The Simultaneous Impact of Patient's and Doctor's Financial Incentives

The Case of Dental Diagnostics in NHS Scotland

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Abstract

Aims: To test whether simultaneous consideration of supply and demand side cost sharing yields different findings than previous studies which have been investigating both incentive mechanisms distinct from each other, using dental diagnostics in NHS Scotland as an example.

Methods/Data: We use 2001 to 2005 panel data from the Management Information and Dental Accounting System (MIDAS) which provides 388,652 claims by Scottish dentists for non-traumatic treatment delivered to NHS patients above 18 years of age. Controlling for unobserved heterogeneity from patients and/or dentists we estimate a series of fixed-effects models in order to identify the influence of demand and supply side cost sharing on utilization of diagnosis via mirror/probe or via small x-ray imaging, respectively.

Results: We find a significant effect of doctor's reimbursement type on the extent to which mirror/probe examinations are utilized. For the utilization of dental x-rays, we observe significant and equally sized effects of both doctor's reimbursement and patient's insurance coverage. Moreover, if conditioning use of x-rays on prior use of mirror/probe examinations, there is a particular increase in utilization of x-rays for patients who are exempt from charges and treated by a salaried dentist.

Conclusions: This study shows how financial incentives for both doctor and patient simultaneously determine utilization of dental diagnostics. Specifically, the observed utilization patterns suggest that dentists are influenced by reimbursement schemes when they advice x-rays. Then, upon advice of an x-ray by the dentist, patients appear to follow the ex post consumer moral hazard track.

JEL CLASSIFICATION: I10, I11, I12, I18

Keywords: ex post moral hazard, physician agency, utilization of dental services, diagnostic methods, demand and supply side cost sharing, dentists remuneration, supplier induced demand.

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1 Introduction

Previous literature on incentives in health care has been separately investigating the influence of patient's insurance against treatment costs and doctor's reimbursement on the utilization of health services. However, in 'real world' health service settings both demand and supply side incentives are at work simultaneously.

Assume that treatment decisions were completely determined by providers. Then there may still be a role for patient charges to influence treatment through 'physician-agency' effects (McGuire, 2000). If dentists have a concern for what the patient pays, patient charges may yet affect utilization because dentists will be concerned about very costly treatments that damage the financial well being of their patients. Note that the dentist's concern does not need to be purely altruistic: if patients choose between dentists it may be beneficial for a dentist to engage in less intense, lower cost treatment regimes in order to retain their patients. This potential role for patient charges - acting through the supply side - is important because it suggests that policy towards patient charges need to be considered together with dentist remuneration.

Analogously, from the patient's perspective it may be relevant how doctors are reimbursed. Patients may envisage that some of the treatment advised by the physician may follow financial incentives in the sense that fee for service induces more treatment than salary, vice versa. If patients expect any of both doctor's reimbursement schemes to result in another extent of treatment than desired, they may voice such concerns during dental attendance, hence wielding influence towards the dentist. The latter may than choose to counteract the patient's concern in order to satisfy patients.

A potential concern for health policy, thus, is that the combination of both incentive mechanisms may lead to altered treatment variations than the pure aggregation of demand and supply side effects would suggest. In this paper we exploit the unique opportunity of accessing administrative dental records in NHS Scotland. The data observe patients and dentists over multiple treatment episodes and, thus, allow to identify alterations in the use of health services once changes in patient's insurance status and/or dentist's method of reimbursement take place. For this purpose we rely on two commonly utilized diagnostic procedures - diagnosis via mirror/probe and via small x-rays.

2 Financial Incentives in Health Care

2.1 Economic Theory

The literature on incentives in health care distinguishes between cost sharing on the demand and on the supply side. The former refers to the case when patients share the cost of health care provision with a third party whereas cost sharing on the supply side applies when the provider of a service is not fully reimbursed for the costs of what she has supplied.

Demand Side Cost Sharing

A suitable theoretical framework for the evaluation of health care market demand assumes that patients determine the amount of services to consume by comparing the costs and benefits of consumption. Specifically, the consumption of more treatment leads to increasingly lower benefits, i.e. the marginal benefit of treatment falls as more treatment is consumed. The benefits of dental treatment might include the arrest of pain, a reduction in the probability of pain in the future, a recreation of the ability to chew or an improvement in aesthetics. The costs could consist of time off work, travel costs and the patient charge. Only if the benefits are greater than the costs will a patient utilize dental treatment. Furthermore, once at the dentist, a patient will only willingly pay for treatments for which the benefits exceed the costs. Hence, an increasing patient charge may reduce the utilization of dental services in two distinct ways.

First, patients who choose to receive treatment may choose to receive less on account of patient charges - this will henceforth be referred to as a reduction in use at the 'intensive margin'. Second, some patients may no longer attend at all, may attend less frequently or may seek private treatment, i.e. a reduction in use of services at the 'extensive margin'. In both cases the reduction in utilization occurs because the marginal cost of treatment to the patient increases with the infliction of patient charges.

Without demand side cost sharing patients are likely to consume more health care resources than under patient charges. In the economics literature this increased consumption is termed ex post moral hazard (Zweifel and Manning, 2000). It is, therefore, commonplace to discuss demand side cost sharing as a response to ex post moral hazard problems and to consider it as a mechanism for reducing over-consumption.

