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THE USE OF DEPUTISING SERVICES IN GENERAL PRACTICE: A MULTILEVEL ANALYSIS

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December 1998

Abstract

Aim: This paper investigates the factor related with the use of deputising services in the provision of primary medical care in England. The empirical specification is based on a model of utility-maximising behaviour that recognises that general practitioner makes work/leisure choices.

Data: Data are mainly derived from the October 1997 GP Census. The data have a clear hierarchical structure with general practice information nested within geographical areas.

Results: The use of a multilevel modelling framework allows us to partition unexplained variation between levels. The analysis also provides more accurate estimates of the effect of gender and age of the GPs, practice list size and the number of practice in the area.

Key word: Primary care, out of hours, deputising services, multilevel model.

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1. INTRODUCTION

Out-of-hours care is currently provided in the NHS by a variety of services and professionals, including general practitioners (GPs), accident and emergency departments (A&E), ambulance services, evening nurses, social services, pharmacists and dentists. GPs and A&E departments are the most important, both in terms of the proportion of the total out-of-hours care provided and resources used.

In April 1967 the GP's contract introduced a £1 fee per night visit. The financial mechanism were modified several times over the years. Most of the GPs regard out of hours work as a negative aspect of the career in general practice (Rowsell 1995). Out of hours calls, especially night calls are described as a source of stress and many fell that family life is constantly interrupted by telephone calls (Rout 1996).

It is not surprising that GPs are keen on reducing their personal availability and then they have tried alternative arrangements for out of hours care delivery (Lattimer et al 1996). Many GPs provide out of hours care for their patients themselves, but a larger proportion of GPs provide out of hours cover via rotas with other GPs, through commercial deputising services or through co-operatives of GPs (Hallam and Cragg 1994).

There has been a large increase in the use of deputising services over the last 35 years. In 1964, less than 10% of GPs used these services. By the 1980s, over 40% of GPs subscribed to them nationally, with 75% of inner city GPs using them for at least some of their out of hours work (Hallam et al 1996). In 1990 the remuneration system for night visits changed such that a higher fee of £45.00 was paid for a night visit done by GPs themselves and a lower fee of a £15.00 for night visit by deputies. This change discourage the use of deputising services, but still the use of deputising services raised from 44% in October 1990 to 66% in October 1994 (NHS Executive 1992, 1996).

A new remuneration system was introduced on 1 January 1996 which offers to GPs an annual fee of £2,000 per year plus £20 per night visit. GPs get the same rate for seeing any patient, whether or not they are on their list and whether or not they see them at home or at the surgery (Hurwitz 1995).

Previous research have examined the relationship between the use of deputising services and the number of night visits by using multiple regression analysis. Buxton *et al.* (1977) used data aggregated at Family Health Service Authorities and found that the proportion of GPs with permission to use deputising services was positively associated with the night visiting rate. Sheldon and Harris (1984) examined the claim forms for night visits submitted by general practices located in the Nottingham Family Practitioner Committee and concluded that the use of a deputising service was associated with a small rise in the rate of night visits.

The aim of this study is to examine the factors associated with GPs' decision to use deputising services in the provision of out-of-hours.

The next section discusses the theoretical background of the study. In the third section we present the data and the methodology used. Section 4 reports the results and section 5 concludes the paper with a discussion of the possible extensions.

2. THEORETICAL BACKGROUND AND ECONOMETRIC MODEL

Theoretical model

Giuffrida and Gravelle (1998) discussed a model of GP's choice to use deputising services and therefore to seek permission from the HA. They assumed that GPs are constrained to meet the total demand for night visits from their patients and they do not attempt to influence the demand, positively or negatively. A practice must decide on how much of the demand to meet themselves and how much to pass on to a deputising service.

We ignored the distinction between different means GPs may use to meet the demand themselves (own visits, shared rotas, joining a co-operative), since from the first of January 1996 all such types of night visit attracted the same fees.

We assumed that the use of a deputising service affects only the income and leisure of GP. Further we assume that the patients are indifferent between the care provided by a deputy and his/her own GP. Dixon and Williams (1988) suggested that a high proportion of patients were satisfied with the deputising service they received. A recent and more

sophisticated randomised controlled trial (McKinley et al 1997) found evidence that patients were more satisfied with the out of hours care provided by GPs than provided by deputising services, but there was no significant differences in heath outcome between the two services.[1] If patients do care about who provides the night visit, the demand and supply equations would become be determined simultaneously and this could cause problems in the estimation.

