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Chris Bojke
Hugh Gravelle
Karen Hassell
Zoe Whittington

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Increasing patient choice in the management of minor ailments in primary care*

Chris Bojke[+] **Hugh Gravelle**[+] **Karen Hassell**[++]
Zoe Whittington[++]

Abstract. We examine the effects of a feasibility scheme to provide easier access to pharmacists for patients with minor ailments. The scheme allowed pharmacists to prescribe and dispense medicines currently limited to general practitioners (GPs) without patients loosing their right to free prescriptions. We formulate a model of the rationing of GP consultations and GP supply decisions. We estimate a reduced form equation for total GP consultations and find that they are unaffected by the intervention but that the proportion for minor ailments decreases. We also examine patient choices between GP and pharmacies with a variety of multinomial models and find that the main determinant is the type of minor ailment. Distance appears to have no effect on patient choice.

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Key words: Access. Primary care. Pharmacy. Consultations.

[+] National Primary Care Research and Development Centre, Centre for Health Economics, University of York, York, YO10 5DD
[++] School of Pharmacy and Pharmaceutical Sciences, University of Manchester, Manchester M13 9PS

1. Introduction

In the British National Health Service patients register with a general practitioner (GP) and about 90% of patient contacts with the NHS take place in primary care. Most consultations are for minor ailments [1,2] and typically result in the GP writing a prescription for the patient to take to a commercial community pharmacy for dispensing. Many GPs perceive consultations for minor ailments as an "inappropriate" use of their time. There is evidence that many GP consultations for minor ailments can be dealt with satisfactorily by community pharmacists providing advice and dispensing an over the counter (OTC) product which does not require a doctor's prescription [3]. Government policy is to encourage the shifting of demand for minor ailment consultations from GPs to pharmacists [4].

One way to shift demand is to extend the range of medicines which pharmacists can provide to patients without a doctors prescription. Figure 1 illustrates schematically the effect of such a change on different groups of patients. Patients with minor ailments are distributed along a road on which are situated a pharmacy and a GP surgery. Travel costs imply that patients at different points on the road have different net benefits from consulting the pharmacy and the GP. Patients further away from the surgery or the pharmacy have lower net benefits, as shown by the height of the relevant net benefit lines. All patients to the left of the pharmacy prefer a pharmacy consultation to a GP consultation, though those who are far enough from the pharmacy will consult neither the pharmacy nor the GP. Similarly for patients to the right of the GP. Patients between the pharmacy and the GP may go to either depending on the height of the net benefit curves.

Initially, with the net benefit curves for the pharmacy and GP at b_1^{ph} and b_1^{gp} patients between p_1 and d_1 go the pharmacy and those between d_1 and g_1 go to the GP. An increase in the range of medicines which the pharmacy can prescribe shifts the net benefit curve from consulting the pharmacist to b_2^{ph}. Initially patients between d_1 and d_2' are attracted from the GP to the pharmacy. If there is no change in the supply of consultations by the GP, the reduced demand at the GP will lead to a reduction in waiting times for appointments. The net benefit curve for GP consultations shifts upward to b_2^{gp}. When the pharmacist is able prescribe a wider range of medicines, minor ailment patients between p_2 and d_2 go the pharmacy and those between d_2 and g_2 go to the GP.

Patients between p_2 and p_1 who did not previously consult either the GP or the pharmacist now consult the pharmacist and are better off. Those between p_1 to d_1 who previously chose the pharmacist gain because they get greater benefit from consulting. Patients between d_1 and d_2 who shift to the pharmacy from the GP also gain because they shift to a preferred option. Patients between d_2 and g_1 who continue to consult the GP gain from reduced waiting times at the surgery and the patients between g_1 and g_2 who now consult the GP also gain.

There will also be gains to patients who consult the GP for non minor ailments because of the reduction in waiting times for appointments. The gain will accrue both to the infra marginal patients who previously consulted the GP and to those who are now induced to consult or to consult more frequently.

The change in the rules to widen the range of products which pharmacists can prescribe will also change NHS costs. There may be an increase in NHS prescriptions for minor ailments because more minor ailment patients are seen in total. GP costs may change if the GPs change their supply of surgery sessions in response to the change in the mix of their patients. Finally, there may be changes in NHS costs because of the increase in non minor ailment GP consultations.

There has been no overall cost benefit analysis of policies to encourage use of pharmacists as a substitute for GPs and there is little evidence about the magnitude of possible demand shifts. Philips et al [5] examined the effect of a scheme to encourage patients to use pharmacies for advice and prescription for head lice. The proportion of head lice patients at pharmacists who were referred by their GP fell from nearly 80% to just over 10% over the course of the intervention. There were also significant cost savings, mainly because of a lower cost of pharmacists' time compared with GP time and because the pharmacists were restricted to a smaller range of products for head lice than the GP.

Our study is complementary to Philips et al [5]. We examine an intervention which covered a wider range of minor ailment conditions. We focus on the demand implications and do not consider the cost implications of easier access. We look at the effect of the intervention on GP workload, and on the numbers of minor ailment and non minor ailment consultations. We also examine the factors which affected patients' choices between GP and pharmacist consultations for minor ailments.[1]

We first set out a simple model of the rationing of GP consultations. We use the model to guide the empirical analysis of the responses of patient demand and GP supply of consultations to the change in the accessibility of pharmacies.

2. Modelling the implications of easier access

2.1 GP workload

There are no charges for GP consultations. Demand depends on the waiting time for a consultation, other costs incurred by patients and the costs and convenience of the alternative of seeking advice direct from a pharmacy. As with the market for elective admissions to hospitals, the market for consultations is cleared by adjustments in waiting times. We first set out a simple model in which patients consult a GP by booking an appointment in advance. We then discuss the equilibrium in the market when patients can also consult a GP by turning up at the surgery and waiting to be seen and suggest that the implications of the model with booked appointments for the interpretation of our data are unaffected

Divide GP consultations into those for minor ailments and those for all other reasons. Denote expected demand for minor ailments by $D_1(t,k,y)$, $D_{1t} < 0, D_{1k} < 0$, and for other consultations by $D_2(t,y)$, $D_{2t} < 0$ where t is the waiting time for an appointment. k is parameter reflecting the convenience or net cost of a pharmacy consultation and y is a vector of demand shifters. Realised demand for each type of consultation is $\tilde{D}_i = D_i + e_i$

[1] A full account of the study is contained in Whittington et al [6] and a summary in Hassell et al [7].

($Ee_i = 0$), which may differ from expected demand, as the literature on missed appointments suggests [7].

The practice's GPs plan to supply S consultations in a session. Decisions on planned supply (the number of GPs taking consultations in the session) are made before realised demand is known. Increases in planned supply S reduce the length of time patients have to wait for an appointment. There is equilibrium when planned supply equals planned demand:

$$D_1(t, y, k) + D_2(t, y) - S = 0$$

and the equilibrium waiting time is

$$t = t(S,y,k), \qquad t_S < 0, \ t_k < 0.$$

The GPs always see the actual number of patients who turn up at a session. Their actual supply $\tilde{S}$ is equal to the realised demand for that session:

$$\tilde{S} = D_1(t, y, k) + e_1 + D_2(t, y) + e_2$$

and because planned supply equals expected demand in equilibrium

$$\tilde{S} = S + e_1 + e_2$$

In Figure 2, the demand curves plot expected demand for GP consultations against the waiting time for an appointment. Suppose initially that the planned supply of GP consultations is fixed and consider the effect of easier access to pharmacies, modelled as an increase in k. (In terms of Figure 1, the net benefit curves for pharmacy consultations shift upward.) Total expected demand for GP consultations at any waiting time is reduced and waiting time falls to clear the market. Since the demand curve for GP consultations for other conditions is unchanged, there are more expected consultations for them. The expected number of minor ailment GP consultations is reduced by easier access to pharmacies and increased by the reduction in waiting time. Since the overall supply of consultations is fixed and the expected number of other consultations has increased, the overall effect of easier access to pharmacies is to reduce the expected number of minor ailment GP consultations: $D_{2k} + D_{2t}t_k < 0$. In Figure 2 the aggregate expected demand curve shifts down and waiting time falls, leading to an increase in other GP consultations and a reduction in minor ailment

GP consultations. The smaller the elasticity of other consultations the less the fall in the ratio of expected minor ailment consultations to expected total consultations. Only if demand for other consultations is perfectly inelastic will the expected number and proportion of minor ailment consultations be unchanged: the expected minor ailment consultations diverted to pharmacy are replaced by additional minor ailment consultations generated by the fall in waiting time.