Supply Side Cost Sharing

Cost sharing on the supply side refers to the concern that health care providers have discretion over quantity, inputs that affect costs, quality and prices of health care. Hence, these issues of 'Physician Agency' (McGuire, 2000) particularly involve the question which incentives arise from different reimbursement arrangements in terms of cost containment, quality of care and supplier induced demand.

A purely prospective payment system (capitation) can be expected to give virtually no incentives for supplier induced demand, strong incentives for cost containment, and adverse incentives on treatment quality. For the latter case Ellis and McGuire (1996) distinguish between a selection effect (accepting only low risk patients for treatment), a moral hazard effect (decreased provision of services to patients) and a practice style effect (narrow practice scope, i.e. the doctor refers patients to other colleagues rather than treating them herself). In contrast, a purely retrospective payment system (FFS) is not encouraging cost containment by the doctor. It is yet likely to induce supplier induced demand and a broad practice scope. Because of the imperfectness of both pro- and retrospective systems different types of mixed reimbursement have evolved which seek to eliminate the disadvantages of the previously described arrangements (for a detailed discussion see e.g. Robinson, 2001).

2.2 Previous Empirical Findings

The RAND Health Insurance Experiment (HIE, see Newhouse et al., 1993) incorporated 6,692 individuals who were randomly allocated to dental insurance plans with demand-side cost sharing of either 0 per cent, or 25 per cent or 50 per cent or 95 per cent. However, an upper limit of 5, 10 or 15 per cent of family income and an upper limit of USD 1000 on the overall use of healthcare was created. There was also an arrangement called 'individual deductible' (ID) plan which comprised a 95 per cent coinsurance rate on all outpatient services up to a limit of USD 150 per person or USD 450 per family. All dental service providers received reimbursement on a fee per item basis. The findings of the HIE can be summarized within three categories.

First, demand side cost sharing is found to reduce the overall utilization of dental services. Compared to the 95 per cent coinsurance case patients on the free plan had a by 31 per cent higher probability to use any dental service. They also made 34 per cent more visits and dental expenses which were higher by 46 per cent.

Second, demand side cost sharing affects different types of dental treatment to a different extent. Specifically, the gap for diagnostic/preventive or restorative procedures with respect to insurance scheme is less progressive than for prosthetic or endodontic/periodontic procedures.
Third, the HIE reviews the effects of demand side cost sharing on oral health outcomes. In contrast to overall health as measured by the general health index (GHI) differences were identified with respect to oral health for specific patient groups. Individuals who were assigned to a cost sharing contract had a tendency towards more decayed and less filled teeth as compared to individuals exempt from co-payment. Similarly, patients in the free plan (except of individuals aged 35 to 64) had a better periodontal outcome than the comparison groups with cost sharing.
The HIE also carried out analyses in order to explore the micro-foundation of the observed oral health outcome differences. Issues considered were income, education, and baseline oral health status. In comparison to a 95 per cent coinsurance scheme patients in the free plan were more likely to have a greater utilization of dental services when in the lowest third of the income distribution than individuals in the highest income class. Moreover, a free insurance scheme had only positive impact on DMFT if an individual came from average or below average educational background and if an individual had average or above average dental decay when assigned to the insurance scheme. Finally, full insurance lead to improved periodontal index scores only for 12-17 year old individuals who in addition had either low-average education or higher than average and average periodontal index scores.

Generally not much evidence exists on the interaction between insurance schemes and dental services apart from the RAND HIE. Nonetheless, the existent literature supports the three main findings of the HIE. To wit:
The effects of demand side cost sharing operate mainly at the extensive margin. Matee and Simon (2000) and Olsson (1999) show that the introduction of cost sharing reduces the number of visits by 33 per cent and 20 per cent, respectively. Milgrom et al. (1998) reveal that insurance increases the attendance of children by only ca. 10 per cent and Manning et al. (1985) suggest that the effect of increasing the coinsurance rate from 0 to 25 per cent leads to ca. 30 per cent less visits. In contrast to the extensive margin the evidence for the intensive margin is rather ambiguous. While Kington et al. (1995) and Conrad et al. (1988) find no evidence for an influence of insurance status on expenditure, Mueller and Monheit (1988) and Manning and Phelps (1979) suggest that there actually exist interdependencies for both specific treatments and overall expenditure.
At the intensive margin, some treatments are more responsive to cost sharing than others. Though there are not much empirical estimates on the influence of cost sharing on specific treatments, some studies examine the impact on specific dental treatment procedures. Matee and Simon (2000), Zammit (1993) and Parkin and Yule (1988) show that prosthetic services are highly responsive to cost sharing. An essential finding by Manning and Phelps (1979) is that the utilization of examinations is less responsive to cost sharing than other services. They find that price elasticities are about -.6 for adult females and children, but near zero for adult males and argue that the time-cost component of demand may be dominant amongst employed males.
The durable nature of oral health may generate transitory surges in utilization in response to changes in insurance coverage. A part of the literature debates that the specific effects observed within empirical studies as the RAND HIE may be due to the fact that some individuals received treatment only after becoming insured for dental services. This links to the nature of dental care which can be delayed but most often with the result that more intensive treatment will be necessary later on (see e.g. Conrad et al., 1988 and Parkin and Yule, 1988). A specific finding from Korea by Jung (1998) implies that a substitution between the intensive and extensive margins can arise when the extent of patient charges is increased. In comparison to a previously more lenient patient charge

Korea's introduction of per visit patient charges in 1986 had reduced visits by 25 per cent but the costs per visit had risen by 19%. The underlying causality is suggested to result from behavioural modification by both dentists and patients.