The decision to use deputising services reduces the net income of the practice as the practice will have to pay the deputising service, either per visit or a flat fee, but GPs gain extra leisure (fewer interrupted nights).

Following Scott and Shiell (1997a; 1997b), we assume that GPs in the practice maximise a random utility function where the random errors represent indeterminate or unknown influences on individual behaviour and the explanatory variables represent arguments in the GP's utility function or predicted influences on tastes and preferences. The utility associated with each mutually exclusive alternative in the choice set is assumed to vary depending on the tastes and preferences of the individual making the choice and the utility-bearing characteristics of each alternative.

GPs are assumed to compare the utility of using a deputising service for out of hours primary medical care with the utility of not using deputising services. Since it is whether or not the choice is made that is observed and not the actual difference in utility, the dependent variable is binary.

Econometric specification and multilevel model

In our study, we have a binary variable as dependent variable, y_{ijk}, which indicates whether the practice had consent to use deputising services. The data show a clear hierarchical structure, with GPs nested within practices. Practices nested within small geographical area: wards. Wards are in turn nested into Health Authorities (HAs). HAs

[1] The same studies provided evidence that deputising doctors give telephone advice less readily, take longer to visit home and have patters of prescribing that may be less discriminating that practice doctors (Cragg *et al.* 1997).

are the body that gives the consent to use deputising services and that are responsible for the organisation of primary care within their geographical boundaries.

With hierarchical structured data, the estimated regression has as many subscripts on its variables as the number of levels used in the econometric model. We can write the multilevel regression model as

$$y^*_{ijk} = \alpha + \sum_m \beta_m x_{ijk} + \sum_n \lambda_n z_{jk} + e_{ijk} + v_{jk} + u_k$$

with $y_{ijk} = 1$ if $y^*_{ijk} > 0$ and 0 else.

Where y^*_{ijk} is the latent variable, e.g. the difference in utility between providing out of hours care without and with using a deputising services. Following the standard approach, we assume that the dependent variable is binomially, which requires that the level 1 variance, σ^2_e, is equal to one.

The model to be estimated has three levels, hence y^*_{ijk} denotes the difference in the utility of the i-th general practice, in the j-th ward, in the k-th HA. The fixed part of the model is $\alpha + \sum_m \beta_m x_{ijk} + \sum_n \lambda_n z_{jk}$, where α is the intercept; β_k is the regression coefficient for the k-th explanatory variable, x_{ijk}, measured at level 1 (i.e. general practice); λ_n is the regression coefficient for the n-th explanatory variable, z_{jk}, measured at level 2 (i.e. ward).

The error term is $e_{ijk} + v_{jk} + u_k$. Where e_{ijk} represents the variation across general practices; the second term, v_{jk} is the variation among ward; and u_k is the variation across HAs.

It is possible, using least squares dummy variables techniques, to estimate direct effects by fitting dummy variables for each general practices, ward and HAs. This approach is unfeasible in our sample as it would require to fit a too large number of dummy variables. Therefore the four components of the term (e_{ijk}, v_{jk} and u_k) are assumed to be random with zero mean and constant variance (namely σ^2_e, σ^2_v and σ^2_u), and independent of each other.

Researchers have recognised the importance of multilevel models, as social and many other systems typically have a hierarchical organisation. For instance when population surveys are carried out, the sample typically reflects the hierarchical structure of the population, in term of geographical and household membership (Rice et al 1998).

The advantages in recognise explicitly the hierarchical structure of the data in the econometric model are two fold. Firstly, the use of a multilevel model allows to assign the unexplained variance to the appropriate level (Goldstein 1995). Secondly, because of the hierarchical structure, data for practices in a specific geographical area (ward or HA) might be correlated. For instance one HAs might have a more restrict policy in authorising the use of deputising services. When the intra-level correlations are non-negligible, OLS underestimate the standard errors. Hence, confidence intervals based on the OLS will be too small and significance tests of coefficients will too often reject the null hypothesis (Goldstein 1987).[2]

Multilevel modelling has considerable potential in the analysis heath care system (Rice and Leyland 1996; Rice and Jones 1997; Rice 1999). The hierarchical structure of primary health care data have been considered in a number of empirical works. Among the others Jones and Moon (1991) presented an multilevel analysis of immunisation uptake in general practice and then distinguishing between variation at patients level and variation at practice level. The authors demonstrate that the use of a multilevel procedure to control for patients characteristics had a significant impact on the estimated performance of the practice. Scott and Shiell (1997a) used data collected at the level of consultations, and then nested within GPs which were in turn nested within geographical area, to asses of using content-based descriptors on GPs' decision for the management of URTI and sprain/strain. Using the similar type of nesting Scott and Shiell (1997b) examined if higher competition among GPs influenced the decision to recommend follow-up consultation.

