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Abstract

In the Norwegian capitation system each general practitioner (GP) has a personal list of patients. The payment system is a mix of a capitation fee and fee-for-service. From a model of a GP's decisions we derive the optimal practice profile contingent on whether a GP experiences a shortage of patients or not. We also find the conditions for whether a GP, who experiences a shortage of patients, is likely to increase the number of services he provides to his patients.

Data give us the opportunity to reveal patient shortage, i.e. a positive difference between a GP's preferred and actual list size, at the individual practice level. From the analysis of 2587 Norwegian GPs (out of a total 3650) the main result is that patient shortage has a positive effect on a GP's intensity of service provision and hence, on the income per listed person. We also find that a GP's income per listed person is influenced by the composition of the list according to indicators of need for services, and of accessibility according to the GP density in the municipality. These results are also valid when possible selection bias is accounted for, although the magnitude of the effects is then smaller.

1. Introduction

As McGuire (2000) shows, regulated fee-for-service payment is likely to result in excessive number of services under monopolistic competition in the physician market. On the other hand, pure capitation payment is likely to result in underprovision of services. Hence, optimal payment systems for physicians are likely to be a mix of several components (Newhouse, 1992, Robinson, 2001). In the present study we are interested in studying the effects of a mixed capitation and fee-for-service system on the amount of services provided by physicians. In particular, we study to what extent the variation in service intensity among general practitioners may be explained by an observation that some physicians have fewer regular patients than they would like to have (they experience a shortage of patients), combined with fee-for-service payment. If physicians who experience a patient shortage, increase their intensity of service provision as a means to increase their income, we call it income-motivated behavior. To study the prevalence of income-motivated behavior, we employ data from the recently introduced list patient system in Norway.

The reason for income-motivated behavior may coincide with less rationing of services by the physician or with physician-induced demand (PID). According to McGuire (2000), "Physician-induced demand (PID) exists when the physician influences a patient's demand for care against the physician's interpretation of the best interest of the patient". Hence, according to this definition a physician who helps the patient to move towards the consumer's optimal point is not practicing physician induced demand. McGuire (2000) distinguishes between PID and rationing. While under PID the physician influences the patient's preferences, under rationing he fixes the quantity of services such that a discrepancy between the patient's demand for services and his actual use of services occurs. Hence, under rationing the patient is dissatisfied with the services he received, while under PID he is satisfied because his preferences are manipulated. Since the problem to be addressed in this paper is confined to whether income-motivated behavior can be found among physicians who experience a shortage of patients, we do not need to give much attention to whether this happens because of PID or because of direct quantity setting[1].

[1] But the question is of course of importance when social welfare is considered.

The kind of income-motivated behavior studied in this paper is unlikely to occur in systems with a pure capitation fee, since additional services would then not be monetary rewarded. The problem with pure capitation systems is that risk selection by providers is likely to occur (Newhouse, 2002). Hence, patients with an unverifiable need for care are likely to receive insufficient care. We see that the classical trade-off between inefficiency and risk selection is a part of the balance between fee-for-service and capitation. In the end we present an estimate for what the insurer must be willing to pay in terms of inefficiency to avoid risk selection in general practice in Norway.

In Iversen and Lurås (2000) we present results from the capitation trial in four Norwegian municipalities during the period 1993-1996. In short, we find that physicians who experience a shortage of patients have higher income, longer and more frequent consultations and more laboratory tests per listed person than their unconstrained colleagues. We conclude that preferences for a certain practice style is not the only motivating factor for general practitioners (GPs). Also the economic motive is a factor of considerable importance for the level and composition of service provision in general practice. In Iversen (2004) similar results are obtained with data for a longer time period from the same four municipalities.

This paper extends the analysis with a data set consisting of all Norwegian GPs after the introduction of the nationwide list patient system in 2001. The central results with data from 2000-2003 is that patient shortage increases a GP's income per listed person from provision of services with 10-15%. We also find that a GP's income per listed person is influenced by the composition of the list according to indicators of need for services, and of the accessibility according to GP density in the municipality. These results are also valid when possible selection bias is accounted for by means of Difference-in-differences estimation, although the magnitude of the effect is then somewhat smaller.

The paper proceeds as follows. Section 2 derives the hypotheses to be tested. Section 3 introduces the institutions of primary care in Norway, and gives a description of the data for this study. Section 4 presents the estimation methods and results, and Section 5 concludes with some reflections on the implications of the findings.

2. Hypothesis

As described in Scott (2000), there is no unanimity in the literature with regard to the modeling of GP behavior. Our approach stems from the observation of variation in practice style among physicians. For a number of encounters between a GP and his patient it is not clear what constitutes 'the right medical treatment'. For instance, views among physicians may differ with respect to how often a patient with diabetes or a patient with hypertension should be called in for check-ups. Views may also differ on whether a GP who prescribes antibiotics to a patient should call in the patient for a follow-up consultation in one week or ask the patient to contact him if he does not recover. The intensity of service provision will on average be higher in the first case than in the second. An implication seems to be that for many treatment choices there is an interval of health service provision where the marginal effect on health is not documented to be different from zero[2]. For our purpose, an interesting consequence of the lack of medical standards is that several practice profiles are all regarded as satisfactory from a professional point of view. We assume that economic incentives have an effect on the intensity of service provision only in this area. This assumption corresponds to the exposition by McGuire (2000) of 'medical ethics as a constraint on choices'.

If income-motivated behavior exists, the payment system for physicians may influence whether an optimal level of service provision is attained. The optimum can be interpreted from the patient's, the physician's or from the social perspective. In this paper the physician is the optimizing agent. This means that the level of service provision is always optimal from the physician's perspective given the constraints he faces. This level of service provision may or may not be the optimal level also from the patient's perspective and from the social perspective. This issue is further discussed in the concluding remarks of the paper.