Some authors suggest complementary findings to the RAND HIE in terms of the impact of cost sharing. Specifically, a self-selection of patients is proposed, i.e. that different insurance arrangements enforce a systematic assortment of patients with respect to their individual characteristics. For instance, Godfried, Oosterbeek and van Tulder (2001) observe this phenomenon within the Dutch system. Patients who could determine the extent of their own dental insurance are shown to choose a higher coverage when expecting a higher utilization of dental services, vice versa. Hence, the individuals' risk characteristics can lead to adverse selection if no appropriate adjustment of insurance premiums is achieved.

3 Empirical Framework

3.1 Institutional Background

The delivery of dental care in Scotland is accomplished via private and public sector (NHS) providers. The latter are again categorized within three subgroups: the General Dental Services (GDS), the Community Dental Services (CDS) and the Hospital Dental Services (HDS). While the HDS receives referrals from dentists, from general physicians and from other hospital departments the CDS are mandated by health trusts who aim to provide care to disadvantaged individuals and persons with special needs like e.g. elderly people in residential care. Nonetheless most NHS dental services are delivered by General Dental Practitioners (GDPs) which account for about 80 per cent of Scottish dentists. Therefore, this paper concentrates on the GDS.

Further institutions involved in the delivery of dental services are the Primary Care Trusts (PCTs) and Island Health Boards (IHBs) which are in charge to provide dental care to the population and do so by means of contracting with GDPs. The main task of the Scottish Dental Practice Board (SDPB) is to review payments to GDPs and to monitor the treatment quality of GDPs and to supervise the Scottish Dental Reference System.

The reimbursement of dentists itself is carried out in two different ways within the GDS. Salaried GDPs receive a fixed salary or a salary plus a bonus which is deduced according to the number and types of treatments delivered. These salary schemes were introduced in order to tackle the problems of GDPs who do not accept NHS registrations of insured patients or differences in the extent to which patients receive treatment with respect to their insurance contract.

Only about four per cent of dentists are employed by PCTs/IHBs and most dental care in Scotland is carried out by self employed dentists who can either be principal dentists, i.e. they own the practice. Or they can be associates who have signed a contract with a principal dentist and usually pay a proportion of their fees to the principal as a charge for the use of the practice's facilities. Generally, self-employed GDPs are paid under a mixed system consisting of capitation and fee-for-service (FFS) elements. They receive a fixed payment for every person registered with them and a fee for every treatment procedure performed. The exact arrangements are constituted in the Statement of Dental Remuneration (SDR).

From a patients' perspective dental care is not generally free at the time of treatment. In contrast FFS items are partially financed by the patients through a charge. About 50 per cent of GDS expenditure are composed by these patient based fee-for-item arrangements. According to the National Health Service (Dental Charges) Regulations 1989 and its subsequent amendments non-exempt patients pay 80 per cent of the value of the claimed treatment fees, albeit with an upper limit set at 366. However there are several different reasons why a patient may be exempt from charges. These encompass reasons of age (below 18 years, full-time education if aged 19), reasons of income (disabled persons, receiving family credit, income support, income based jobseekers allowance), reasons of health (nursing mother, pregnancy) and partial remissions.

3.2 Dataset and Estimation Strategy

The data used for this paper originate from the Management Information and Dental Accounting System (MIDAS). This database collects claims by Scottish dentists for the services they have delivered to NHS patients and forms the basis for working out future dentist's salaries or, fees per treatment item, respectively. It's reliability is verified by regular state-controlled inspections in order to prevent fraud. For the purposes of our analysis we obtained a simple random sample from the MIDAS database for claims made between 1st April 2000 and 31st March 2005. The sample was created by extracting all the claims made by self-employed dentists on behalf of patients whose unique identifier ended in 000, 001, 002 or 003 and all claims made by salaried dentists on behalf of patients whose unique identifier ended in 001, 101, 201, 301, 401, 501, 601, 701, 801 or 901 between 1st April 2000 and 31st March 2005. Note, that there are relatively specific regulations for traumatic treatment and persons aged 18 years or below. Therefore, the according claims are not considered for purpose of this paper. In total 388,652 claims by Scottish dentists (for non-traumatic treatment of persons above 18 years of age) were recorded between April 1st 2000 and March 31st 2005. This provides the advantage of following up individual patients and dentists at multiple points of time. These panel characteristics enable to powerfully examine what results from changes in terms of a patients' insurance status or a dentist's method of remuneration. In total, our sample contains 84,785 patients; 62,623 of these are observed over multiple time periods. During the observation period 10,477 patients had switched their insurance status and 872 patients had switched between dentists with different remuneration contracts. Moreover, the sample comprises 2,379 dentists of whom 2,343 are observed at multiple time stages. During the observation period 40 dentists had switched their reimbursement scheme.

The objective of this paper is to examine whether demand side cost sharing and dentist's type of remuneration have simultaneous impact on the utilization of common diagnostic methods. As dependent variables we, therefore, rely on the following three binary variables:

mirror/probe indicates whether a standard clinical examination was provided; this encompasses investigation via mirror probe as well as vitality probing and percussion testing;

x-ray refers to whether a small dental x-ray ('dental film') was provided (regardless of other prior diagnostics applied);

x-ray given mirror/probe indicates whether a small dental x-ray was provided conditioned on prior mirror/probe investigation. The rationale of this variable is to depict the 'routine' pathway of dental diagnosis and to exclude cases of immediate x-raying (which will primarily occur in cases of non-scheduled ('emergency') treatment of pain).