The planned supply of consultations offered by GPs may depend on the expected mix of consultations. They might regard consultations for non minor conditions as more deserving of their time and so increase their time input as the proportion of minor ailment consultations decreases. Suppose that the practice GPs choose planned supply to maximise expected utility

$$Eu = a_1 E[D_1(t,y,k)+e_1] + a_2 E[D_2(t,y)+e_2] - EC(S+e_1+e_2,z)$$

where a_i is the weight on the i'th consultation. GPs who dislike "inappropriate" minor ailment consultation have $a_1 < a_2 > 0$, and possibly $a_1 < 0$. C is the cost of consultations and z is a cost shifter. Assume that the cost function is linear in the total number of consultations, with marginal cost c(z), so that $EC = c(z)E(S+e_1+e_2) = c(z)S$. Using $t = t(S,y,k)$, the first order condition

$$dEu/dS = [a_1 D_{1t} + a_2 D_{2t}]t_S - c(z) = 0$$

yields the planned supply of consultations $S^*(k,y,z)$.

We estimate the reduced form workload equation $\tilde{S} = S^*(k,y,z)+e$ to test the effect of easier pharmacy access on GP workload. Predictions about the effects of demand and supply shifters on realised workload are based on their effects on planned supply S^*.

Increases in the marginal cost of GP consultations reduce GP planned supply (and raise waiting times and reduce expected demand by an equal amount). The response of planned GP supply to demand shifts is less obvious. Thus for easier patient access

$$\text{sgn } S_k^* = \text{sgn } \frac{\partial}{\partial k}\left(\frac{dEu}{dS}\right) = \text{sgn }[(a_1 D_{1tt} + a_2 D_{2tt})t_k t_S + (a_1 D_{1t} + a_2 D_{2t})t_{Sk} + a_1 D_{1tk} t_S]$$

where

$$t_{Sk} = \frac{1}{(D_{1t} + D_{2t})^3}\left[D_{1k}(D_{1tt} + D_{2tt}) - D_{1tk}(D_{1t} + D_{2t})\right]$$

The effect of easier pharmacy access on planned supply of consultations $S^*(k,y,z)$ is ambiguous, even with this simple specification, without quite detailed further restrictions on the form of the expected demand functions. For example, if demand is linear in waiting time and pharmacy access, then planned GP supply and hence expected GP workload is unaffected by the change in pharmacy access.

The effects of demand and cost shifters on the mix of minor ailment and other GP consultations is also ambiguous. We observe $\tilde{r} = \tilde{D}_1 / \tilde{D}$. The effect of the cost shifter z which raises the marginal cost of supply and thus reduces planned supply has

$$\text{sgn}\ \tilde{r}_z = \text{sgn}\left[\frac{D_{1t}t}{\tilde{D}_1} - \frac{D_{2t}t}{\tilde{D}_2}\right] = \text{sgn}\left[w_{1t}\frac{D_1}{\tilde{D}_1} - w_{2t}\frac{D_2}{\tilde{D}_2}\right]$$

where w_{it} is the elasticity of demand for the i'th type of consultation with respect to expected waiting times. The expected effect on the mix is more likely to be negative the more elastic is the expected demand for minor ailment consultations. The effect of easier access is more complicated but if expected demands are linear in waiting time and pharmacy access, so that planned supply of GP consultations does not change, the realised proportion of consultations for minor ailments will fall.

The above account neglects the fact that patients can choose between booking an appointment or attending a GP surgery session without an appointment and waiting in the surgery until they can be seen. The complication does not affect the basic structure of the model. Queuing theory suggests that there will be a distribution of waiting times at the surgery for those attending without an appointment because of random fluctuations in the rate at which GPs see unbooked patients and in the rate of arrival of unbooked patients. An increase in planned supply will reduce expected surgery waiting times and an increase in demand will increase them. If demand for unbooked consultations falls as expected in surgery waits increase, the markets for booked and unbooked consultations will be cleared by the waiting time for an appointment and the expected waiting time at the surgery for unbooked appointments. The practice GPs will choose planned supply to maximise expected utility as before and we can again investigate the effects of easier access to pharmacies on the realised workload of the practice by estimating $\tilde{S} = S^*(k, y, z) + e$.

2.2 The intervention

2.2.1 Background

In the NHS there are two barriers to increasing the role of pharmacists in the treatment of minor ailments and widening patient choice. The first is legal: some medicines required for the treatment of minor ailments can only be prescribed by a doctor. The barrier is lowered when regulations are changed so that products which previously required a doctor's prescription (prescription only medicines - POMs) can be sold direct to the patient by the pharmacist over the counter (OTCs).

The second barrier is financial. There is a flat rate charge to patients, payable when they take their GP's prescription to be dispensed. Patients on low income, the elderly and children are exempt, and 85% of prescribed items are dispensed without charge to the patient [9]. Since GPs can write prescriptions for products which are available as OTCs (eg aspirin) the prescription charge can exceed the market price of the dispensed product. Patients who are not exempt have an incentive to buy the OTC product at the market price rather than have it dispensed on prescription. If they know what condition they are suffering from, they need not consult the GP. Exempt patients may prefer to get the product on prescription at no charge and so must consult their GP.

Neither exempt or non-exempt patients are able to substitute pharmacy advice for a GP consultation for POMs. For OTCs whose market price exceeds the prescription price, both types of patient would be better off financially consulting the GP to get an NHS prescription. For OTCs with a market price below the prescription charge, exempt patients are better off getting an NHS prescription from their GP.

An intervention which switches some POMs to OTC status therefore increases choice for non exempt patients but has a smaller effect on exempt patients. The intervention we examine took place in a practice where most patients were exempt and so the intervention was designed to remove the financial disadvantage of the pharmacy option for exempt patients. There was also no change in the legal status of the medicines, so that it was necessary to retain GP responsibility for prescriptions by pharmacies whilst making the effect on the patient be as nearly as possible the same as a formal legal change from POM to OTC status for medicines for minor ailments. The two requirements led to the rather involved administrative procedures in the intervention.

2.2.2 Intervention design

The intervention took place in a practice in a deprived area of Bootle in Liverpool over a 26 week period in 1999/2000. All patients visiting or telephoning the practice for prescriptions or appointments for the 12 intervention minor conditions listed in Table 1 were offered the opportunity to visit one of the eight local intervention pharmacies for advice, and if required, a pharmacist prescribed medicine, instead of a consultation with a GP. Some 1,113 patients requested minor ailment consultations on 1522 occasions during the intervention period.

If the patient declined a pharmacy referral, they were given a GP or nurse appointment as normal. If the patient accepted the pharmacy referral, a form which identified the condition for which the patient was seeking advice and/or medication was completed by the reception staff at the practice and then faxed to the pharmacy selected by the patient. The form was necessary for monitoring the intervention and to limit the scheme to patients registered with the study practice. When the patient came to the pharmacy, the pharmacist could provide advice about self-care, or dispense a medicine from a formulary agreed by the practice GPs and pharmacists. Or, if the pharmacist decided that the patient needed to see a GP she would refer the patient to the GP using a Rapid Referral form, which was faxed, to the practice.