The physician maximizes a quasi-linear utility function in monetary terms, $c+v(\ell)$, where c is income (all income is consumed) and ℓ is leisure. We assume $v'(\ell)>0$ and $v''(\ell)<0$. The net income from the physician's practice is defined as $w+qn+pn(\alpha(\theta)+k)$, where w is a fixed salary or practice allowance, q is a capitation payment per person on the physician's list, p is the fee per item of health service (or equivalently, a fee-for-service) and n is the number of

[2] In health economics literature this interval is often referred to as "flat of the curve medicine"; see for instance Enthoven (1980).

listed patients. The lowest acceptable level of service provision is denoted by $\alpha(\theta) = \gamma\theta$, where $\theta \in [0, \bar{\theta}]$ is a parameter that describes the need for services among the physician's population of patients and γ is a positive parameter. The greater the need parameter is, the greater is the minimum acceptable level of service provision. We assume that the density function f(θ) is rectangular uniformly distributed and exogenous to the physician. The health services above α, provided at the physician's discretion, is denoted by *k*. The definition of leisure is $T - tn(\alpha(\theta) + k))$ where T is the exogenous total time endowment and t is an exogenously given time cost related to each consultation. The practice profile is characterized by the length of the list and the number of services per listed person. The physician maximizes a constrained quasi-linear utility function:

$$\underset{n,k}{Max} \quad w + qn + pn\int_0^{\bar{\theta}} (\gamma\theta + k)\frac{1}{\bar{\theta}}d\theta + v[T - tn\int_0^{\bar{\theta}} (\gamma\theta + k)\frac{1}{\bar{\theta}}d\theta]$$

s.t.

$$0 < n \leq \bar{n}$$

The constraint says that the number of patients is less or equal to the demand for being added to the GP's list, $\bar{n}$. We assume that a participation constraint is fulfilled, such that n>0. Here, $\bar{n}$ is considered to depend on exogenous characteristics of the physician (for instance age, gender, personality) in addition to the number of services provided at the physician's discretion. Assume that a (potential) patient evaluates the practice style of a particular GP compared with other GPs. Following McGuire (2000), a patient's perceived benefit, denoted in monetary terms, is B(k)[3]. The marginal benefit B'(k) is positive and declining. We further assume that all fees are paid by the insurance implying that also net benefit equals B(k). An interest in being listed with a particular GP requires that the perceived benefit is greater or equal to the benefit the individual may receive from the best alternative GP, denoted B^0. Hence, $B(k) \geq B^0$, and the best alternative GP is assumed to have his optimal number of patients and services. We can then determine the number of services, $\hat{k}$, that makes the individual indifferent between being listed with this particular GP and the best alternative GP. Assume that $\hat{k}$ among a GP's potential patients has a rectangular uniform distribution in the

[3] Since we do not have data at the patient level, we abstract patient characteristics, as income and opportunity cost of time.

closed interval $[\underline{k},\overline{k}]$. The number of patients interested in being listed with the GP is then contingent on the magnitude of k offered by the GP:

$$\overline{n} = \tilde{n}\int_{\underline{k}}^{k} \frac{1}{\overline{k}-\underline{k}}\,dk = \tilde{n}\frac{k-\underline{k}}{\overline{k}-\underline{k}}$$

where ñ is the maximum number of people interested in being listed with the GP. We can then make the Lagrangian and solve the problem by means of concave programming:

$$\underset{n,k}{Max} \quad w+qn+pn(\frac{\gamma\overline{\theta}}{2}+k)+v[T-tn(\frac{\gamma\overline{\theta}}{2}+k)] - \mu(n-\tilde{n}\frac{k-\underline{k}}{\overline{k}-\underline{k}})$$

Necessary and sufficient conditions for k≥0 and n>0 to solve the problem are that there is a non-negative μ such that:

$$[p-v'(\ell)t]n+\mu\frac{\tilde{n}}{\overline{k}-\underline{k}}\leq 0 \qquad (1a)$$

$$q+[p-v'(\ell)t](\frac{\gamma\overline{\theta}}{2}+k)-\mu=0 \qquad (1b)$$

where the lhs of (1a) is the utility from an additional consultation, and the lhs of (1b) expresses the utility from an additional person listed.

Since the empirical data in this study are from a list patient system with a combination of capitation payment and fee-for-service, we assume w=0, q>0 and p>0.

We can now distinguish between three types of GPs, according to volume of health services delivered per person on the list.

Type 1: The unrationed ($\mu=0 \Rightarrow k=0$)

From (1b) we see that $\mu=0$ requires $[p-v'(\ell)t]<0$. The lhs of (1a) is then negative, and accordingly $k=0$. This GP experiences an excess demand of people who prefer to be listed with him. Since the capitation fee is positive, there is always more rewarding for the GP to

add new people to the list than to increase the level of service provision to those already listed[4]. Hence, k=0 and the minimum service intensity is offered.

The remaining two types have in common that they do not achieve their optimal number of patients; hence μ>0, i.e. they are constrained with regard to the number of patients.

Eq. (1b) inserted in (1a) gives:

$$pn+[p(\frac{\bar{\theta}\alpha}{2}+k)+q]\frac{\tilde{n}}{\bar{k}-\underline{k}} \quad -v'(\ell)t[n+(\frac{\bar{\theta}\alpha}{2}+k)\frac{\tilde{n}}{\bar{k}-\underline{k}}]\leq 0 \qquad (2)$$

Type 2: High service intensity (k>0)

The first term in (2) measures the income from providing extra services to the people already listed. The second term measures the income from additional people who are attracted to the list because of the increase in the level of services provision. The third term of (2) (after the minus sign) measures the loss in utility related to the increase in working time. What characterizes type 2 is that the marginal utility from income exceeds the marginal disutility from work at k=0. Hence, (2) is fulfilled with equality for k>0.