Finally, note one particularity of the dependent variable "mirror/probe": according to the SDR this position can only be reimbursed once per 6 months. Expectably, a dentist is rather unlikely to claim this position when the same patient has already received this type of examination within the past half year. In the model specifications for the dependent variable "mirror/probe" we therefore account for potential state dependency by inclusion of an

explanatory lag-variable which indicates whether "mirror/probe" was provided within the past 6 months.
As for other explanatory variables, our model specifications consider dummy variables for patients exempt from treatment charges ("exempt patient": representing the extent of demand side cost sharing), the way the dentist gets paid ("salaried dentist" representing the extent of supply side cost sharing) and the according interaction term "(exempt patient)*(salaried dentist)". Moreover, patient characteristics will be controlled for by the variable "patient's age" and a variable for deprivation category ("patient's deprivation") which is measured on a scale from 1 (most affluent) to 7 (least affluent). It refers to the postcode of the dental practice but the assumption that most patients utilize dental care where they live allows this variable to be applied as a proxy for patient's deprivation. The data also allow to control for some dentist characteristics. Details of the according variables ("orthodontist"; "principal dentist") as well as of all other dependent and explanatory variables are shown in table 1.

3.3 Controlling for Unobserved Heterogeneity

A serious concern of biased estimation results stems from the fact that the available variables in our data set do not enable to fully control for patient and/or dentist characteristics. In particular, we expect considerable unobserved heterogeneity regarding the health condition of patients and regarding treatment styles of dentists. As for the latter, note that dentists may for instance vary in terms of the extent to which they replace preventive by more invasive techniques.
Fortunately, we can apply panel regression methods in order to control for unobserved heterogeneity. We therefore establish a series of fixed effects models, assuming that patient and/or dentist heterogeneity is constant over the observation period and that individual specific effects are correlated with the independent variables. Justification for the latter assumption comes by arguing that (1) exemption from treatment charges is correlated with patients' health status (e.g. mediated by socioeconomic status) as well as (2) dentists' reimbursement scheme impacts on treatment styles.
Identification of fixed effects is implemented as follows. First, the time dimension is captured by the sequential timing of treatment claims. Second, the group dimension is modeled via

a) **patient** fixed effects

b) **dentist** fixed effects

c) **patient & dentist** fixed effects

d) fixed effects for **patient/dentist couples**

Formally, the corresponding regression equation can be written as

$$\mathrm{y}_{ijk} = \mu + \phi + \beta * w_{ijk} + \vartheta * z_{ijk} + \delta * (w_{ijk} * z_{ijk}) + \gamma * x_{ijk} + \epsilon_{ijk}$$

where

y_{ijk} $\equiv$ diagnostic procedure provided by dentist i to patient j during course of treatment k

w_{ijk} $\equiv$ remuneration scheme of dentist i when seeing patient j during treatment course k

z_{ijk} $\equiv$ co-payment by patient j when seeing dentist i during treatment course k

$w_{ijk} * z_{ijk}$ $\equiv$ denotes interaction between dentist's remuneration scheme and patient's co-payment

x_{ijk} $\equiv$ additional controls that vary across dentists, patients and their treatment courses

$$\phi = \begin{cases} \nu_j & \text{for patient-specific effects;} \\ \eta_i & \text{for dentist-specific effects.} \\ \nu_j + \eta_i & \text{for patient \& dentist-specific effects.} \\ C_{ij} & \text{for patient/dentist-couple specific effects.} \end{cases}$$

As per the nature of treatment decisions which - at least to some extent - are negotiable between patient and dentist, we consider the patient/dentist couple identifier of major relevance. A further robustness check relies on omitting the variable 'days since last visit' in order to assess whether the coefficients of interest are affected by the duration of time that has elapsed since the patients last visit. By inclusion of this variable we intend to control for potential effects due to accumulated treatment needs over time. However, this inevitably results in loss of observations because there is no information regarding duration since last visit for patients' first appearance in the panel.

4 Results

Regarding the mirror/probe examination, table 2 shows a significant and negative effect on utilization probability when the dentist is reimbursed via salary as compared with fee for service. For the patient/dentist-couple identifier, we detect a variation in the probability to apply a mirror/probe examination of 14.3 %(see table 2), and 13.8 % respectively (drop 'days since lasst visit; see table 3)). The negative sign of the parameter estimate holds robust across all model specifications and when dropping 'days since last visit' as a control variable. Note that effect size varies with respect to different fixed effect identifiers (tables 2 and 3) but dimensions are alike when it is controlled for unobserved heterogeneity on the part of both patient and dentist (column (4) or patient/dentist couples (column (5)).

In contrast to physician reimbursement the influence of patient's extent of cost sharing on utilizing a mirror/probe examination (tables 2 and 3) is not uniform across model specifications and, if any, has a rather small effect size when factoring in unobserved heterogeneity on behalf of the patient (columns (2), (4), and (5)). Specifically, a slight tendency towards less mirror/probe examinations for patients exempt from treatment charges is observed if "days since last visit" are left out as control (see table 3). At most the according effect size accounts to about 1.2 % (couple fixed effects, column (5)).