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[2] In the example presented by Goldstein, two levels and intra-level correlation of 0.2, the true standard error were on average twice the OLS estimate.

3. DATA

The principal source of data is the October 1997 GP Census. This database was provided by the GMS STATS division of the NHS Executive and collects information about all GPs having contract with the NHS. Each GP has an unique identification number and GPs working in the same practice have a common and unique practice identification number that allows to identify GPs practising in the same practice. The GP census database has been used previously to describe the recruitment and retention of GPs and changes in their time commitment in England from 1990 to 1994 (Taylor and Leese 1997a), to quantify the rate of partnership change (Taylor and Leese 1997b), and the rate of turnover and migration (Taylor and Leese 1998).

In the October 1997 GP census 28,957 GPs were recorded and they were grouped into 8,967 practices. A substantial number of observations had to be excluded because of missing data and erroneous postcodes. This did not allow us to calculate the number of practices within 5 km and to match these practices with the information derived from the 1991 Census of Population. We used in the analysis a sample of 5,970 observations (general practices). Table 1 presents the definition and the summary statistics of the variables used in the analysis.

Dependent variable

The dependent variable used in the regression model is whether or not the practice had consent from the HA to use deputising services for of out of hours medical care. Permission to use a deputising service is normally granted, and is given to the whole practice which represents the unit of analysis. Once the authorisation is obtained, than the single member of the practice decide whether to use the services or not.[3]

What we observe in the data, is whether the practice obtained the permission to use deputising services. The consent to use deputising services is an imprecise measure of the actual use of deputising services (Hallam and Cragg 1994), but we may assume that a rationale GP would seek the authorisation only if he/she would use the services.

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[3] Riddell (1980) described the organisation of a general practice using deputising services.

The GP Census collects information for each GPs within the practice and few practices recorded that only a part of the GPs had authorisation. We decided to exclude these observations from the sample. The variable is coded as 1 if all GPs in the practice had consent to use deputising services, and as 0 if all GPs had not consent.

Explanatory variables

Let us now briefly present some of the factors which may affect the probability of the practice to use deputising services and therefore to seek consent to the HA.

Firstly, we consider the relationship between using deputising services and GPs' *age and gender*. It is reasonable to expect that the relationship between age and the propensity to use deputising services either is positive or follows an inverse "U" shaped function. This relationship is expected to arise because of financial, family responsibilities and health reasons. From the financial point of view, the use of deputising services requires a financial sacrifice, since the earning of a GP clearly increase with the number of years of practice, the result would be positive linear relationship. Moreover, out of hour work is a source of distress for the GP and those who are older may find heavier the burden of night visits and be forced to work only at regular hours (Myerson 1991). From a more general point of view, we can argue that there is a "U" shaped between age and family responsibilities, brought about by marriage and children, which suggest that the relationship between age and use of deputising services might be concave. While the two previous factors may be thought to affect in the same ways both male and female GPs, family responsibilities may be more important for female GPs. Hence, we expect that female GPs use deputising services more than male.

The second factor we relate with the use of deputising services is *the general practice list size*. The relationship is hypothesised to be positive as a larger list, implies more daytime work and potentially more night visits. Hence, it is more likely that the GPs in the practice want to reduce the burden of out of hours work by using a deputising service.

The number of patients in the list are related to the amount of workload in the practice, but another important factor is its composition in term of age and level of morbidity.

Previous studies have showed that higher night visit rates are expected in general practices were there is an higher proportion of patients aged under five, chronically ill (Majeed et all 1995) and deprived (Carlisle et al 1993).[4] Therefore practices with higher proportion of patients with these characteristics, are more likely to use deputising services to help them to cope with the higher demand for night visits.

In addition, we expect a negative relationship between the number of GPs in the practice and the probability of using deputising services. The rationale is that, *ceteris paribus*, GPs working in larger partnership may find easier to arrange rota within their practice without having to use commercial deputising services.