Type 3: Forced leisure (k=0)

Since this GP is rationed, he would have preferred more patients, higher income and less leisure. But the income from providing more services is considered to be too small to compensate for the loss of leisure. Hence, the lhs of (2) is negative for *k*=0 and he experiences a kind of forced leisure. This is typically expected to happen if the difference between preferred and actual number of patients is small, if *q* is small relative to the fee-for-service component or if the impact of service provision on additional patients listed is considered to be small.

We can now classify the GPs in a community according to the three GP types. In the empirical section we shall study whether we can identify Type 2 among the rationed GPs. We also take account of how characteristics of the community, as for instance physician density, and characteristics of the population's need for services, are expected to influence a GP's

[4] In Iversen and Lurås (2000) we show that this may not be true with more than one type of service, if relative fees deviate too much from relative costs of providing them.

expected provision of services. We predict that variation in service intensity among GPs depends on:

- Variables that characterize the composition of a list of patients
- GP characteristics, including whether or not a GP has his optimal number of patients on his list.
- Physician density in the community

3. Data

In Norway, primary care is the responsibility of the municipalities, which constitute the lowest level of government. Almost every GP and the whole population participate in the patient list system introduced nationwide June 1st 2001. Hence, the problem of self-selection is negligible compared with systems where GPs select the kind of system they wish to join. The GPs are not allowed to selectively refuse to list a person, but they are permitted to close their list for new patients when they consider the list to become too long.

Some GPs are municipal employees on a fixed salary, while the majority (90 per cent) are privately practicing and contracting with the municipality. The financing of general practice is split between the state (the National Insurance Scheme), the municipalities and the patients. Before the reform, the municipalities paid an input based practice allowance to the privately practicing GPs depending on opening hours, number of auxiliaries etc, while the state paid a fee-for-service component according to a fixed fee schedule negotiated between the state and the Norwegian Medical Association. Compared with the former system, the practice allowance is replaced with a capitation component. A GP's income from the capitation component depends on the number of patients he has on his personal list. The capitation fee is flat in the sense that no risk adjustment occurs. The patients pay a fixed fee per consultation with an annual ceiling. If the ceiling is reached, the fee is refunded from the National Insurance Scheme. In addition a GP receives a fee from the National Insurance Scheme for every 15 minutes a consultation lasts beyond the first 20 minutes. He also receives an additional fee per consultation if he is a specialist in general medicine, and he receives fees for diagnostic and curative work for instance related to laboratory testing. By and large the reform left the structure of fee-for-service schedule unchanged. All GPs in our study are

privately practicing. This means that the ten per cent of the GPs who are still municipal employees, are disregarded.

Before the capitation system was initiated, every inhabitant was invited to state his or her first, second and third choice of GP to be listed with. Also, each GP stated the number of people he or she would like to have on the list (*Prelistsize*). The National Insurance Administration then assigned GPs and inhabitants according to preferences. Those inhabitants who had not expressed any preference, were assigned a GP with available capacity. *Prelistsize* is regularly updated based on information from the GPs to the local branch of the National Insurance Administration. Since GPs' preferred workload vary, the preferred number of people on a GP's list is likely to vary substantially between GPs. Table 1 shows the development of *Prelistsize* and actual list size (*Listsize*) from the initiation of the system to our last observation in July 2003 for 2907 GPs[5].

TABLE 1

From Table 1 we see that *Prelistsize* on average has been fairly stable through the period, while there has been a slight increase in *Listsize*. For each GP we compare preferred and actual list size and obtain an indicator of whether a GP is constrained regarding the number of people listed. We denote GPs with at least 100 fewer people on his list than preferred, as having a shortage of patients (*Short*), corresponding to the GP types 2 and 3 in the classification scheme in Section 2. We see from Table 1 that the proportion of GPs with a shortage of patients has decreased during the period. Similarly, we denote GPs with at least 100 more people on his list than preferred, as having too many patients (*Toomany*). Table 1 shows that the proportion of GPs with too many patients has been fairly stable since January 2002. In the empirical analyses we use time-dependent information of patient shortage in the sense that figures from January 2002 are used together with claims data for 2001, figures from July 2002 are used together with claims data from 2002, and figures from July 2003 are used together with claims data from 2003.

[5] The total number of GPs registered at the implementation of the reform is 3650. The number of (omitted) municipal employees is 378. An additional 64 is disregarded because they contract with two municipalities and we are not able to register their practice income according to each of the municipalities. Finally, 301 GPs are omitted because they quitted their practice during the period 2001-2003. The group who quitted has on average lower practice income, more patient shortage and fewer specialists in general medicine compared with the remaining GPs. We are then left with 2907 GPs.

It may be of some interest to describe the development of *Prelistsize* and *Listsize* for the various subgroups. For those who experienced a shortage of patients in January 2002 and had enough patients in July 2003, we see from Table 2 that the switch of their status both came as a result of a smaller preferred list size and an increased list of patients. The reduction in the list size may have been caused by a more demanding list than initially expected. It may also be caused by a strategic signal of preferred list size before the introduction of the system. In some municipalities those GPs who did not achieve their preferred list size would end up with a list size proportional to the preferred list size they signaled. For those GPs who feared a shortage of patients, this allocation mechanism would be an incentive to exaggerate their actual preferred list size. Those who experienced a shortage of patients both in 2002 and 2003 had only a small increase in the number of patients, while their preferred list size was about constant. Since their actual list size was a long way from their preferred list, they may not have bothered to reduce their initial signal. Contrary to their colleagues who had changed status, these GPs had no incentives to reduce their preferred list size even if their preferred list size was inflated initially.