In terms of x-ray utilization, tables 4 and 5 indicate that both dentists' reimbursement as well as patients' cost sharing matter. First, if a dentist is reimbursed via salary this will result in less x-raying as reflected in the according parameter estimates. The effect size varies between 2.4 % and 4.3 % across different model specifications. Estimates do not reveal uniform significance, though. Second, the degree of patient's cost sharing is a significant parameter for utilization of x-rays. The according parameter estimates are highly significant across all model specifications and indicate that a patient who is exempt from treatment charges receives more x-rays (tables 4 and 5). Specifically, the couple fixed effects estimators (column (5)) identify an effect size of 3.3 % (when controlling for "days since

last visit", see table 3) and 3.1 % per cent respectively (when dropping "days since last visit").
Note, however, that tables 4 and 5 report on dental x-raying in a rather general way. I.e. the dependent variable "x-ray" detects x-raying regardless of baseline medical condition, albeit it may mix up cases of routine ('planned') with non-scheduled ('emergency') pain treatment. Thus, the dependent variable "x-ray given mirror/probe" may more suitably depict the pathway of routine dental diagnosis by excluding cases of immediate ('emergency') x-raying. As shown in tables 6 and 7, the parameter estimates for "no patient's charge" are similar to those in table 4 and 5. In contrast, two notable alterations arise when regressing on "x-ray given mirror/probe" as compared to (unconditional) "x-ray":
On the one hand, the model specifications based on patient/dentist couple fixed effects (see column (5)) identify a significant parameter estimate for dentist's reimbursement method. More precisely, less routine x-raying occurs when a dentist is paid via salary as compared with fee for service and the effect size accounts to 12.1 per cent % (when controlling for "days since last visit"; see table 6) and 8.4 %, respectively (when leaving out "days since last visit" as control, see table 7).
On the other hand, the parameter estimates for the interaction term "(exempt patient)*(salaried dentist)" proof significant in model specifications which account for unobserved heterogeneity on the part of patients and/or dentists. The probability of routine x-raying is topped up when a patient who is exempt from treatment charges is seeing a salaried dentist. Particularly when factoring in patient/dentist couple fixed effects, the according effect size accounts to 6.2 % (when controlling for "days since last visit"; see table 6)and 9.8 % (when leaving out "days since last visit" as control, see table 7), respectively.

5 Discussion

The findings of the present paper add a new perspective to the so far literature on financial incentives in health care. Previously, cost sharing on the part of the patient and the dentist have been considered conceptually distinct from each other. However, our study shows that such a view may be to too simplistic.
Our results suggest that utilization of mirror/probe examinations is largely influenced by the dentist's reimbursement scheme in the sense that salary leads to less mirror/probe examinations than fee for service; whereas the impact of patient's insurance status appears relatively minor. This observation could reflect incentives which are due to particular SDR regulations for diagnosis via mirror/probe. More precisely, the latter restricts claimable cases of the according position to once per six months (per patient). In this context, one could argue for a non-linear pricing mechanism on the part of dentists. While a fee for service dentist may have a generally higher incentive to offer mirror/probe examinations to patients (as compared to a salaried dentist whose earning is irrespective of any examination) she may yet be immune to urges for further increased utilization as potentially caused by a patient who is exempt from treatment charges. Accordingly, our findings could be seen as evidence for the irrelevance of financial incentives operating through the demand side once doctors' earnings are limited in the sense that the number of claimable cases is restricted over time.
Moreover, the present paper gives evidence for simultaneous impacts of patient's and doctor's financial incentives on health service utilization when the number of claimable cases is not restricted over time. Consistent with the standard consumer moral hazard argument, our findings clearly point towards increased utilization of dental x-rays when patients become exempt from treatment charges. Yet this effect seems overlapped by incentives which operate through different dentist's reimbursement schemes.

First, when pooling cases of 'routine' and 'emergency' x-raying, the results give some (albeit weak) evidence for a reimbursement effect, i.e. that salaried dentists perform less x-rays than their counterparts who receive fee for service. This effect is in the order of the variation in x-ray utilization as caused by different degrees of cost sharing on the part of patients.
Second, when considering only cases of 'routine' x-raying, we identify a specific interdependency between patients' and dentists' financial incentives as per patient/dentist couple fixed effects: the margin in x-ray utilization between a salaried dentist and a colleague who receives fee for service is smoothed once a patient is exempt from treatment charges. In other words, an exempt patient seing a salaried dentist appears to "catch up" with x-ray utilization in comparison with an exempt patient seing a paid per service dentist. One interpretation of this finding may be that salaried dentists suggest a routine x-ray to patients less frequently than colleagues who are paid fee for service. Then upon advice of an x-ray patients follow the consumer moral hazard track - the less costs a patient bears the higher the demand. In particular, exempt patients attending a salaried dentist may compensate less frequently suggested x-rays by a higher probability to take up the dentist's offer.
In conclusion, this paper may give advice to policy makers who seek quantity setting of health services via patients' and/or doctors' cost sharing. On the one hand, the example of the mirror/probe examination suggests that patients' moral hazard can be addressed via restricting the quantity of services which are claimable by doctors. This is in line with a non-linear pricing scheme for a good which, for the provider, yields a profit for the first unit but no profit for subsequent units. Hence, the market equilibrium will contain at most one unit of the good irrespective of any demand exceeding this single unit of the good. On the other hand if the quantity of a health service is not restricted as in the case of dental x-raying, supply side cost sharing policies may not easily meet targets. A serious flaw may be due to patients who are insured against treatment costs. According consumer moral hazard effects may not only be static phenomenons but may also work across time as per intertemporal substitution. I.e. even if doctor's reimbursement may induce only rare advice of a particular health service (in the sense of take it or leave it offers), patients may substitute less frequent occasions of health service utilization by a higher probability to accept treatment when offered by the doctor.