The pharmacists' reimbursement from the NHS for the cost of drugs dispensed was unaffected by the scheme. In addition they received a consultation fee of £1.50 per pharmacy consultation, regardless of whether a medicine was dispensed or not.[2]

The intervention was not fully equivalent to changing the legal status of some POMS to OTC since patients still had to contact the practice before they could take advantage of the ability of the pharmacy to provide advice and supply without reference to the GP. If the legal status of the medicines changed patients would not need to contact the GP first, so that access would be easier than in the scheme we examine.

2.3. Patient choice between pharmacy and GP

Figure 3 illustrates the choices which patients could make given that they felt in need of advice or medication. They could either go direct to the pharmacy and be treated outside the NHS or they could contact the GP practice. The practice provided open access clinics, where patients turn up without appointment and wait until seen, and non-open clinics, which must be booked by the patient. In either case patients who made contact for a minor ailment were offered the choice of a consultation at the practice (with a GP or with a nurse practitioner (NP)) or of going to the pharmacy for advice and medication. The advantage of the pharmacy option for those contacting the practice by telephone was that they could get medication and advice from the pharmacy without having to wait for an appointment or waiting in an open access clinic, and they were saved a visit to the practice in order to get a prescription. The waiting time for booked appointments was typically several days and the waiting time in the open access surgeries could be an hour or more. The advantage for patients who contacted the practice by attending for an open access clinic was that they could avoid the wait at the clinic by going to the pharmacy.

The numbers in the boxes in Figure 3 indicate the number of consultation requests at each

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[2] Although head lice consultations were sometimes made on a family basis, the pharmacist only received one consultation fee regardless of how many people received treatment. GP prescribing data indicated that the GPs were prescribing 200ml at a time, which is enough to treat two patients. The Health Authority was worried about the financial implications if the pharmacists prescribed on a per person basis and got consultation fees for each person in the family.

stage of the consultation choice under the intervention.[3] We have no information about patients who felt ill nor about the number who felt ill but decided to contact the pharmacist directly or to consult neither the pharmacist or the GP. Outside the intervention period the set of choice available was the same as in the Figure 3 except that the pharmacy option after contacting the practice was not available. We have no data on patient choices outside the intervention period.

3. Data

We have data for two 42 week periods from April to January in two consecutive years. The second year covered the 26 week intervention period and the baseline period in the 16 preceding weeks. See Figure 4. During the second year, the practice had an additional permanent GP, but the nurse practitioner left midway through the intervention period (week beginning 1/11/99).

3.1 Weekly consultations

For both 42 week periods data were recorded on the number of consultations per week by each GP and by the nurse practitioner. For the second period (1999/2000) we have data on the number of clinics per week put on by the practice. We also know which weeks were school holidays for the area and whether they contained a bank holiday. For the first 42 week period there is data only on the number of consultations per week but for the second period the total number of consultations and the number for minor ailments is known

3.2 Patient Level Data

No individual level patient data on consultations is available for the first 42 week period. For the second period, individual patient level and consultation detailed data were collected each time a request was made for a consultation with the GP for a minor ailment category included in the intervention. The data were collected over the baseline 16 week period preceding the intervention period as well as for the 26 week intervention period. Patient data included gender, age, number of previous consultations in past year, home address, the method of requesting a consultation (eg. phone, open access, etc.), ailment type, which member of the practice saw the patient, treatment given and the length of the consultation. For the intervention period there was also data for patients who chose the pharmacy option and attended a pharmacy and on the pharmacy used.

3.3 Summary statistics

Summary statistics on GP workload and patient characteristics are given in Tables 2 and 3. There is considerable weekly variation in the total number of consultations, consultations per GP, nurse practitioner consultations, and minor ailment consultations. The majority of the patients consulting were female. The low mean age is due to the large number of school age patients. The modal number of visits by a patient during the previous 12 months and during the intervention was one. During the intervention period of the second year there were 1522 minor ailment consultation requests, 575 (38%) of which resulted in a pharmacy consultation.[4] See Figure 3. Table 1 shows the high frequencies of headlice and URTI conditions.

4. GP Workload

We now consider whether the intervention had an effect on the overall workload of the GPs, as measured by the weekly number of consultations, and whether it changed the composition of the workload, as measured by the proportion of minor ailment consultations.

4.1 Total Consultations

4.1.1 Specification

Since we are interested in the effect of easier pharmacy access on total workload we can avoid the issue of identification of patient demand and GP supply decisions. Recalling the model in section 2.1, equilibrium planned supply of consultations is $S^*(k,y,z)$ where k is a measure of pharmacy accessibility and y and z are demand and supply shifters. The realised

[4] One of the recorded consultation observations had a missing patient identifier and so age and postcode information could not be attached to it. We therefore dropped the observation from the statistical analysis which is based on 1521 minor ailment consultations by 1112 patients during the intervention period.

supply (GP workload) in any week is $\tilde{S} = S^*(k, y, z) + e$ and we estimate this reduced form by OLS using data on weekly consultations in the first and second years.

There are two interpretations of the decision context and they have different implications for the reduced form workload equation. The first is that the number of GPs available each week to take surgeries varied because of holidays, training absences etc and did not reflect decisions about planned supply. The number of GPs available in a week affected the marginal cost of putting on surgeries in that week since with fewer GPs available the remaining GPs must work harder. Hence we can enter GP availability as an exogenous variable in the reduced form workload equation.

The second possibility is that number of GPs available each week was jointly determined with the number of planned consultations. In this case GP availability is endogenous and should not be entered in the workload equation.

We investigated both possibilities by estimating the supply equation with and without the variable *gp_diff* which is the which is the number of GPs taking consultations in the week minus the average number of GPs available for the year.

We also distinguish between changes in the numbers of GPs available due to holidays/absences and the change when an extra GP joined the practice for the second year. The year dummy in the estimated equation captures the effect of the additional GP but it may also pick up other, unobserved, systematic differences between the two years.

For all of the first year of data collection, the baseline period in the second year and the first half of the observations for the intervention period, a nurse practitioner was available to take consultations. The variable *np* is the number of consultations taken by the nurse practitioner that week. We could treat the availability of the nurse practitioner as an exogenous variable as far as weekly workload planning is concerned. We would then expect that nurse consultations reduced GP workload. Alternatively, rather than regarding them as exogenous, we could treat nurse practitioner consultations as endogenous, with the practice planning to increase nurse practitioner sessions when demand is expected to high. We allow for both possibilities in the estimation.

Bank holidays led to workload changes, since no surgeries were provided. Weeks containing a bank holiday are captured by the dummy variable (*bank*). Dummy variables (*bef_bank* and *aft_bank*) are included to pick up any pre-emption or catch-up effects. A positive *bef_bank* dummy might indicate patients anticipating the reduced supply of consultations and requesting consultations in advance of needing treatment (possibly more likely for predictable ailments such as hayfever). A positive *aft_bank* effect would indicate that the reduced supply of consultations in the previous week has led to displacement of demand to the following week.

Dummies indicate if the week was a school holiday week (*hols*) for the practice's catchment area and the preceding (*bef_hols*) and succeeding (*aft_hols*) weeks. Whereas the bank holiday dummy capture the effect of a temporary reduction in supply, the school holiday dummies reflect changes in demand. Anecdotal evidence from practice staff suggested that school-age patients (31% of the consulting population) were less likely to consult during school holidays than during term time.

Other temporal effects were captured by monthly dummy variables. The weeks during the intervention are indicated by the *interven* dummmy.

There is a further variable which we would have liked to consider - the number of clinics held per week. The practice computer system only recorded this data for the last year of data collection. We have analysed the data using only the second year of data with and without the clinic data and results were largely unaffected and the number of clinics held was not significant. We present the results based on data from the two years and drop the number of clinics from the analysis.

4.1.2 Results

An initial regression revealed two observations (weeks 50 and 80) with high Cook's distances[5] [10]. The two observations had exceptionally low numbers of total consultations (327 and 301 compared to an average of 539). Week 50 was a bank holiday with 2 GPs on holiday and week 80 was Christmas week 1999. Both observations were dropped for the final regression which was based on 82 observations.