TABLE 2

Norway is a sparsely populated country (4.5 million people on 385000 km^2) with many remote areas and few cities. The largest city is the capital Oslo with 0.5 million inhabitants. In Table 3, practice characteristics according to the municipality's level of centrality (Statistics Norway, 1994) from the lowest to the highest level of centrality are shown. We see that 7 percent of the GPs have their practice in municipalities with the lowest level of centrality, while 58 percent have their practice in municipalities with the highest level of centrality. Due to the smaller number of inhabitants, the mean list size is smaller in a municipality with a low level of centrality compared with a municipality of a high level of centrality. There is however not much difference between the percentage of GPs that experiences patient shortage at each end of the scale.

TABLE 4

Data on income from fee-for-service (excluding co-payment) at the individual GP practice level are collected in 2001 after the list patient system was introduced and in 2002 and 2003 for the full year. The number of GPs with registered data of sufficient quality in at least one of

the years is 2587[6]. The fee-for-service component from the National Insurance Scheme per listed person (*Feepercap*) is calculated in nominal terms for each GP in 2001 (*Feepercap01*), in 2002 (*Feepercap02*) and in 2003 (*Feepercap03*). From Table 4 we see that there has been an increase from 2001 to 2003. This increase is both related to the fact that the full year is covered in 2002 and 2003 and to an increase in the general level of fees. In the empirical analyses *Feepercap* is used as an indicator of the intensity of a GP's service provision. More detailed observations on service provision from claims data are collected during three periods of one month (November 2001, November 2002 and November 2003). These data include the number of consultations (*Consult*), the number of long consultations that gives an extra fee to the physician (*Duration*), the number of medical examinations and procedures, the number of laboratory tests *(#Labs*) and the total income from fees including co-payments (*Tfeepercap*) at the individual GP practice level. Since these data are collected by the National Insurance Administration from an (unbiased) sub sample of 10 - 15 per cent of GPs, the number of observations of these separate items of services provision is considerably smaller than the number of observations of the aggregate level of service provision.

We see from Table 4 that GPs with a shortage of patients differ from their unconstrained colleagues in several respects. They have a higher income per listed person. The proportion of people on the lists having the GP as their first choice (*Proplist)*, is greater for the unconstrained than for the constrained GPs. We also see that the proportion of the GPs who are specialists in general medicine, is greater among the unconstrained than among the GPs who experience a shortage of patients.

4. Estimation and results

From Section 2 we would expect that three groups of variables influence a GP's volume of service provision:

- The **need** for services among the GP's patients:

[6] The difference between 2907 GPs (reported in Tables 1 – 3) and 2587 GPs (reported in Table 4) is due to missing observations of practice income. Apart from a slightly lower proportion of specialists in general medicine among the missing compared with the non-missing, we have not found observable differences between the two groups.

As indicators of need we use the proportion of the list who had this GP as their first choice (*Proplist*), the proportion of elderly (*Propold*) and the proportion of females (*Propfem*) on the list. A high value of *Proplist* is likely to indicate that a high proportion of the list has been the GP's patients previously. Since previous episodes of care are positively related to future episodes, *Proplist* is used as an indicator of the patients' need for care[7]. We include *Propfem* since females on average use more health services than men. *Propold* is included since the need for health services in general increases with the age after the childhood is passed.

- Whether the GP experiences a **shortage** of patients (*Short*) or not
- The density of GPs in the municipality where a GP practices (*Gpdens*). A high GP density could increase the number of consultations positively since the **accessibility** is better. Hence, patients' waiting time is likely to be shorter and the number of patient initiated consultations higher. Also, the GP is more likely to prescribe follow-up consultations and controls because more capacity is available for each patient. We also include dummies for the level of centrality of the municipality's location.(*Lowcent, Med1cent, Med2cent and Highcent* in increasing order). These dummies are supposed to control for geographical variation in access to specialist health care.

In addition we include certain characteristics of the GP: The GP's gender (*Man*), age (*Age*) and whether he is a specialist in general medicine (*Specialist1*) and/or community medicine (*Specialist2*). A priori we have no hypotheses regarding the direction of these variables' impact on the volume of services provision.

Two characteristics of the data are important for the choice of estimation methods. First, since we have panel data (three periods: 2001, 2002 and 2003), unobserved heterogeneity is likely to occur. Unobserved heterogeneity violates the assumptions of ordinary least squares regression since errors terms of different periods are then correlated for each GP. Second, we suspect that rationing is not a random event. From Table 2 we see that GPs with a shortage of patients have a higher preferred list size than GPs with enough patients. On the other hand, we see from Table 4 that a smaller proportion of people on their lists have the GP as their first choice compared with their unrationed colleagues. We also see from Table 4 that a smaller

[7] On the other hand, one could claim that since the GP already has acquired information of regular patients, less diagnostic services are required after the implementation of the new system.

proportion of rationed GPs are specialists in general medicine and a higher proportion of these GPs are men. Hence, with a potential selection bias the characteristics that determine whether a GP experience patient shortage may also explain why he has a high intensity of service provision. There may for instance be a particular type of GP who both has a taste for many patients and for giving them much treatment. We then have a problem similar to the selection problem in the evaluation of social programmes, reviewed by Blundell and Costa Dias (2000). Analyses that correct for self selection are done by means of a Difference-in-differences estimator. We first introduce the panel data models and then consider selection bias.

Unobserved heterogeneity among GPs is handled by generalized least squares estimation. We have:

$$y_{it} = x_{it}\beta + v_{it} \qquad (i = 1,....,m; \quad t = 1,....,T) \tag{3}$$

y_{it} is the dependent variable with a subscript indicating observation number t of GP number i and $\mathbf{x}_{it}$ is a vector of explanatory variables with a similar subscript, β is a vector of coefficients and v_{it} is the stochastic error term. We assume that:

(a) $E(v_{it})=0$,
(b) $Var(v_{i,t})= \sigma_i^2$
(c) $Cov(v_{i,t}, v_{i,s})= \sigma_u^2$.
(d) $Cov(v_{i,s}, v_{j,t})= 0$ for $i \neq j$

Homoskedastic error structure across panels was rejected. Hence, heteroskedasticy across panels, as described in (b), is assumed. As expressed in (c) no autocorrelation within panels is assumed, and (d) states that the error terms are not assumed to be correlated across panels.