References

Bailit, H, Newhouse, J, Brook, R, Duan, N, Goldberg, G, Hanley, J, Kamberg, C, Spolsky, V, Black, A, and Lohr K (1985) 'Does more generous dental insurance coverage improve oral health?' Journal of American Dental Association, Vol. 110, pp701-707.

Chalkley, M, and Tilley, C (2002a) 'Provider Payment Under Fixed and Flexible Reimbursement: Dentists in the British NHS', Invited paper presented at the International Health Economics Conference at the Hong Kong University of Science and Technology, March 11-13, 2002.

Chalkley, M, and Tilley, C (2002b), Patient charges for NHS dental services in Scotland, mimeo.

Conrad DA, Grembowski D, and Milgrom P (1987), 'Dental Care Demand: Insurance Effects and Plan Design', Health Services Research, Vol. 22, No. 3, 341-367.

Ellis, RP and McGuire, TG (1996), Hospital Response to Prospective Payment: Moral Hazard, Selection, and Practice-Style Effects, Journal of Health Economics 15, 257-77.

Godfried M, Oosterbeek H, and Van Tulder F (2001) 'Adverse Selection and the Demand for Supplementary Dental Insurance', De Economist, Vol. 149, No. 2, 177-191.

Jung K (1998) 'Influence of the Introduction of a Per-Visit Copayment on Health Care Use and Expenditures: The Korean Experience', The Journal of Risk and Insurance, Vol. 65, No. 1, 33-56.

Kington R, Rogowski J, and Lillard L (1995) 'Dental Expenditures and Insurance Coverage Among Older Adults', The Gerontologist, Vol. 35, No. 4, 436-443.

Manning WG, Benjamin B, Bailit HL, and Newhouse JP (1985) 'The demand for dental care: evidence from a randomized trial in health insurance' Journal of American Dental Association, Vol. 110, 895-902.

Manning WG, and Phelps CE (1979) 'The demand for dental care', The Bell Journal of Economics, Vol. 10, 503-525.

Matee M, and Simon E (2000) 'Utilisation of dental services in Tanzania before and after the introduction of cost-sharing', International Dental Journal, Vol. 50, 69-72.

Milgrom P, Mancl L, King B, Weinstein P, Wells N, and Jeffcott E (1998) 'An Explanatory Model of the Dental Care Utilization of Low-Income Children', Medical Care, Vol. 36, No. 4, 554-566.

McGuire, TG (2000) 'Physician Agency', in Culyer, AJ and Newhouse, JP (eds), Handbook of Health Economics, Elsevier, Amsterdam.

Mueller CD, and Monheit AC (1988) 'Insurance Coverage and the Demand for Dental Care', Journal of Health Economics, Vol. 7, 59-72.

Newhouse, JP, and the Insurance Experiment Group (1993), 'Free For All? Lessons From the RAND Health Insurance Experiment', Harvard University Press, Cambridge, MA.

Olsson, C (1999) 'Visiting a Dentist: Is Dental Insurance Important?', Ume Economic Studies 491, Ume University.

Parkin D, and Yule B (1988) 'Patient charges and the demand for dental care in Scotland, 1962-1981', Applied Economics, Vol. 20, 229-242.

Robinson, JC (2001), Theory and Practice in the Design of Physician Payment Incentives, Milbank Quarterly, 79(2), 149-177.

SDPB (2001), Scottish Dental Practice Board Annual Report 2000/01. Statement of Dental Remuneration, Amendment No. 91 (2004), Scottish Dental Practice Board.

The National Health Service (Dental Charges) Regulations 2005.

Zammit MP (1993) 'Patterns of Patient Attendance and Dental Services Utilization in Northern Labrador 1985-1989', Arctic Medical Research, Vol. 52, 5-12.

Zweifel, P and Manning, WG (2000) 'Moral Hazard and Consumer Incentives in Health Care', in Culyer, AJ and Newhouse, JP (eds), Handbook of Health Economics, Elsevier, Amsterdam.

6 Tables and Figures

6.1 Descriptive Statistics

Table 1: **Summary Statistics**

Variable	Description	Mean	Std. Dev.	N
mirror/probe	Equals 1 if ”clinical examination (mirror/probe/tooth vitality)” was claimed	0.66	0.474	388652
x-ray	Equals 1 if ”small x-ray” was claimed	0.186	0.389	388652
x-ray given mirror/probe	Equals 1 if ”small x-ray” was claimed, given that code1a was also claimed	0.149	.356	256688
patient’s deprivation	Deprivation category of dentist’s practice	3.839	1.531	388652
patient’s age	Patient’s age	45.888	15.935	388652
exempt patient	Equals 1 if patient is exempt from treatment charges	0.261	0.439	388652
days since last visit	Duration since last visit (days)	225.879	187.371	306228
claims per year	Number of claims per dentist per financial year	68.271	32.295	388652
dentist’s age	Dentist’s age	43.981	9.768	388652
orthodontist	Equals 1 if dentist is specialized in orthodontics	0.001	0.032	388652