Table 4 reports the final reduced form OLS models of GP workload. In the first model the number of GPs available to take surgeries and the number of consultations by the nurse practitioner are treated as exogenous. In the second they are assumed to be endogenous and dropped from the reduced form workload equation.

In model 1 the short term variations in GP availability (*gp_dif*) have significant effects (at the 5% level) and are in the direction expected. A reduction of one in the number of available GPs led to a reduction in 18 consultations per week. Since each GP had on average 120 consultations per week, the result suggests that the majority of the absent GP's consultations were passed to the other GPs. The number of consultations by the nurse practitioner had no significant effect on the number of GP consultations. This may be because the nurse practitioner was not a substitute for a GP and catered for a different demand. Alternatively nurse sessions might have been put on when demand was expected to be high so that *np* is endogenous.

Comparing the two models, we see that the assumptions about the exogeneity of the *gp_dif* and *np* variables have little effect on the magnitude and significance of the other variables. The RESET test does not suggest that the first model in which *gp_dif* and *np* are treated as exogenous is mis-specified.

Table 4 shows little monthly variation in consultations and a non-significant year dummy. The non-significance of the year dummy is surprising given the permanent addition of an

[5] Cook's distance identifies observations which have a disproportionate influence on the regression because they have unusual values of the explanatory variables (high leverage) and ill fitting predictions (large standardised residuals).

extra GP for the second year. However, the recruitment of an extra GP was primarily to allow existing members of staff to pursue their own research interests on one day per week.

The bank holiday dummy is significant and the magnitude of the coefficient indicates that almost a full day's worth of consultations were lost. The dummy variables for the weeks preceding and following a bank holiday week are much smaller and are not significant, indicating that lost consultations are not pre-empted in a previous week or re-scheduled for the following week.

The school holiday indicator is also negative. On those weeks which are local area school holidays, the GPs had 30 fewer consultations in total. Whilst the bank holiday dummy probably reflects a supply constraint, the school holiday dummy captures a change in demand for consultations by the patients, perhaps reflecting absence from the area on holiday.

The coefficient on the intervention dummy is positive and of the same magnitude as the monthly effects. The estimated effect is about 3% of average weekly consultations and is smaller than its standard error, suggesting that the intervention had little effect on total GP workload. The practice GPs did not adjust their planned supply noticeably when pharmacy access became easier and the mix of their patients changed.

4.2 Proportion of GP consultations for minor ailments

4.2.1 Specification

Although GP workload was not affected by the intervention, the model predicts that the mix of minor and non-minor consultations may change. We can distinguish minor ailment consultations from other consultations in the 42 weeks of the second period of data collection and can construct a measure of the mix by the proportion of all GP consultations which are for minor ailments. More formally, we group the data into covariate classes defined by week, with each observation within a class sharing the same covariate vector of p factors $(x_{i1},\ldots\ldots,x_{ip})$. We observe total numbers of consultations $(n_1,\ldots\ldots\ldots,n_{42})$ and numbers of minor ailment consultations ($m_1......m_{42}$). The dependent variables are $m_1 / n_1,........,m_{42} / n_{42}$. The model can be estimated by a generalised linear model (*glm*) with the binomial family and the canonical logit link function, with the parameters interpreted as the usual logit parameters. Stata *glm* maximum-likelihood with a Newton-Raphson algorithm command was used to determine the global maximum [11].

The exogenous variables used are similar to those for total GP workload. Since we are only using one year of data and because the intervention period is autumn and winter, we are unable to estimate seasonal effects. We can however include the number of clinics (*clinics*) held that week amongst the exogenous variables. For an average week, over both the intervention and baseline period, the GPs took 536 consultations per week of which 36 were for one of the 12 minor ailments.

4.2.2 Results

The week containing two GPs on holiday was dropped as an outlier and the final model is based on 41 observations. Due to the possible endogenous nature of GP and nurse consultation supply two models were fitted; a full model and a reduced form model which excluded *gp_diff* and *np*. Table 5 shows the results from both models. Table 5 shows that both models produce very similar results in terms of model fit, significant variables, similar coefficient values and identical signs. We discuss the results from the reduced form models.

McCullagh and Nelder [12] suggest that the deviance of the regression model may be used as a straightforward measure of goodness of fit, but argue that the deviance is most useful for comparing two nested models.[6] We re-ran the model fitting only a constant and compared the two deviances, which is equivalent to the likelihood ratio test statistic. We find that the deviance for the fitted model is 107 and for the constant only model is 151. The difference is significant at the 5% level.

[6] The residual deviance is defined as twice the difference between the maximum achievable log likelihood and that attained under the fitted model and behaves in much the same way as

The bank holiday dummies are significant at the 5% level and have a greater effect than the intervention dummy. Odds ratios for the week preceding a bank holiday week, a week containing the bank holiday and the week succeeding a bank holiday week are 1.25, 1.51 and 0.818 respectively.

A school holiday week was likely to contain a smaller proportion of consultations for minor ailments, with an odds ratio of 0.787 compared to a week which was not a school holiday. It is plausible that demand for minor ailments will be more elastic with respect to waiting times than the demand for non-minor ailments. From these results it appears that demand for non-minor ailment consultations may be inelastic to changes in the covariates relative to that for minor ailments.

The intervention had a clear significant effect in reducing the proportion of GP consultations which were for minor ailments during intervention weeks compared with the baseline period. For an average week the number of GP consultations for the limited set of minor ailments included in the intervention fell from 37 in the baseline period to 29 in the intervention period. On average the proportion of GP consultations which were for minor ailments fell by about one fifth from 7.8% to 6.3%.

5 Patient Choice

We now consider the factors affecting patients' choices of route to medication and advice for minor ailments when they had the opportunity to seek advice from the pharmacist as well as the practice GPs.

5.1 Specification

5.1.1 Model Specification

Under the intervention patients had to contact the surgery to avail themselves of the choice between a pharmacist and a consultation at the surgery. They had two methods of

the residual sum of squares does in ordinary linear regression.

contacting the surgery (telephoning to make a booked appointment or turning up at an open surgery session) and three choices of whom to consult (pharmacist, GP, nurse practitioner). The main issue in model specification is whether to model the patients as simultaneously choosing a method of contacting the surgery and whom to see or as making two sequential decisions: first how to contact the surgery and who to see. Different specifications lead to different estimation methods.

Van Ophem and Schram [10] argue that sequential choice models are appropriate when there is incomplete information at the first stage. As an extreme state of incomplete information, a patient may be unaware of the pharmacy option until they contact the surgery. Such patients therefore make decisions in two stages. Alternatively informed patients who are aware of the pharmacy option are more likely to make a single step decision on how they would access treatment.

In most cases we do not observe whether a patient has been informed of the intervention. However, we can proxy patient information in a number of ways, for example patients who have already consulted in the intervention period are more likely to be informed about the pharmacy option. As this example suggests, incomplete information raises another issue, in that the appropriate model for an individual may change over time from sequential simultaneous choice.

Even when patients are aware of all the options available there is still scope for sequential decision making since they not be fully informed about waiting times for open or booked appointments. The method of contacting the surgery has implications for how much uncertainty is resolved. For example, uncertainty over waiting time for booked appointments may be removed however the surgery is contacted. But uncertainty over waiting times for open surgeries may be more accurately resolved by turning up to the practice in person rather than by phoning the surgery in advance.

In the absence of direct information on patient information and how it changes over time we estimate both simultaneous and sequential models.

We model the single step simultaneous decision model as a multinomial logit, with each distinct route to medication being a combination of access (open or booked) and provider of consultation (GP, nurse or pharmacist). The nurse was only available for open sessions so there were in fact five possible routes (open GP; open nurse; open pharmacy; booked GP; booked pharmacy[7]), though there were very few open pharmacy consultations (22 out of 1521). The two step decision model is modelled as a Heckman selection model[8] where the decision of how to contact the surgery (open or booked) is analysed as the selection equation.