Table 5 shows the estimated effect of the explanatory variables on income in NOK from fees paid by the National Insurance per listed person (*Feepercap*), the number of consultations (*Consult*), the number of consultations with a long duration (*Duration*) and the number of laboratory tests (*#Labs*), all per 1000 people listed.

TABLE 5

We see from Table 5 that all need indicators have a positive impact on *Feepercap,* as expected. It is however unexpected that *Propfem* has a negative impact on the number of

consultations. This estimated effect is contrary to other studies that show females to be more frequent visitors than men.

We also see that the effect of *Short* is positive and significant at the one per cent level. The magnitude of the effect in year 2003 (the reference) is NOK 72. This accounts for 15 per cent of *Feepercap* in 2003. We also see that the impact of patient shortage on *Feepercap* is smaller (but still positive) in 2002 (72-11) and, in particular, in 2001 (72-44). The reasons for the increasing estimated impact of patient shortage over time are three: First, 2001 only includes half of the year. Second, nominal fees increase over time. Third, as shown in Table 1, a proportion of the GPs with indicated patient shortage in 2001, had enough patients in 2003. We would expect that the GPs who still have a shortage of patients in 2003, are more likely to consider patient shortage as a permanent state and hence, that patient shortage is likely to have a more profound impact on their service intensity compared with their colleagues who only experience patient shortage as a temporary event. Further estimations give support to this prediction. A distinction between the two groups results in an additional effect of *Persistent patient shortage* (shortage in all three years) of NOK 40. The estimated effect of shortage on the number of consultations per 1000 listed is 26 consultations per month in 2003. This is about 12% more than the average number of consultations per month per 1000 listed (210 consultations) among the GPs with enough patients in 2003. Also, the estimated effect of *Short* on *Duration* is positive. In 2003 a GP with patient shortage is estimated to provide 8.7 more consultations of a long duration per 1000 listed per month compared with a GP with enough patients. In relative terms, this amounts to 14 per cent more long consultations. The last column shows the estimated effects of the explanatory variables on *#Labs*. Also here, there is a positive impact of S*hort*, but surprisingly, there is also a positive effect of *Toomany*. Otherwise, we see from Table 5 that the effect of too many patients (*Toomany*) on service provision is negative, as expected. The magnitude of the effect is, however, quite small.

We also see that men and specialists in general medicine have a higher income from fees, NOK 65 and NOK 78, respectively. Hence, the effect of being a male GP without patient shortage is comparable to the effect of being a female GP with patient shortage in magnitude. An important reason for the higher income from fees for specialists in general medicine is the additional fee they receive per consultation. Table 5 also shows that the practice profile differs between specialists and non-specialists. The specialists have more and shorter consultations and fewer laboratory tests than the non-specialists. Since the specialists receive a higher fee

per consultation irrespective of the consultation length, this result is in accordance with their economic incentives. But the result may also be related to their superior knowledge and experience. The effect of age is bell-shaped with an estimated maximum effect on *Feepercap* at age 47 (corresponding to the mean age among the GPs).

As expected, we find that increased accessibility at the municipal level, measured by *Gpdens* implies an increased income from fees per listed person. The effect of a municipality's level of centrality is not monotonic and has a maximum at *Med2cent*. It is claimed that GPs in the cities and in particular GPs in Oslo exaggerated their preferred list when the patient list system was initiated. The reason is that they feared that a shortage of patients would occur and since people who had not expressed preference for a particular GP, were allocated to GPs in proportion to the GPs' preferred number of patients, there was an incentive to exaggerate the preferred number of patients. To account for this possibility, we included an interaction term between Oslo and patient shortage at the introduction of the system (*Short*Oslo*). The effect (not reported in Table 5) is negative of the magnitude of NOK 40.

A higher income from fee-for-service per person listed is of course not equivalent with a higher total practice income. According to Table 2, GPs with a shortage of patients had in July 2003 on average 1140 people listed, while GPs with enough people listed had approximately 1320. Compared with his colleague with enough patients, the GP with patient shortage earns on average NOK 82,080 (NOK 72*1140) from the extra service provision. With a similar list as his colleagues with enough patients he would have earned the sum of capitation fee (NOK 300) and the average income from fees (NOK 461) times 180 people (the difference between lists of 1320 and 1140). This amounts to NOK 136,980. Hence, a conservative estimate of his loss of income from experiencing patient shortage is NOK 54,900[8] (NOK 136,980 – NOK 82,080). This amounts to just above 5 per cent of the total income from fees of a GP with enough patients.

We now consider the potential selection bias involved in the characteristics of those GPs who experience patient shortage compared with those GPs who have enough patients. Luckily, we also have access to data one year before (year 2000) the patient list system was initiated.

[8] This is a conservative estimate since we disregard that the GPs who experience patient shortage have a longer preferred list size than the GPs with enough patients have.

