurance	-0.0308	-1.02	0.1209	3.15***
private insured	-0.0012	-0.04	-0.3304	-8.88**
mean for random parameter	2.3361	31.95***	-1.3740	-11.28***
$\sigma_{\alpha 1}$	1.1854			
$\sigma_{\alpha 2}$	3.0226			
θ	0.0150			
ρ	-0.0760		Wald test $\rho = 0$ (Chi²)	47.84***
Log-Likelihood	-21122.91			
McFadden R²	0,1269			
McFadden R² adj	0,1254			
AIC	1.7955			
N	23568	n = 7856	T = 3	

*** significant at the 1-%-level
** significant at the 5-%-level
* significant at the 10-%-level

If one looks at the equation for the physician visit, it is obvious that all predisposing variables show the same sign as in the first equation except the dummies for the year 1998 and 1999. They both have a significant positive impact, which means that compared to the year 2001 the probability of a physician visit was higher in these years. This may display the effect of several health care reform acts introduced in the years 1998 to 2000 that aimed at cost containment in the SHI. The gender variable shows a strong significant positive effect but the coefficient for the interaction term is significantly negative. The latter implies that women demand less medical services with an increasing age. The probability for a physician visit reaches its minimum at the age of 35 years for men and 40 years for women. We observe the same u-shaped connection between physician visit and age. One possible explanation is the co-morbidity of older patients. Solitary persons have a lower probability to visit a physician. The same is true for foreigners although the coefficient for non-Germans is only significant at the 10 % level. One explanation for the negative coefficient is a language problem for this population group.

The socioeconomic variables used in this estimation are unemployment and a dummy for sports. Both have a significant positive coefficient. The result for the unemployment variable supports the assumption of lower opportunity costs of time for this group. The positive sports effect can be interpreted on the one hand as higher health awareness and on the other hand as the result of more injuries.

Considering the group of health and insurance variables one realizes that a hospital stay in the previous year leads to a higher probability of a physician visit in the current year. The reason for this may be aftercare or post-operative treatments. Moreover, a hospital stay may have its reason in chronic or severe illnesses. The health status has a significant and positive influence indicating that people with health problems seek medical care more likely than other people do. The variable physician density per state is positive and significant at the 5 % level. A better supply of medical services leads to a higher demand and goes along with the theory of supplier-induced demand. The insurance parameters show different results. A supplemental insurance increases the probability of a physician visit while it is reduced if the individual is fully private insured. An explanation for the first effect is that supplemental insurance enhances the benefits catalogue or reduces the coinsurance one has to pay. Therefore, medical services are relatively cheaper then. The lower demand of fully private insured individuals

may have its cause in the existence of a co-payment for medical services that is higher than for standard SHI insured people.[21]

The covariance parameter r has the value -0.076. A Chi² test rejects the null hypothesis that the parameter does not differ from zero. This result implies that the two equations are not independent and that two single probit estimates would have led to inefficient standard errors. From an economic perspective, this confirms us in the belief that the patient's behavior cannot be analyzed independent from the demand for medical services. The goodness-of-fit for the results can be proved by the use of several criteria: First, the McFadden pseudo-R^2 measure and second, the Akaike information criterion (AIC) (cf. Long (1997)). Generally, the McFadden-R^2 is a kind of "likelihood-ratio index" (Long (1997), p. 104) that informs about the relation of the likelihood of the estimated model and the likelihood of the constant-only model. An unambiguous interpretation is only possible for the case of the McFadden-R^2 equal to zero because none of the estimated coefficients differs from zero. In contrast to this, the measure never reaches the value of one. Moreover, it is not possible to give a comprehensible interpretation for values between zero and one. Despite this, the measure is useful for comparing the goodness-of-fit of different models. The Akaike information criterion is based on the log-likelihood of the estimated model as well. It represents the trade-off between the goodness of the estimation, given via the log-likelihood and the parsimony of the specification, which is given through the number of estimated parameters. The AIC is often used to compare different model specifications. That model which possesses the lowest value of the AIC is chosen as the best (cf. Verbeek (2000), p. 54 and 204). Given the results presented in Table 3, we have a value for the McFadden-R^2 of 0.1269, for the adjusted McFadden-R^2 of 0.1254 and for the AIC of 1.7955.

The second estimation is a bivariate probit model with recursive effect. In this case, one of the dependent variables acts as an explanatory variable in the other equation. First, one has to prove how the recursive effect looks like. On the one hand, the probability of a physician visit might influence the health related behavior; on the other hand, the reverse case is also possible. One argument against the first opportunity is that the causes of a physician visit lie in the individual actions of the patient and that the health related behavior expresses these individual actions. In contrast to this, it is not clear whether a physician consultation leads to changes in the individual behavior because the compliance of the patient also depends on the kind of

[21] Another interpretation of this result is that the private insured individuals represent better risks compared to members of the SHI.

illness, the kind of information of the patient, and his communication to his physician. On this account, we include the binary variable of patient's health related behavior into the estimation of the probability of a physician visit. The results of this recursive bivariate probit are presented in Table 4.