5.1.2 Explanatory Variables

Condition type is likely to be important for a variety of reasons. First, patients with a potentially embarrassing ailment (such as vaginal thrush) may prefer the greater privacy of GP or nurse consultation. Second, conditions which require an examination may also be unsuitable for a pharmacy consultation. Third, there were some limitations on the medications that the pharmacists could prescribe compared to GPs. The limitations involved POMs and may have been more restricting for some conditions. For example, in the case of headlice both GPs and pharmacists should have been limited to either Derbac M or Suleo M, but in some cases GPs prescribed the more patient-popular but non-formulary Lyclear which was not available via a pharmacist consultation. The baseline data suggested that GPs were prescribing antibiotics for earache, sore throats, urtis and coughs, and this was also not possible for pharmacists. We capture ailment specific effects with ailment dummies for the common minor ailments; diarrhoea (*diarr*), vaginal thrush (*thrush*), earache (*earache*), cough (*cough*), headlice (*headlice*), sore throat (*sore_thrt*) and upper respiratory tract infections (*urti*).

Whilst the pharmacy option was likely to involve less waiting than GP consultations, the

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[7] The 'booked' in booked pharmacy does not mean that the patient made an appointment with the pharmacy, but refers to the initial means of contacting the GP surgery. There were no fixed appointment times for any pharmacy consultation.

[8] Other possibilities for future work include the sequential multinomial models suggested by Van Ophem and Schram [13]

difference may have been small for open access patients. Open access surgeries were held every week day morning and all patients attending were seen that morning. Patients requesting appointments typically had to wait 2 to 3 days. In the absence of waiting time data we use as proxies the number of consultations by GPs in the week the patient consulted (*total*) and the number of consultations by the nurse practitioner (*np*). We also use the measure of GP availability (*gp_dif*). It is plausible that waiting times are increased when the GPs are busier and these variables are exogenous with respect to individual patient's choices of route to treatment.

From the postcodes for the practice, local pharmacies and patients and Ordnance Survey 5m grid references, we calculated straight-line distances between the patient's home and their nearest pharmacy (*ph_dist*) and between the patient and the practice (*dist*). We also computed the difference between these distances (*dist_diff*). The latter variable is non-negative since patient distance to the nearest pharmacy was never greater than distance to practice. We hypothesise that the larger the difference between these two distances the more likely was the patient to choose a booked pharmacy consultation. Since the three distance variables are perfectly collinear we drop the distance to the nearest pharmacy from the regression. We also checked for a non-linear relationship between by introducing the distance to the practice squared (*dist_sqd*). It is plausible that elderly patients will be more affected by distance and so we also considered various interactions of distance and patient age. Those for *agedist* and *agedistdif* are reported.

We know whether a patient had already consulted in the intervention period (*featured*). We assume that those patients who have already been offered a choice in a previous consultation are fully informed when choosing routes for future consultations. It is possible that patients may also be informed about the intervention through informal routes, like talking to other patients or attending a consultation for a non-minor ailment in the same practice. Exposure to these informal routes was more likely the longer the intervention had been in progress. We include a variable (*int_day*) which measures the length of time in days that the intervention has been running when a patient contacts the practice for a consultation. It is also possible that patients who consulted in the baseline period may have been informed of the intervention. The dummy variable (*baseline*) indicates whether the patient consulted in the baseline period in the 16 weeks immediately preceding the intervention period.

5.2 Results

5.2.1 Multinomial logit regression

We first modelled patient choice over all five routes to treatment as a single step decision and estimated a multinomial logit regression with robust standard errors to allow for the clustering which arises because some patients consulted more than once. With the full model, we found a very poor fit for the open nurse and open pharmacy routes, with the model predicting these outcomes correctly only 33% and 18% respectively.[9] We therefore re-estimated the multinomial logit model with the open nurse and open pharmacy routes excluded. This also allows us to test the assumption of the independence of irrelevant alternatives (IIA) underlying the multinomial specification. Kennedy [14] suggests that if IIA is valid the estimated coefficients in the reduced model should be unchanged from those in the full model.

Table 6 reports the effects of the independent variables on the probability of choice of open GP and booked pharmacy against the base option of booked GP. Personal characteristics have little influence: age, sex and all of the distance measurements and interactions had no significant effect on patient choice.

Having previously consulted during the intervention period (*featured*) significantly increases the chance of choosing the booked pharmacy relative to the booked GP and open GP options with a similar magnitude. The other proxies for patient information about the possibility of a pharmacy consultation, *int_day* and *baseline*, were insignificant.

The condition appears to be the main explanation for patient choice, especially for the

[9] Given that there are 5 options, randomly guessing which option would be taken should be successful 20% of the time.

choice of the booked pharmacy route relative to the booked GP route. Patients with vaginal thrush and headlice are more likely to go to the pharmacist than patients with coughs, earaches and sore throats which suggests that the greater privacy of a GP consultation may not affect choice. The conditions where the GPs had a history for prescribing antibiotics (which pharmacists were unable to do) or which may require greater expertise (because they are defined by symptoms rather than diagnosis) are less likely to result in the pharmacy routes. Unsurprisingly patients suffering from diarrhoea prefer a GP consultation sooner, via the open surgery session, rather than later via an appointment.

The small but significant positive coefficients on *total* for booked pharmacy and open GP suggests that patients may be more inclined to take the pharmacy option or turn up to an open session when the surgery is busy and hence waiting tines for appointments are greater. There is also a similarly small sized significant and negative coefficient for the number of consultations seen by the nurse, *np*, for the booked pharmacist option which may reflect greater accessibility of advice at the practice.

Comparison with the results from the full model regression strongly suggests that the IIA assumption is satisfied: although not shown here, there was little difference in coefficients values and the same variables are significant in both specifications. Personal characteristics have little effect and condition type is the main determinant of choice

The model has a maximum likelihood R^2 of 0.394 (full model - 0.507) and an adjusted count R^2 of 0.368 (full model - 0.342). Table 7 gives predicted against actual outcomes and shows that within sample predictive power is largely the same as in the full model, with 75% of pharmacy outcomes being predicted correctly.

Figure 5 graphs the logit function scores against actual outcome for each outcome. For each route to treatment option the graph show the actual outcome (a binary yes or no) on the vertical axis plotted against the observation's logit score for that outcome (horizontal axis) as obtained from the regression coefficients and the observations exogenous characteristics. The vertical line is at the zero logit score, where the outcome of choosing and not choosing that particular route to treatment has an equal probability. Scores to the right of this line indicate that model predicts that the patient will choose this outcome, and scores to the left of the line indicate another choice is predicted. The likelihood of choosing or not choosing the graphed option is a non-linear function of the logit score. This is illustrated by the superimposed symmetric logit function, which maps the logit score to the predicted probability of the patient choosing that treatment option (the vertical axis which is already bound by 0 and 1 may also be read as a probability scale). As the logit score increases, the logit function line approaches 1 indicating an increasing probability of choosing that option. At very high logit scores the probability is very close to 1. Similarly those observations with very large negative scores have an associated probability that indicates that it is highly unlikely that this patient will choose this particular outcome. Patients with positive (negative) logit scores close to zero are only slightly more likely to choose (not choose) that option. Consequently for good fitting models we would expect to see that observations with very high positive or negative logit scores are almost always correctly predicted.

Figure 4 has a satisfactory pattern for the pharmacy outcome with the actual (non-) pharmacy outcomes having an average logit score well to the right (left) of the vertical zero score line. However, the two GP options do not show such a satisfactory pattern. In particular both GP outcomes seem to have a significant proportion of positive outcomes with negative logit scores (though the opposite is not true - there are very few observations with positive logit scores and negative outcomes). The model is capable of predicting a pharmacy or non-pharmacy outcome but struggles to distinguish between open and booked GP outcomes.