Hence, we may correct for a potential selection bias by estimating a Difference-in-Differences estimator (see for instance Blundell and Costa Dias, 2000)[9]:

$$y_{it} = a + \eta_i + \theta_t + \sum_{t=2000}^{2003} \tau_t x_{it} + u_{it}$$

where y_{it} is the outcome variable (for instance income from fees per listed person similar to previously), a is a constant term, η_i is the individual specific fixed effect, θ_t is the common time specific fixed effect, x_{it} is a binary variable equal to one if individual i experiences a shortage of patients in period t and zero otherwise, and u_{it} is a temporary individual specific effect with zero expectation and constant variance. The year previous to the implementation of the list system is denoted, t=2000. In the next paragraph we argue that none of the GPs experienced patient shortage then. Hence, x_{i0}=0 for all GPs. In the diff-in-diffs approach unobserved time-invariant individual effects are adjusted for, since we have data both for the years before and after the reform. Hence, unobserved individual characteristics that select some GPs into patient shortage are adjusted for, and the effect of patient shortage may then be identified. If we compute the difference in outcome during the treatment period for each individual and then compute the difference between the treated and non-treated, a, η_i and θ_t cancel out, and we are left with τ_t as the expected treatment effect. According to Blundell and Costa Dias (2000) there are two critical requirements that has to be fulfilled for the treatment effect (in our study, the effect of patient shortage) to be identified by the diff-in-diffs approach. First, the unobserved individual effect must be time-invariant. If a temporary unobserved individual effect influences who ends up in each of the two groups, we may not be able to distinguish between this temporary effect and the effect of patient shortage. The second requirement is that the common time specific effect (θ_t) has an equal impact on both groups.

We have four periods of observations, one period (2000) prior to the introduction of the list patient system and three periods (2001, 2002, 2003) after the introduction. Before the introduction the GPs received in addition to fee-for-service an input based practice allowance independent of the number of patients who saw them regularly. Hence, a GP could obtain a certain level of income both by providing many services to few patients and by providing few services to many patients. Hence, we claim that none of the GPs were rationed prior to the introduction of the list system. After the introduction of the list system the practice allowance

[9] See Blundell and Costa Dias (2000) for a more detailed description of the method.

is replaced by a capitation component. It then becomes more rewarding (at least in the short run) to provide few services to many patients than to provide many services to few patients, since the first strategy implies more income from capitation. The practice allowance was about 360,000 NOK per year and the capitation fee is about 300 NOK per person per year. This means that a GP needs to have 1200 patients listed for not experiencing a decline in the income component that is independent of the number of services provided. Hence, a GP who obtains only 800 patients experiences a decreased income of 120,000 NOK if he provides the same number of services per patient as previously. The decline in income is expected to initiate an income effect in the direction of providing an increased number of services, and is accounted for in the regression analysis by both including *Short* and an interaction term between shortage and list size (*Short*list*) . We expect the estimated sign of the effect of the interaction term to be negative. The reason is that a longer list makes the income loss smaller and hence, the effect of patient shortage on service intensity is also expected to be smaller.

We do not know the number of regular patients that a GP had before the list patient system was implemented. In the analysis we assume that this number is equal to the list when the new system was initiated. However, some GPs may have seen the opportunity of having a reduced work load when the new system was introduced. We say that a GP is of this type if the GP's preferred list size at the time the system was implemented is smaller than the number of people who had this GP as their first choice. We then use the number of people who had the GP as their first choice as an indicator of his number of regular patients in year 2000.

TABLE 6

Table 6 shows the results from the Difference-in-differences estimation. We see that *Short* has a positive effect on *Feepercap*. We also see that the interaction effect between shortage of patients and listsize, i.e. (*Short*list*), has a negative impact, as predicted in the previous paragraphs. A GP who experiences a shortage of patients and the number of patients equal to 1140, is expected to have a net effect on *Feepercap* of shortage of the magnitude NOK 190 – (0.1042*1140), which equals NOK 71; in fact the same magnitude as estimated in Table 5. *Toomany* has, as expected, a negative effect. We also find that S*hort* has a positive and statistically significant effect on the other indicators of service provision; *Consult, Duration* and *#Labs*. The effect on *Consult* when we take the average list (1140 people) into account, is 19 additional consultations per month per 1000 listed. This is a smaller magnitude than

estimated in Table 5. The effect on the number of consultations with a long duration (*Duration*) is 9 consultations per month per 1000 listed, which is similar to Table 5. Lastly, we see that patient shortage is also estimated to have a positive impact on the number of laboratory tests (*#Labs*).

In a recently published report, Grytten, Sørensen and Skau (2005) show that a certain proportion of a GP's consultations are with patients listed with other GPs. Reasons for these consultations are emergency care, a second opinion or that several GPs co-operate in handling each others patients during temporary leave from practice. From survey data Grytten and Sørensen (2005) conclude that the volume of external consultations amounts to 9.6 per cent of the total number of consultations for GPs who would like to have a longer list and to 6.1 per cent for the GPs who are satisfied with the length of their list. For GPs who would like to have a shorter list, the volume of external consultations is 4.8 per cent of the total number of consultations[10]. Since the proportion of external consultations is higher for GPs with a shortage of patients relative to the other types, Grytten, Sørensen and Skau (2005) assert that the effect of patient shortage on service provision is overstated if the proportion of external consultations is not adjusted for. Data from the National Insurance Administration do not distinguish between internal and external patients in a reliable way. To account for the point made in Grytten, Sørensen and Skau (2005) we have adjusted our income and service provision figures according to their survey data and re-estimated the models. The downward adjustment made is 5 per cent for GPs with enough or too many patients and 10 per cent for GPs with patient shortage. The estimated effect of patient shortage on income from fees is still statistically significant at the one percent level. The magnitude of the estimated effect decreases from NOK 72 to NOK 42. The percentage increase in income per listed person due to patient shortage accordingly falls from 15 per cent to 10 per cent of the income from fees of a GP with enough patients. Similarly, the effect on the number of consultations per 1000 listed decreases from 26.0 to 12.9 consultations per month. This corresponds to a decline from 12 per cent to 6.5 per cent of the total number of consultations of a GP with enough patients. For consultations with a long duration the effect falls from 8.7 to 5.1 consultations per 1000 listed per month, corresponding to a decline from 14 per cent to 9.6 per cent of the total

[10] These figures apply to GPs in group practice (about 80 per cent of the total number of GPs). For GPs in solo practice the corresponding figures are 9.6 per cent for those who would like to have a longer for list, 7.7 per cent for those who are satisfied with the list size and 6.9 per cent for those who would like to have a shorter list.

number consultations with a long duration of a GP with enough patients. All effects are statistically significant at the one per cent level.