Table 4: Estimation results recursive, bivariate probit model

	health behavior		**physician**	
	coefficient	**z-value**	**coefficient**	**z-value**
health behavior			0.1049	3.59***
predisposing variables				
1998	-0.0093	-0.58	1.4988	46.819***
1999	-0.0429	-2.57**	0.2266	11.61***
age	-0.0341	-12.33***	-0.1043	-26.75***
age²	0.0004	15.29***	0.0015	38.12***
gender	0.3065	7.43***	1.7065	28.62***
interaction	-0.0012	-1.37	-0.0187	-12.05***
single	-0.2237	-12.06***	-0.2356	-9.47***
foreign	-0.1765	-7.76***	-0.1872	-6.35**
socioeconomic variables				
unemployed	-0.1746	--6.21***	0.0916	2.55**
Eastern Germany	-0.1414	-7.85***	-	-
income	0.0380	11.54***	-	-
university	0.2070	7.77***	-	-
high school	0.2965	12.43***	-	-
O-level	0.1282	6.71***	-	-
religious	0.3481	14.07***	-	-
sports	0.3413	21.14***	0.2063	9.40***
health and insurance variables				
hospital	-	-	0.3624	11.55***
health status	-1.030	-100.53***	0.7351	50.67***
physician density	-	-	0,0087	4.19***
supplemental insurance	-0.0314	-1.04	0,1208	3.15***
private insured	-0.0017	-0.06	-0,3340	-8.98***
mean for random parameter	2.3350	31.94***	-1.4653	-11.77***
$\sigma_{\alpha 1}$	1.1845			
$\sigma_{\alpha 2}$	3.0168			
θ	0.0449			
ρ	-0.1347	Wald-Test $\rho = 0$ (Chi²)		-129.34***
Log-Likelihood	-21122.80			
McFadden R²	0.1269			
McFadden R² adj	0.1254			
AIC	1.7956			
N	23568	n=7856	T=3	

*** significant at the 1-%-level
** significant at the 5-%-level
* significant at the 10-%-level

First, with respect to the physician equation, it is obvious that patient's health related behavior has a significant positive impact on the probability of a physician visit. This means that the decision to contact a physician depends on the own association about health and how to it could be preserved. For persons who have a high valuation of health and who behave according to this the probability of a visit is higher. In the dataset, there is no distinction made between illness-specific and preventive visits. Overall, from a theoretical perspective, this result strengthens the view that health related behavior and physician visits are complements (cf. Schneider (2004)).[22] For all other variables, we observe only slight changes in the coefficients' values. The same is true for the significance levels: For the variable foreigner the coefficient is now significant at the 5 %-level and for the variable private insured at the 1 %-level. The lowest probability for a physician visit is for men at the age of 35 and for women at the age of 41 years.

The estimation of the health related behavior is robust and shows no difference to the bivariate probit without recursive effect. All estimated coefficients have the same sign as in Table 3 and the magnitude changes only slightly. Only the significance level of the dummy for 1999 deteriorates a little bit. If one looks at the age coefficients, it is clear that the computation of the age with the lowest probability of a good health related behavior gives the same results as in the first estimation. The covariance parameter r is also negative with a value of -0.1347. Using the Chi² test, we can reject the null hypothesis that there is no correlation between the equations. Again, this result strengthens our thesis that patient's behavior and the demand for medical services are dependent decisions. With respect to the goodness-of-fit measures, only minor changes for the AIC are identifiable so that there is no clear evidence if one of the model specifications is to prefer.

To conclude our findings, the health related behavior of the patient and the probability of a physician visit are dependent decision processes and the result of the recursive model gives incidence that the patient's behavior has a positive impact on the demand for medical services (*hypothesis 1 and 2*). From a health politics perspective, the results obtained argue for a better preventive medicine. Moreover, it is necessary to integrate the patient in the medical process (*hypothesis 4*). Central elements are an improved communication and information structure (cf. Schneider (2002b)) as well as a better orientation of the physician on his position as a gatekeeper (*hypothesis 3*). In this context, the implementation of managed-care systems in

[22] One has to keep in mind that in the theoretical model only the treatment situation and therefore the compliance is analyzed while the estimation covers all kinds of health related behavior of the patient.

Germany may serve as one instrument to interconnect the health related behavior and the medical process (*hypothesis 5*). Generally, it is possible to use contractual arrangements to implement incentives for the patients for a better health related behavior but one has to keep in mind the interdependency between patient behavior, physician visit, and medical treatment.

4 Conclusion

The importance of the physician-patient relationship for the health care market is beyond controversy. Most theoretical work is done in a principal-agent framework, dealing with moral hazard problems. Recent work emphasizes a two-sided asymmetric information relationship between physician and patient (double moral hazard). In contrast to most work looking only at the physician's perspectives, our paper concentrates on the patient's view. The paper aims at investigating the physician-patient relationship in a principal-agent framework. We look at patient's and physician's behavior and their impact on health and health care demand. Therefore, we develop testable hypotheses about their behavior and estimate a model including patient's health-related behavior.

Based on the results of a Cooper-Ross like double moral hazard model, we formulate hypotheses to test the physician-patient relationship. Data basis is the German Socio-Economic Panel (GSOEP), a representative longitudinal study of private households in Germany. We use both cross-section and panel data. Dependent variables are the probability of a physician visit and an index of patient's health related behavior. We estimate a bivariate probit model to include the simultaneous decision of "compliance" and physician consultation. Moreover, a recursive bivariate probit model is estimated. Here, we are interested in estimating the direct impact of patient's compliance on the probability of a physician consultation. The set of independent variables includes predisposing and socio-economic variables as well as variables concerning health status, type of health insurance and living conditions.

Estimation results support the hypotheses that physician consultation and health-relevant behavior are not stochastically independent. This means that health care demand is basically determined by the patient and not by the physician. In the recursive bivariate probit model, the patient's health-relevant behavior has a significant positive influence on the probability of a physician visit.

One conclusion of our empirical findings is that existing literature underestimates the patient's role in the health care market with respect to the demand for physician services. Therefore, future health policy should concentrate more on the patient's needs and behavior. A ba-

sic instrument for health care reforms could be to focus on incentives controlling the patient's health care behavior. Moreover, the results support the attempt to encourage patient's preventive activities. Therefore, it is necessary for the patient to be integrated into the medical treatment chain. This means that the physician-patient communication should be enhanced and that the physician's gatekeeper position should be strengthened.

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