We also test the existence of a relationship with the density of general practices, measured by the number of general practices within 5 kilometres, which was constructed using the postal addresses of the practices. The interpretation of this variable may be somewhat controversial. From one point of view, we can argue that practice density measures the extent of competition amongst GPs (see Scott and Shiell 1997), therefore if patients cared about who provides out of hours care, we would expect a negative relationship between practice density and use of deputising services. On the other hand, is more likely that practice density measures the availability of commercial deputising services, which are more available in urban and more populated areas. If the second factor prevails, we would find a positive relationship between practice's density and use of deputising services. Moreover, we tried to control for the rurality of the location introducing in the regression model a dummy variable measuring whether the practice claims payment for practising in a rural area.[5]

Finally, we test whether practices where there are GPs working part time are more (or less) likely to use deputising services. We do not have any *a priori* hypothesis about the direction of relationship. From one point of view, *ceteris paribus*, the presence of part time GPs in the practice, may produce more work for the other GPs in the practice, so it

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[4] In the regression we included the percentage of permanently sick among the adult population living in the ward where the practices is located. This information is taken from the 1991 Census of Population.

[5] The practice is eligible to be credited with Rural Practice Units if, and only if, shows that at least 10% of the patients on the list were resident in Rural Practice Payment Areas and at least three miles distant from the main surgery by the normal route.

would be more likely for the practice to use deputising services. On the other hand, part time GPs work in almost all cases in partnership.[6] We can imagine that one partner is more likely to be allowed to work part time if the average workload within the practice is not too high. Therefore the presence of GPs working part time, may be a proxy of low workload and we might expect a negative relationship with the probability to use deputising services.[7]

4. RESULTS

The model is estimated using the Iterative Generalised Least Squares (IGLS) method developed by Goldstein (1995).[8] Table 2 presents the coefficients of the multilevel probit.[9] The bottom part of Table 2 shows the results from the random part of the model. First we estimated the model conditional on binomial variation and then we allow for extra-binomial variation.

Most of the variables included in the analysis have the expected sign and are statistically significant. The average age of the GPs in the practice is, as expected, positively related with the probability of using deputising services, and practices with an higher percentage of female GPs are more likely to have consent to use deputising services.[10]

Practices with larger list size are more likely to use deputising services. Furthermore practices which higher percentage of deprived patients and children, are more likely to use deputising services. Also the estimated coefficient for the percentage of adult population living in the ward that is permanently sick is related with an higher probability to use deputising services, but the coefficient is not statistical significance.

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[6] Only 5 GPs that work part time were solo practitioners.

[7] We report that the average number of patients per GP in practices where there were GPs working part time was 1,447, while in practice where there were not GPs working part time was 2,091.

[8] We used the software MLwiN 1.0 (Goldstein et al 1998)

[9] To ensure that variations at each of the levels are estimated for the typical practice, the variables measuring the average GPs' age, the practice list size and the number of practices within 5 km, were centred around their mean before being included in the regression model.

[10] We considered the possibility the probability of using deputising services being concave function of GPs' age. However, the coefficient estimated for the squared term was not statistically significant, which argues in favour of a linear relationship.

The higher is the number of practices within 5 km, higher is the use of deputising services. The positive sign of this variable suggests that this variable may be interpreted as a measure of the availability of deputising services, and supports the assumption that patients are not affected in the choice of their practice by the fact that GPs use deputising services.

The presence of part time GPs in the practice is associated with a lower probability of using deputising services. This finding indicates that the hypothesis that the presence of part time GPs is a proxy of low workload in the practice is correct, which explains why these practices are less incline to use deputising services.

Finally, practices that claim fees for being located in rural areas are less likely, to use deputising services, as in rural areas is more difficult to find a substitute for the provision of night visits. However, this effect is not statistically significant.

We notice that there is no random variation in decision making between practice in the same ward (level 2). The reason for this is due to the fact that the average number of practices per ward is small. Therefore, assuming that level 1 variance is equal to one, washes out all the level 2 variation.

The ratio between the estimated variance at each level and the total variance gives the intra-level correlation. The higher is this correlation the stronger is the clustering. Value of over 0.2 suggest strong clustering (Goldstein 1995). We notice that the intra-HAs correlation is 0.43, which indicates a strong clustering at this level of the hierarchy.

We relax the assumption that the level 1 variance is equal to one in the estimation. The results allowing for extra-binomial variation are presented in the second column of Table 2. The estimated σ_e^2 diverges significantly from one. This suggests either the presence of some form of misspecification, because of the use of a wrong functional form, or the omission of relevant variables (Rice 1999). Following the suggestion of Scott and Shiell (1997a) we included the extra-binomial variation in the model to controls for such misspecification when evaluating the fixed parameter.