5.2.3 Maximum likelihood probit model with selection

The multinomial models above are based on the assumption that the patient simultaneously made the decisions on how to contact the practice for a consultation and who they wished consult. However, patients who had not previously consulted in the intervention period might have not have been aware of the intervention. We therefore modelled the choices between a GP or pharmacist consultation for those patients who choose the booked access route to the practice and allowed for the endogeneity of the method of access with a Heckman selection equation. Since knowledge of the intervention will affect the choice of access route, we omitted the variables *featured* and *int_day* from the equation for choice of consultation type but used them in the selection equation.

The regression was based on 1360 observations, of which 354 were censored for the choice between pharmacy and GP consultation. Robust standard errors were calculated due to the clustering on patients who appear more than once in the intervention. A Wald Chi-squared test indicates that the model is significant but a formal test that the selection and consultation choice equations are independent cannot be rejected (P> chi2 = 0.125). Accordingly we do not feel that the two stage model is preferable to the one stage multinomial models reported above.

6 Conclusion

The intervention was primarily intended as a feasibility study. Attempts to generalise the implications from the study, especially on patient choice need to be made cautiously. First, national policy changes to make it possible for pharmacists to prescribe as well as dispense a wider range of medicines are unlikely to take the same form as the intervention. In particular, the requirement that patients first contact their practice before being able to use the pharmacy option could be removed by suitable legislative changes, thereby further increasing the attractiveness of the pharmacy option. Second, the practice was in a highly deprived inner city area with a relatively homogenous population where distances to pharmacies and the practice were quite small. Third, there were significant data limitations, in particular the absence of data on personal characteristics other than age and sex and on waiting times. Nevertheless the results give an indication of some of the consequences of using community pharmacies as alternative providers of advice and prescription for minor ailments

The main factor determining whether patients took advantage of easier access to pharmacies was their type of minor ailment. Patients were more likely to choose the pharmacy option, after contacting the surgery to arrange a GP appointment for thrush and headlice and less likely if it was earache, cough or sore throat, conditions with less obvious diagnoses and treatment. There was some indirect evidence that patients were more likely to take the pharmacy option when the practice was busier and waiting times possibly longer. Information on individuals' personal characteristics was limited to their age and sex and these had no effect on consultation choice. Nor did distance from the patient's home to the pharmacy or the surgery. They were also more likely to take the pharmacy option if they had previously consulted the practice and presumably then become aware of the option.

Overall GP workload was not altered by the intervention: the 38% of minor ailment consultations displaced to pharmacies were replaced by other consultations.

One aim of the policy of making access to pharmacies easier is to divert minor ailments to pharmacies and away from more expensive GP consultations. But even if some minor ailment patients are diverted, the mix of patients seen by GP may not change by much. It is possible that minor ailment patients who previously consulted the GP and are diverted to pharmacies will be replaced by minor ailment patients who previously consulted neither GPs or pharmacists and are now encouraged to consult GPs by the fact that demand diversion to pharmacies makes access to GPs easier as well. If the elasticity of demand for GP consultations with respect to waiting time is much greater for minor ailment patients than others, there may be little change in patient mix. In fact we found that the proportion of GP consultations which were for minor ailment fell by about a fifth from 7.8% to 6.3% during an average week. This modest reduction needs to be seen in the context of the limited intervention, which focused on only 12 minor ailments. However, care must be taken in extrapolating this result over a wider set of minor ailments, as our results indicate that the shift from GP to pharmacist is highly dependent on the type of minor ailment.

Although there has been no full cost benefit analysis of the effects of making it possible for pharmacists to advise and prescribe for a wider range of patients our results, and those of Philips et al [5], suggest that the policy has obvious benefits and few costs. Patients who have a wider range of consultation options for minor ailments benefit: either by switching to a more convenient provider or by consulting the pharmacist when they would not now consult their GP. Better access to pharmacists implies better access to GPs as demand for GP consultations is reduced. This benefits minor ailment patients who continue to consult or are encouraged to consult the GP. It also benefits other patients of GPs who consult for other conditions. To the extent that GPs prefer treating non minor ailment patients the change in the mix of patients makes GPs better off as well. It is intuitively obvious, and estimates by Philips et al [5] support the proposition, that pharmacists can provide cheaper advice than GPs for minor ailments. In short, the admittedly sketchy but highly plausible evidence suggests that relaxing restrictions on pharmacists prescribing for minor ailments benefits all groups of patients, does not make providers worse off and reduces NHS costs. It may be an example of that very rare phenomenon: a Pareto improvement.

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Table 1: Minor ailment consultations

Minor ailment	Number	Minor ailment	Number
Thrush	(39) 67	Hay Fever	(134) 4
Headlice	(109) 396	Diarrhoea	(39) 55
Cough	(128) 268	Temperature	(19) 27
Constipation	(10) 21	Earache	(65) 118
Sore Throat	(116) 120	Headache	(13) 15
Nasal Symptoms	(15) 14	Upper Respiratory Tract Infection (URTI)[1]	(107) 413
Dyspepsia	(0) 0		

[1] URTI is a combination of cough, sore throat, headache, nasal symptoms and temperature conditions

Numbers in brackets indicate number during 16 week baseline period.

Table 2: GP workload statistics

	Mean	Min.	Max.
Consultations per week	539	301	660
Minor ailment consultations (2nd year)	35	16	60
Average consultations per GP per week	128	60	191
Nurse practitioner consultations per week[1]	30	0	47
Number of clinics per week (2nd year)	31	27	41

[1] Whilst the nurse was still with the practice

Table 3. Patient Characteristics

	Mean	S.D.	Min	Median	Max
Age	22.4	19.5	0.5	16	94
Sex (female)	61%				
Straight line distance from practice (m)	1228.5	119.6	0	854.4	4810.4
Straight line distance from nearest pharmacy (m)	668.7	590.1	0	424.3	3966.1
Difference in distances (m)	559.8	773.2	0	316.8	3826.1
Appearances in intervention period	0.957	0.920	0	1	8
Appearances in baseline period	0.502	0.636	0	0	4
Consultations in previous year	4.76	4.28	0	4	43

Table 4: Effect of intervention on total weekly GP consultations (OLS)

Variable	Full model			Reduced model		
	Coef	Std Error	P>|t|	Coef	Std Error	P>|t|
constant	**579.29**	19.73	0.00	**587.56**	16.65	0.00
interven	16.54	18.85	0.38	22.65	19.02	0.24
np	-0.58	0.46	0.21			
GP_dif	**21.72**	8.84	0.02			
bef_bank	12.43	17.61	0.48	16.17	18.16	0.38
bank	**-86.01**	18.88	0.00	**-77.78**	19.88	0.00
aft_bank	19.77	18.99	0.30	20.76	20.08	0.31
bef_hols	2.02	15.15	0.89	6.21	16.05	0.70
hols	-29.85	16.71	0.08	**-38.66**	17.02	0.03
aft_hols	2.23	19.78	0.91	-1.47	20.47	0.94
year	-23.71	14.36	0.10	-25.22	15.15	0.10
april	23.54	25.43	0.36	-6.98	25.00	0.78
may	33.89	26.26	0.20	-2.90	25.14	0.91
june	-5.89	23,10	0.80	-38.47	22.00	0.09
july	15.07	25.10	0.55	-17.02	24.63	0.49
aug	-13.88	27.47	0.62	-42.86	27.63	0.13
sept	-34.29	21.02	0.11	**-49.10**	20.79	0.02
oct	-3.80	23.26	0.87	-30.54	22.00	0.17
nov	-11.60	19.59	0.56	-24.18	20.41	0.24
dec	-11.74	24.99	0.64	-33.58	24.90	0.18
R^2	0.59			0.52		
RESET P>F = 0.75						
Obs	82			82		

Dependent variable: total weekly GP consultations.