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... table 1 continued

Variable	Description	Mean	Std. Dev.	N
principal dentist	Equals 1 if dentist is principal dentist for NHS Scotland	0.228	0.419	388652
salaried dentist	Equals 1 if dentist receives salary (fee for service = 0)	0.017	0.13	388652
(exempt patient) *(salaried dentist)	Equals 1 if patient is exempt from charges and dentist is salaried	0.004	0.064	388652
code1a_past6months	Equals 1 if clinical examination (mirror/probe) was claimed within past 6 months	0.001	0.025	388652

6.2 Mirror/Probe Examination

Table 2 (control for days since last visit):

	(1) OLS	(2) patient fe	(3) dentist fe	(4) patient + dentist fe	(5) couple fe
salaried dentist	-0.079***	-0.166***	-0.087***	-0.157***	-0.143**
	(0.008)	(0.022)	(0.022)	(0.020)	(0.072)
exempt patient	-0.087***	0.001	-0.072***	0.001	0.002
	(0.002)	(0.005)	(0.002)	(0.004)	(0.005)
(exempt patient) *(salaried dentist)	-0.029	-0.014	0.003	0.031	0.023
	(0.018)	(0.033)	(0.017)	(0.026)	(0.051)
dentist's age	0.003***	0.003***	0.000	0.004***	0.000
	(0.000)	(0.000)	(.)	(0.000)	(.)
orthodontist	-0.593***	-0.565***	-0.430***	-0.559***	0.000
	(0.017)	(0.032)	(0.077)	(0.045)	(.)
principal dentist	-0.051***	-0.052***	-0.035***	-0.062***	-0.020*
	(0.002)	(0.005)	(0.006)	(0.004)	(0.010)
patient's age	-0.001***	0.003***	-0.001***	0.003***	0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
patient's deprivation	-0.008***	-0.007**	-0.001	-0.009***	-0.025**
	(0.001)	(0.003)	(0.002)	(0.002)	(0.012)
claims per year	0.000***	0.001***	-0.000***	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
code1a_past6months	-0.477***	-0.462***	-0.459***	-0.469***	-0.481***
	(0.019)	(0.022)	(0.019)	(0.027)	(0.025)
days since last visit	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_cons	0.570***	0.329***	0.689***	0.004***	0.376***
	(0.007)	(0.028)	(0.013)	(0.001)	(0.054)
N	306228	63592	2338	63592	91653

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 3 (no control for days since last visit):

	(1) OLS	(2) patient fe	(3) dentist fe	(4) patient + dentist fe	(5) couple fe
salaried dentist	-0.074***	-0.147***	-0.084***	-0.141***	-0.138**
	(0.007)	(0.018)	(0.018)	(0.016)	(0.057)
exempt patient	-0.093***	-0.006	-0.077***	-0.007*	-0.012**
	(0.002)	(0.004)	(0.002)	(0.004)	(0.005)
(exempt patient)	-0.005	0.026	0.005	0.038*	0.041
*(salaried dentist)	(0.014)	(0.025)	(0.014)	(0.022)	(0.041)
dentist's age	0.004***	0.003***	0.000	0.004***	0.000
	(0.000)	(0.000)	(.)	(0.000)	(.)
orthodontist	-0.603***	-0.630***	-0.701***	-0.626***	0.000
	(0.016)	(0.028)	(0.050)	(0.041)	(.)
principal dentist	-0.063***	-0.037***	-0.028***	-0.037***	-0.003
	(0.002)	(0.004)	(0.005)	(0.004)	(0.010)
patient's age	-0.001***	0.006***	-0.001***	0.006***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
patient's deprivation	-0.008***	-0.005**	-0.001	-0.005***	-0.016
	(0.001)	(0.002)	(0.002)	(0.002)	(0.011)
claims per year	0.000***	0.000***	-0.000***	0.000***	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
code1a_past6months	-0.544***	-0.559***	-0.527***	-0.558***	-0.596***
	(0.019)	(0.022)	(0.020)	(0.026)	(0.026)
_cons	0.658***	0.285***	0.804***	-0.000	0.398***
	(0.006)	(0.025)	(0.011)	(0.001)	(0.051)
N	388652	84785	2379	84785	123087

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6.3 X-ray

Table 4 (control for days since last visit):

	(1) OLS	(2) patient fe	(3) dentist fe	(4) patient + dentist fe	(5) couple fe
salaried dentist	-0.025***	-0.030*	-0.024	-0.030*	-0.039
	(0.006)	(0.017)	(0.016)	(0.016)	(0.055)
exempt patient	0.020***	0.029***	0.019***	0.028***	0.033***
	(0.002)	(0.004)	(0.002)	(0.003)	(0.005)
(exempt patient)	-0.022	-0.005	-0.005	-0.005	0.017
*(salaried dentist)	(0.014)	(0.028)	(0.014)	(0.022)	(0.047)
dentist's age	-0.001***	-0.002***	0.000	-0.003***	0.000
	(0.000)	(0.000)	(.)	(0.000)	(.)
orthodontist	-0.194***	-0.120***	-0.164***	-0.143***	0.000
	(0.007)	(0.022)	(0.040)	(0.038)	(.)
principal dentist	0.025***	0.026***	0.023***	0.034***	0.003
	(0.002)	(0.004)	(0.005)	(0.004)	(0.009)
patient's age	-0.002***	-0.002***	-0.002***	-0.003***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
patient's deprivation	0.003***	0.003	-0.002	0.004**	-0.014
	(0.000)	(0.003)	(0.002)	(0.002)	(0.009)
claims per year	-0.001***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
days since last visit	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_cons	0.288***	0.296***	0.233***	-0.009***	0.396***
	(0.006)	(0.023)	(0.010)	(0.001)	(0.042)
N	306228	63592	2338	63592	91653