5. Concluding remarks

The present study exploits data from the whole population of Norwegian GPs. The main empirical result is that patient shortage has a positive effect on a GP's income from provision of services per listed person. These results are also valid when possible selection bias is accounted for, although the magnitudes of some of the effects are then smaller. The result is in accordance with the qualitative focus group study by Carlsen and Norheim (2003), who find that the characteristics of the market have an impact on service provision among Norwegian GPs after the introduction of the list patient system.

A policy implication of the study is that patient shortage is costly to the insurer because of income-motivated behavior fed by the fee-for-service component of the payment system. An alternative would be to drop the fee-for-service component and let the payment system be based on the capitation fee only. The GPs would then compete for patients without considering the income from services per se. Services delivered would be a means to attract patients to the list and hence, to generate capitation income. The problem is of course that under a pure capitation system not all patients are equally attractive because of variation in need for services. A risk adjustment component would then be required to prevent risk selection by the GPs. It is well known from the literature that a risk adjusted capitation system is hard to construct in practice. The present study may therefore demonstrate the classical trade off between selection and inefficiency in health care. In Norway, the total annual sum of fee-for-service paid to GPs from the National Insurance is NOK 2 billions. We calculated the average effect of patient shortage on the income from fee-for-service to NOK 82,000 per GP. If 20 per cent of the total number of 4000 GPs experiences a shortage of patients, the aggregate effect of patient shortage amounts to NOK 65.6 millions or 3.3 % of the total fee-for-service paid by the National Insurance. This figure *may* give some indication of the cost of avoiding patient selection by means of the fee-for-service component of the payment system.

The ‘may’ is important here since in this paper we have not considered the optimal level of service provision from the patient’s point of view or from the society’s point of view. We have so far only considered optimal choice from the physician’s perspective. Hence, we cannot rule out the possibility that patients prefer a higher level of service provision than offered by a GP with enough patients. If a GP with enough patients is rationing his services, the increase in the number of services by a GP with patient shortage is also (cet. par.) preferred by the patients and does not involve physician induced demand (PID). The important question from a welfare perspective is then whether patients would be prepared to pay the cost of those extra services now paid by the National Insurance.

We have shown that the level of service provision among GPs seems to be partly motivated by income, and this finding is a necessary condition for economic incentives to be effective in influencing the volume and composition of services among GPs. An important challenge for future research is therefore to gain more knowledge of the optimal intensity of service provision from society’s point of view and the optimal mix of capitation and fee-for-service to support society’s optimum.

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Table 1 Development of mean (std. dev.) preferred and actual list size and the proportion of GPs who experience a shortage of patients (2907 GPs)[11]

	June 2001	Jan. 2002	July 2002	Jan. 2003	July 2003
Prelistsize	1375 (425)	1371 (416)	1367 (410)	1362 (409)	1360 (404)
Listsize	1236 (382)	1257 (396)	1266 (391)	1270 (388)	1274 (387)
Prelistsize- Listsize	139 (201)	114 (239)	101 (230)	92 (219)	86 (218)
% of GPs with patient shortage (*Short*=1)	40	34	29	27	24
% of GPs with too many patients (*Toomany*=1)	0.3	6	6	5	5

Table 2 Mean list characteristics according to time and patient shortage status (2907 GPs)

	Enough 2002 Enough 2003 (1851 GPs)		Enough 2002 Shortage 2003 (69 GPs)		Shortage 2002 Enough 2003 (349 GPs)		Shortage 2002 Shortage 2003 (638 GPs)	
	Jan 2002	July 2003	Jan 2002	July 2003	Jan 2002	July 2003	Jan 2002	July 2003
Prelistsize	1299	1294	1280	1505	1490	1367	1522	1532
% of GPs with reduction in Prelistsize		25		12		39		3
Listsize	1313	1306	1252	1276	1249	1350	1102	1140
% of GPs with increase in Listsize		66		70		85		54
Prelistsize- Listsize	-13	-12	28	228	242	19	421	392

[11] The table includes GPs in private practice who have been active the entire period.

Table 3 Mean list characteristics according to the municipality's location (2907 GPs)

	Prelistsize	*Listsize*	*%Short*	*%Toomany*	No. GPs	*% of GPs*
Lowcent (level 1)	1117	1038	24	5	215	7 %
Med1cent (level 2-5)	1264	1199	19	6	523	18 %
Med2cent (level 6)	1411	1333	23	6	497	17 %
Highcent (level 7)	1407	1311	26	5	1672	58 %

Table 4 Descriptive statistics - mean (standard deviation) of the variables according to patient shortage as registered July 2003