Table 5: Effect of intervention on proportion of consultations for minor ailments (GLM)

Variable	Full model			Reduced model		
	Coef	Std Error	P>|z|	Coef	Std Error	P>|z|
constant	-2.88	0.276	0.000	-2.78	0.270	0.000
interven	**-0.191**	0.077	0.013	**-0.218**	0.065	0.000
np	-0.002	0.002	0.319			
gp_dif	**-0.121**	0.058	0.037			
clinics	0.011	0.008	0.149	0.007	0.270	0.330
bef_bank	**0.224**	0.100	0.025	**0.205**	0.099	0.038
bank	**0.411**	0.108	0.000	**0.362**	0.105	0.001
aft_bank	**-0.201**	0.102	0.049	**-0.202**	0.102	0.047
bef_hols	0.113	0.766	0.141	0.105	0.076	0.164
hols	**-0.239**	0.094	0.011	**-0.209**	0.092	0.023
aft_hols	0.120	0.117	0.305	0.122	0.116	0.296
Dev	102.32			106.81		
Obs	41			41		

Dependent variable: ln(r/(1-r)) where r is proportion of GP consultations in a week which are for minor ailments.

Table 6. Patient choices: reduced multinomial logit regression

Variable	*Open GP*		*Booked Pharmacy*	
	Coeff.	**Std Er.**	**Coeff.**	**Std Er.**
cons	**-4.867**	**1.776**	-2.910	1.677
age	0.013	0.014	0.023	0.016
age_sqd	-0.000	0.00	-0.000	0.000
agesex	0.002	0.008	-0.006	0.009
sex	0.217	0.225	0.142	0.252
dist	0.000	0.000	0.000	0.000
dist_sqd	-0.000	0.000	0.000	0.000
dist_dif	-0.000	0.000	-0.000	0.001
agedist	-0.000	0.000	-0.000	0.000
agedistdif	0.000	0.000	-0.000	0.000
int_day	-0.020	0.012	0.011	0.013
featured	-0.108	0.189	**0.386**	**0.190**
baseline	0.042	0.201	-0.176	0.202
prev	-0.019	0.020	-0.137	0.022
diarr	**0.992**	**0.474**	-0.121	0.446
thrush	-0.618	0.739	**1.286**	**0.451**
earache	0.337	0.420	**-1.575**	**0.416**
cough	0.378	0.363	**-1.492**	**0.360**
sore_thrt	0.570	0.399	**-1.277**	**0.400**
headlice	-0.709	0.466	**1.809**	**0.338**
urti	0.609	0.370	**-0.906**	**0.330**
total	**0.008**	**0.003**	**0.005**	**0.003**
np	-0.001	0.015	**-0.038**	**0.019**
gp_dif	-0.129	0.267	-0.399	0.308
bef_hols	-0.088	0.358	-0.407	0.329
hols	0.593	0.349	0.316	0.370
aft_hols	-0.125	0.341	0.079	0.339
bef_bank	-0.207	0.402	-0.375	0.404
bank	0.461	0.478	-0.031	0.519
aft_bank	**1.125**	**0.543**	0.063	0.592
sep	-0.008	0.681	0.919	0.913
oct	1.115	1.059	0.453	1.333
nov	2.391	1.283	-0.937	1.480
dec	1.965	1.467	-0.938	1.703
jan	2.870	2.035	-1.793	2.363

Coefficients in bold font are significant at the 5% level.

Table 7. Actual and predicted patient choice – reduced multinomial logit regression

	Predicted Outcome			
Actual Outcome	Open GP	Booked GP	Booked Pharmacy	Total
Open GP	**164**	162	35	361
Booked GP	110	**278**	88	476
Booked Pharmacy	40	100	**413**	553
Total	314	540	536	1390

Figure 1. Effect of easier access to pharmacists on patient choice between GP and pharmacist.

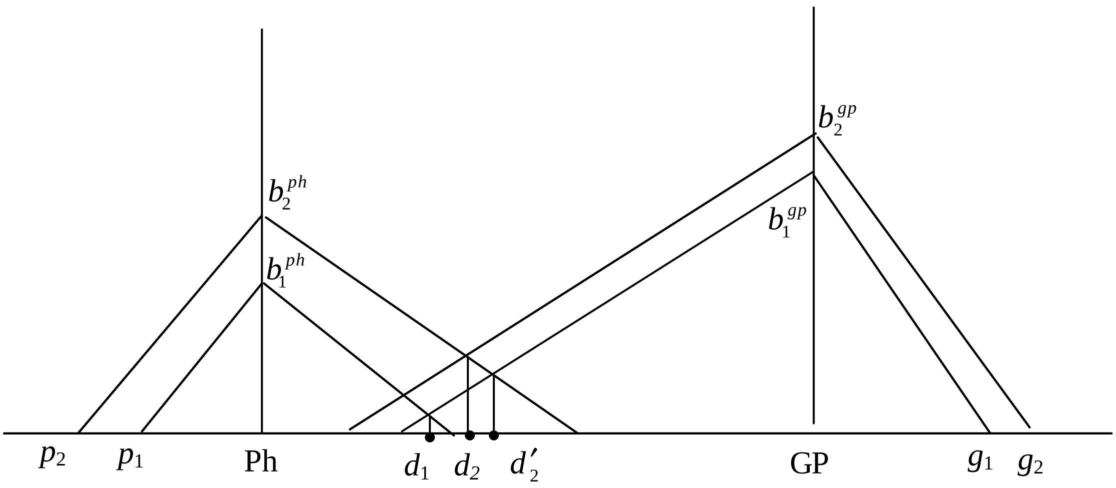
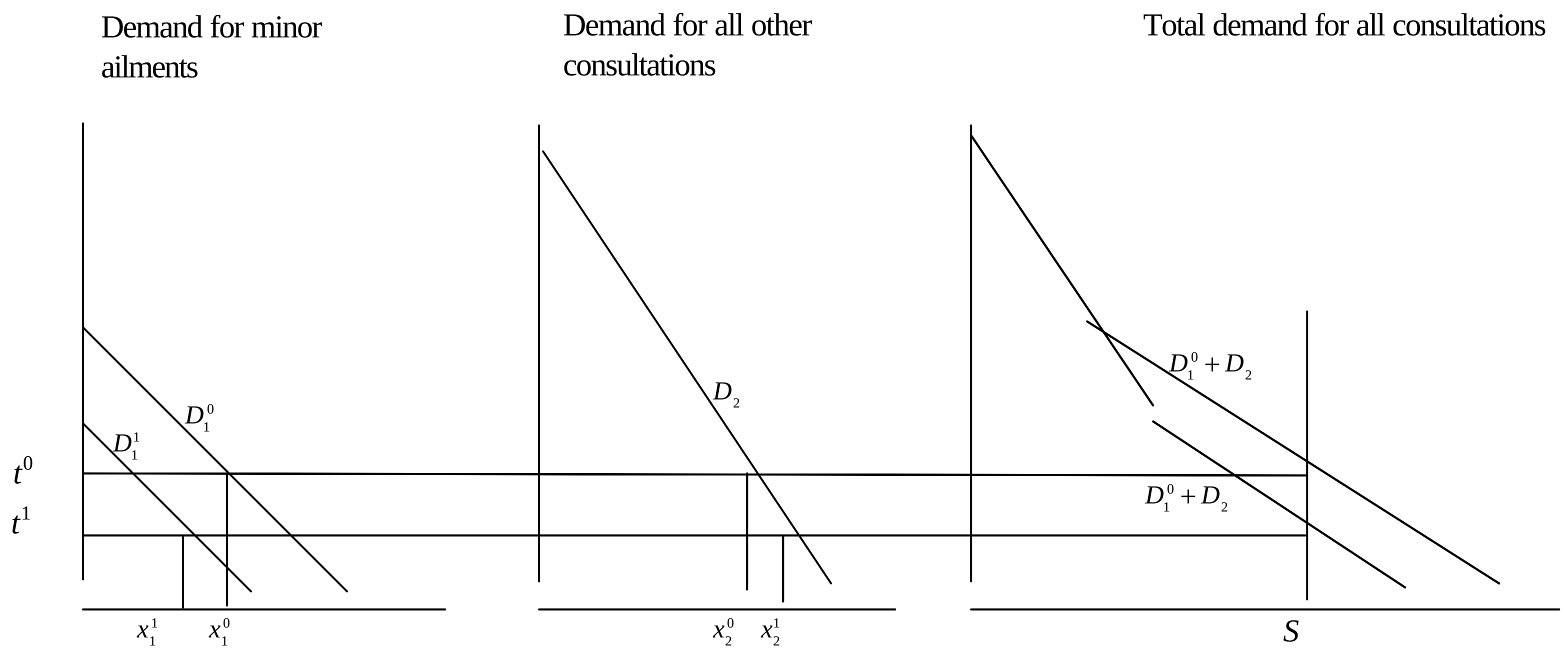