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 5 (no control for days since last visit):

	(1) OLS	(2) patient fe	(3) dentist fe	(4) patient + dentist fe	(5) couple fe
salaried dentist	-0.034***	-0.043***	-0.032**	-0.039***	-0.033
	(0.005)	(0.014)	(0.013)	(0.014)	(0.044)
exempt patient	0.011***	0.025***	0.009***	0.026***	0.031***
	(0.002)	(0.004)	(0.002)	(0.003)	(0.004)
(exempt patient)	-0.029**	-0.003	-0.010	-0.003	0.050
*(salaried dentist)	(0.011)	(0.022)	(0.011)	(0.019)	(0.038)
dentist's age	-0.002***	-0.002***	0.000	-0.002***	0.000
	(0.000)	(0.000)	(.)	(0.000)	(.)
orthodontist	-0.237***	-0.142***	-0.153***	-0.145***	0.000
	(0.007)	(0.021)	(0.021)	(0.034)	(.)
principal dentist	0.037***	0.023***	0.023***	0.020***	-0.014*
	(0.002)	(0.003)	(0.004)	(0.003)	(0.008)
patient's age	-0.003***	-0.005***	-0.003***	-0.005***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
patient's deprivation	0.005***	0.003	-0.000	0.003	-0.015*
	(0.000)	(0.002)	(0.001)	(0.002)	(0.008)
claims per year	-0.001***	-0.000***	-0.000***	-0.000***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_cons	0.385***	0.487***	0.323***	-0.000	0.607***
	(0.005)	(0.021)	(0.009)	(0.001)	(0.040)
N	388652	84785	2379	84785	123087

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6.4 X-ray given mirror/probe

Table 6 (control for days since last visit):

	(1) OLS	(2) patient fe	(3) dentist fe	(4) patient + dentist fe	(5) couple fe
salaried dentist	-0.010	-0.004	-0.007	-0.001	-0.121**
	(0.008)	(0.023)	(0.020)	(0.020)	(0.054)
exempt patient	0.021***	0.028***	0.020***	0.031***	0.022***
	(0.002)	(0.005)	(0.002)	(0.006)	(0.004)
(exempt patient)	0.022	0.092**	0.032*	0.060**	0.062
*(salaried dentist)	(0.019)	(0.043)	(0.019)	(0.027)	(0.056)
dentist's age	-0.001***	-0.001***	0.000	-0.001***	0.000
	(0.000)	(0.000)	(.)	(0.000)	(.)
orthodontist	-0.119***	-0.035	0.000	-0.005	0.000
	(0.044)	(0.078)	(.)	(0.046)	(.)
principal dentist	0.017***	0.023***	0.016***	0.019***	0.012
	(0.002)	(0.005)	(0.005)	(0.004)	(0.010)
patient's age	-0.002***	-0.001**	-0.002***	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
patient's deprivation	0.003***	0.004	-0.001	0.003	-0.004
	(0.001)	(0.004)	(0.002)	(0.003)	(0.011)
claims per year	-0.001***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
days since last visit	0.000***	0.000***	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_cons	0.235***	0.180***	0.195***	-0.004***	0.198***
	(0.007)	(0.028)	(0.012)	(0.001)	(0.048)
N	207948	56703	2235	56703	70964

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 7 (no control for days since last visit):

	(1)	(2)	(3)	(4)	(5)
	OLS	patient fe	dentist fe	patient + dentist fe	couple fe
salaried dentist	0.003	-0.010	0.002	-0.008	-0.084*
	(0.007)	(0.019)	(0.017)	(0.017)	(0.044)
exempt patient	0.017***	0.024***	0.016***	0.021***	0.028***
	(0.002)	(0.004)	(0.002)	(0.003)	(0.005)
(exempt patient)	0.018	0.070**	0.027*	0.057**	0.098**
*(salaried dentist)	(0.016)	(0.034)	(0.016)	(0.023)	(0.046)
dentist's age	-0.001***	-0.001***	0.000	-0.001***	0.000
	(0.000)	(0.000)	(.)	(0.000)	(.)
orthodontist	-0.137***	-0.091	0.000	-0.004	0.000
	(0.038)	(0.076)	(.)	(0.042)	(.)
principal dentist	0.019***	0.022***	0.014***	0.015***	0.002
	(0.002)	(0.004)	(0.005)	(0.004)	(0.009)
patient's age	-0.002***	-0.002***	-0.002***	-0.002***	-0.002***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
patient's deprivation	0.004***	0.003	-0.001	0.001	-0.011
	(0.000)	(0.003)	(0.002)	(0.002)	(0.010)
claims per year	-0.001***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
_cons	0.291***	0.262***	0.261***	0.000	0.320***
	(0.006)	(0.025)	(0.010)	(0.001)	(0.045)
N	256688	68375	2296	68375	87506

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$