Variable	Definition	*Shortage*= 0 (preferred-actual ≤100) (Unless otherwise stated: 5720 observations of 1994 GPs)	*Shortage*= 1 (preferred-actual >100) (Unless otherwise stated: 1726 observations of 593 GPs)	All GPs (Unless otherwise stated: 7446 observations of 2587 GPs)
Feepercap01	Mean income per listed person in NOK from fees paid by insurance June 1st - December 31th 2001 (# obs = 2396)	NOK 204 (NOK 109)	NOK 220 (NOK 140)	NOK 207 (NOK 118)
Feepercap02	Mean income in NOK from fees paid by insurance per listed person January 1st - December 31th 2002 (# obs = 2529)	NOK 429 (NOK 182)	NOK 488 (NOK 313)	NOK 442 (NOK 221)
Feepercap03	Mean income in NOK from fees paid by insurance per listed person January 1st - December 31th 2003 (# obs = 2521)	NOK 461 (NOK 192)	NOK 525 (NOK 305)	NOK 476 (NOK 225)
Consult	Mean no. of consultations per 1000 listed during one month (# obs = 2245)	230 (100)	260 (120)	240 (110)
Duration	Mean no. of consultations per 1000 listed where duration dependent fee is used during one month (# obs = 2101)	60 (40)	70 (60)	60 (50)
#Labs	Mean no. of laboratory tests per 1000 listed during one month (# obs = 2095)	170 (100)	170 (110)	170 (100)
Propselect	The number of people having the GP as their first choice as a proportion of the GP's preferred list size (# obs = # GPs)	0.84	0.47	0.75
Proplist	The number of people having the GP as their first choice as a proportion of the GP's list January 1st 2002 (# obs = # GPs)	0.85	0.60	0.79
Propold	The proportion of persons aged 70 and older on the list	0.12	0.12	0.12
Propfem	The proportion of females on the list	0.52	0.46	0.51
Male	A dummy variable equal to one if the physician is a male *(# obs = # GPs)*	0.70	0.85	0.74
Age	The GP's age in years *(# obs = # GPs)*	47.0 (8.0)	48.0 (8.4)	47.2 (8.1)
Specialist1	A dummy variable equal to one if the physician is a specialist in general medicine *(# obs = # GPs)*	0.63	0.53	0.61
Specialist2	A dummy variable equal to one if the physician is a specialist in community medicine *(# obs = # GPs)*	0.08	0.07	0.08
Gpdens	Number of GPs per 10,000 inhabitants in the municipality *(# obs = # GPs)*	7.7 (1.4)	8.1 (1.3)	7.8 (1.4)

1 USD equals approximately 6.50 NOK

Table 5: The estimated effect (st. dev.) of a shortage of patients on income from fees paid by insurance per listed person (FEEPERCAP) [12] and other indicators of service provision per listed person. Random effects model.

		Feepercap	*Consult*	*Duration*	*#Labs*
	Propold	245** (13.2)	102.0** (7.4)	5.3 (3.1)	280.3**(4.5)
Need indicators	*Propfem*	62** (10.7)	- 42.7** (3.1)	41.2** (1.8)	127.6* (2.3)
	Proplist	54** (1.8)	18.0** (0.8)	2.1** (0.4)	26.3** (0.4)
	Short	72** (2.8)	26.0** (1.2)	8.7** (1.0)	11.0** (0.7)
Patient	*Short*2002*	-11** (3.6)	-3.1 (2.4)	3.9** (1.4)	5.9**(2.1)
Shortage	*Short*2001*	-44** (3.5)	-5.3** (1.7)	-1.1 (1.0)	-7.2**(1.0)
	Toomany	-8** (2.3)	2.9 (1.6)	-2.2** (0.4)	18.7**(1.1)
	Man	65** (2.2)	2.7* (1.1)	4.4** (0.5)	23.1**(0.6)
GP charac-	*Age*	6.6** (0.9)	8.4**(0.4)	1.3**(0.2)	11.2**(0.4)
teristics	*Age*^{2}	-0.07**(0.009)	-0.08**(0.004)	-0.008**(0.002)	-0.1**(0.004)
	Specialist1	78** (1.5)	6.9** (0.9)	-11.9** (0.4)	-8.5**(0.7)
	Specialist2	22** (2.6)	-2.9**(0.7)	-1.3* (0.6)	-14.1**(1.3)
	Gpdens	20** (0.6)	3.4** (0.3)	2.3** (0.1)	2.4**(0.1)
Municipality	*Med1cent*	3 (3.5)	-4.1**(1.1)	-11.8**(0.6)	2.6(1.7)
characteristics	*Med2cent*	62** (3.3)	13.8**(1.0)	-0.7(0.5)	42.9**(1.8)
	Highcent	40** (3.2)	17.9**(1.1)	-5.3**(0.5)	6.2**(1.7)
	Constant	-82 (21.5)	-59.6**(9.0)	-18.6** (4.2)	-281.5**(8.0)
	Dummies for years	Yes	Yes	Yes	Yes
	Number of observations	7446	2112	2101	2112

'*' ('**') indicates that the estimated parameter is significantly different from zero at the five (one) per cent level with a two tailed test.

Table 6: The estimated effect (st. dev.) of a shortage of patients on income from fees paid by insurance per listed person (FEEPERCAP) [13] and other indicators of service provision. Difference-in-differences estimation.

	Feepercap	*Consult*	*Duration*	*#Labs*
Short	190.12** (14.44)	70.94** (19.31)	30.56** (7.77)	44.74* (20.01)
*Short*2002*	-17.64* (7.07)	6.19 (8.39)	1.82 (3.36)	-2.88 (8.43)
*Short*2001*	-71.06** (7.15)	-7.90 (8.57)	-5.43 (3.43)	-8.83 (8.58)
*Short*list*	-0.10** (0.01)	-0.05** (0.01)	-0.02** (0.0054)	-0.03 (0.01)
Toomany	-41.08** (5.74)	-9.33 (8.38)	-1.92 (3.36)	-1.17 (8.42)
Dummies for GPs	Yes	Yes	Yes	Yes
Dummies for years	Yes	Yes	Yes	Yes
R^2 (group effects included)	0.81	0.80	0.87	0.88
No. observations	10440	2557	2538	2557
No. GPs	2725	1377	1371	1378
No. observations per GP	Min:1 Avg:3.8 Max:4	Min:1 Avg:1.9 Max:4	Min:1 Avg:1.9 Max:4	Min:1 Avg:1.9 Max:4