Figure 2 : Demand and supply of consultations



X1

Figure 3. Patient choices during intervention period

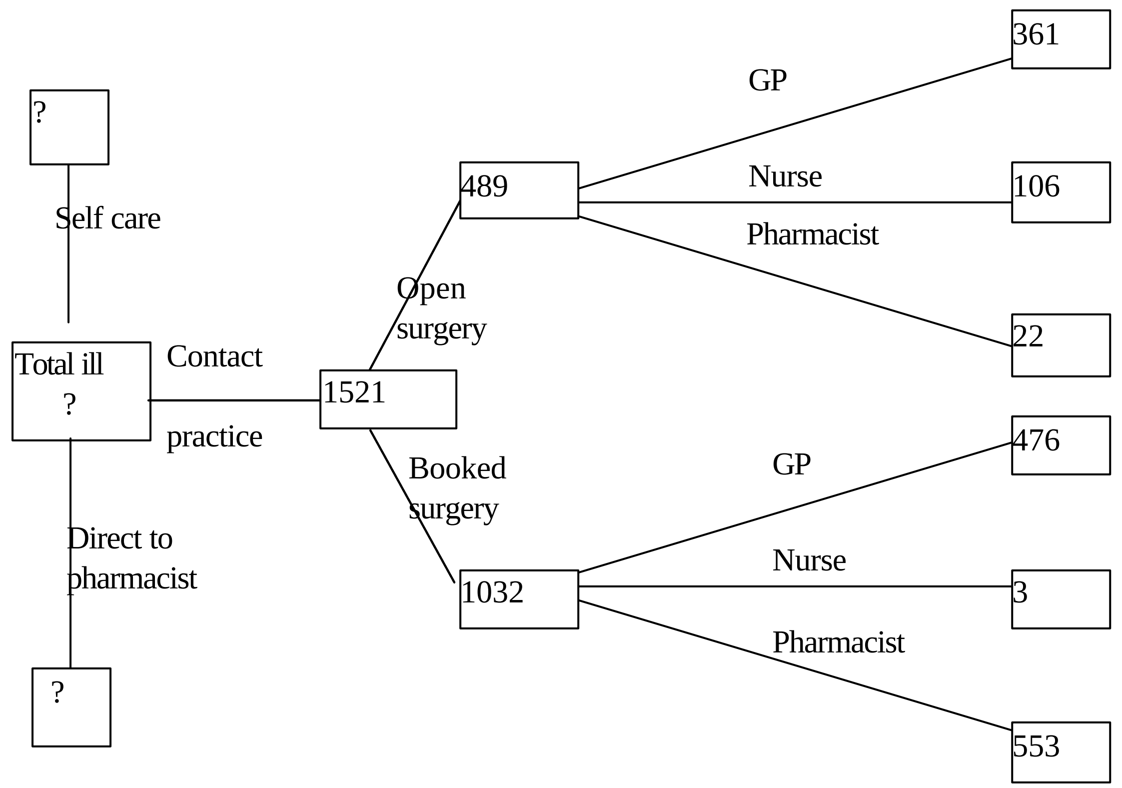


Figure 4. Data collection and intervention timing

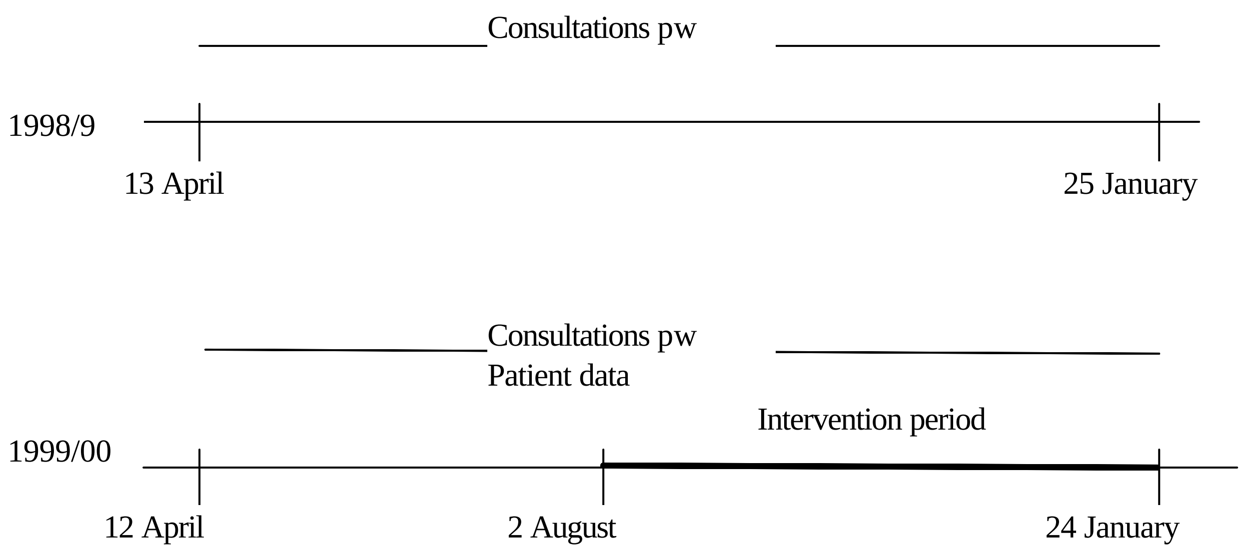
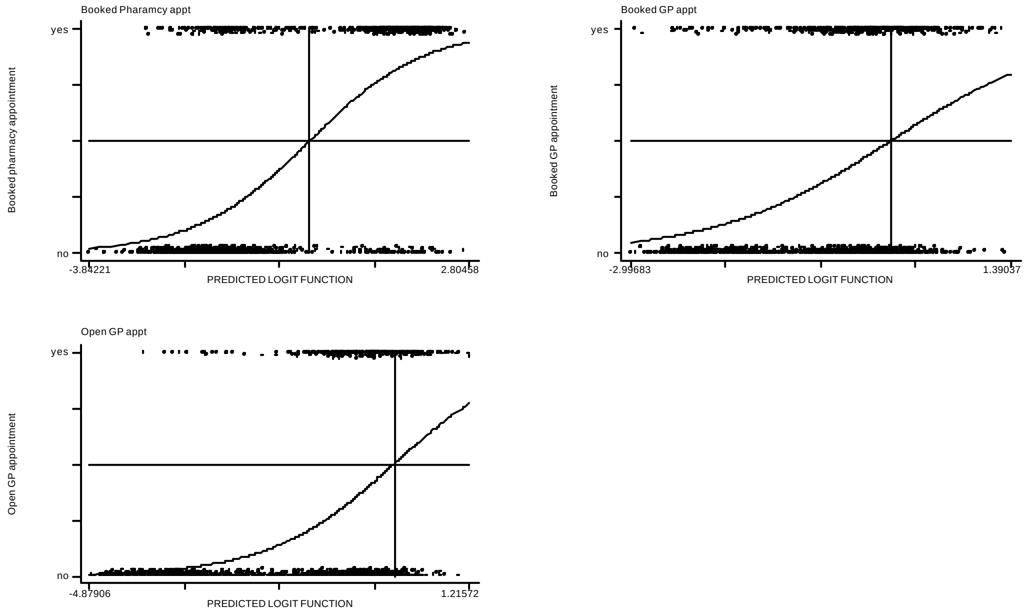


Figure 5. Predicted and actual choices.



Logit function against actual choice