However, allowing for extra-binomial variation, does not produce important changes in the results. Comparing the coefficients in the two columns of Table 2, we do not notice

any difference which is statistically significant. This model, also indicates that the intra-HAs correlation is high (approximately 0.52) and partitions most of the variance at HA level.

5. DISCUSSION

This paper has presented a multilevel analysis of GPs decision to use deputising services for the provision of out of hours care in primary care. Multilevel models allowed to test more accurately the factor that we have hypothesised to be related with the use of deputising services.

The results showed that the probability of using deputising services, increases with the average age of the GPs in the practice, with the presence of female GPs in the practice and with the size of the practice in term of number of patients registered. Also the composition of the list size is important, as practices with larger proportion of patients living in heavily deprived areas, under the age of 4, and permanently sick are more likely to use deputising services to cope with the higher demand of out of hours medical primary care. GPs working in partnership may find easier to organise rota among GPs in the practice and they use less deputising services. Also the urban/rural location is important because it measures the availability of deputising services, and we observe that practices in areas of high GPs density are more likely to use deputising services.

Multilevel analysis allows also to partition the unexplained variance among the levels used in the analysis. We notice that there is a strong intra-HA correlation in GPs' decision about the use of deputising services, which indicates strong clustering at HAs level.

We are still at a early stage in the investigation and among the possible extensions of this work, we plan to add a temporal dimension to the analysis and, more in general, to apply multilevel analysis to other aspects of the primary health care system.

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Table 1: Variables definitions

Abbreviation	Variable	Coding	Mean	Std. Dev.	Min	Max
Dependent variable						
	General practice had consent to use deputising services	Yes (1), no (0)	0.816	0.388	-	-
Explanatory variables						
	Mean age of GPs in the practice	Continuos	47.458	7.351	29	69
	Percentage of female GPs in the practice	Continuos	0.262	0.296	0	1
	Practice list size	Continuos	5406	3375	1279	20858
	Percentage of patients in the practice in heavily deprived areas	Continuos	0.029	0.110	0	0.973
	Percentage of patients in the practice aged 4 and under	Continuos	0.061	0.018	0	0.167
	Percentage of adult population permanent sick [a]	Continuos	0.043	0.021	0.006	0.154
	Number of GPs in the practise	Continuos	2.796	1.844	1	12
	Number of practices within 5 km [b]	Continuos	41	47	0	246
	Percentage of GP in the practice working part time	Continuos	0.017	0.108	0	1
	Practice claims rural practice units	Yes (1), no (0)	0.081	0.273	-	-

Number of observations (general practices): 5,979.
Number of ward: 2,881. Average no. of general practice per ward: 2.08; min: 1; max: 13.
Number of HAs: 100. Average no. of general practice per HA: 59.79; min: 4; max: 217.

a: The variable refers to the population living in the ward where the practice is located. The variable is derived from the 1991 Census of Population.
b: The variable is constructed using the postal address of the practice.

Table 2: Regression results

Variable	Binomial variation Coefficient (std. error)	Extra-binomial variation Coefficient (std. error)
Fixed part		
Constant	-0.135	-0.035
	(0.217)	(0.166)
Mean age of GPs in the practice	0.326**	0.263**
	(0.152)	(0.104)
% of female GPs in the practice	0.164***	0.138***
	(0.078)	(0.053)
Practice list size	0.253*	0.217**
	(0.132)	(0.091)
% of patients in the practice in heavily deprived area	1.021***	0.882***
	(0.339)	(0.252)
% of patients in the practice aged 4 and under	2.230*	1.628*
	(1.276)	(0.892)
% of adult population permanent sick	1.924	1.907
	(1.428)	(1.213)
Number of GPs in the practise	-0.075**	-0.065***
	(0.033)	(0.023)
Number of practices within 5 km	0.395***	0.387***
	(0.042)	(0.036)
% of GP in the practice working part time	-0.252	-0.275**
	(0.182)	(0.125)
Practice claims rural practice units	-0.030	-0.027
	(0.070)	(0.052)
Random part		
σ^2_v (level 3: HA)	0.748***	0.751***
	(0.113)	(0.111)
σ^2_u (level 2: ward)	0.000	0.304***
	(0.000)	(0.022)
σ^2_e (level 1: general practice)	1.000	0.374***
	(0.000)	(0.009)

*** indicates $p \leq 0.01$; ** indicates; indicates $0.01 < p \leq 0.05$; * indicates $0.05 < p \leq 0.1$