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**Choosing and Booking – and Attending? Impact of an Electronic Booking System on Outpatient Referrals and Non-attendances**

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**Abstract.**  Patient non-attendance can lead to worse health outcomes and longer waiting times. In the English National Health Service (NHS) around 7% of patients who are referred by their general practice for a hospital outpatient appointment fail to attend. An electronic booking system (Choose and Book – C&B) for general practices making hospital outpatient appointments was introduced in England in 2005 and by 2009 accounted for 50% of appointments. It was intended, inter alia, to reduce the rate of non-attendance. Using a 2004-2009 panel with 7900 English general practices, allowing for the relaxation of constraints on patient of hospital, and for the potential endogeneity of use of C&B, we estimate that the introduction of C&B reduced non-attendance by referred patients in 2009 by 72,160 (8.7%).

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# Introduction

In the English National Health Service (NHS) health care is funded from taxation and provided without charge to patients. There is a gatekeeping system for access to hospital for non-emergency care. Patients are registered with general practices and must be referred by their general practitioner (GP) to a hospital outpatient department for diagnostic tests, treatment, or to be placed on a waiting list for elective inpatient care. In 2009 there were 11.87M first referrals by GPs to outpatient departments. Patients failed to attend in 7% of these appointments.[[1]](#footnote-1)

Non-attendance is associated with worse health outcomes for non-attenders (Hamilton *et al* 2002; Karter *et al*, 2004; Nelson *et al*, 2000; Sharp and Hamilton, 2001; Shectman et al, 2008). Although hospitals can overbook appointments non-attendance is also costly (Bech, 2005). Over-booking increases uncertainty for patients about their waiting time at clinics when they attend. To the extent that missed appointments are not filled by other patients, non-attendance by a patient increases waiting times for all patients.[[2]](#footnote-2),[[3]](#footnote-3)

In 2005 the NHS introduced an electronic booking system − Choose and Book (C&B) – which enabled GPs and patients to book an outpatient appointment online from the GP surgery, or later online or by phone, with a choice of location, date and time. The aims of the new system were to reduce non-attendance (NAO, 2005) and to help patients exercise a new right to a wider choice of hospital implemented in 2006 (Department of Health, 2004).

Previous studies of the impact of C&B on patient non-attendance have been small scale, for particular specialities, and have mixed results. Some (Modayil et al, 2009; Beckingsale and Wallace, 2009) find higher rates of non-attendance rates with C&B whilst others (Elloy et al, 2011; Parmar et al, 2009) find lower non-attendance rates.

In this paper we investigate the effect of the C&B system on patient non-attendance. We make a number of contributions. We allow for the possibility that C&B may also have affected the number of referrals from practices, cancellations by patients, and cancellations by hospitals, as well as the probability of a referred patient failing to attend. We use a new panel data set on the use of C&B for all practices in England between 2004 and 2009. We allow for unobserved time invariant practice factors by using practice fixed effects and for unobserved time varying factors by instrumenting practice use of C&B with the average C&B rate of neighbouring practices. We allow for the relaxation of restrictions on patient choice of hospital in 2006 and 2008 by including a survey measure of the extent to which patients reported being aware that they had a right to have a choice when referred. Our analysis also contributes to the limited evidence on examined the impact of a national health information technology programme on the effectiveness of healthcare delivery (Encinosa and Bae, 2011; Lapointe et al, 2011; Bassi and Lau, 2013).[[4]](#footnote-4)

In 2009 C&B was used to make 50% of GP first appointments at hospital outpatient departments. We find that C&B reduced non-attendances and GP referrals while also reducing patient cancellations. We estimate that in the absence of C&B there would have been 71,160 (8.7%) more non-attended appointments. Practices where more patients reported being aware of their right to a choice of provider had higher referral rates, lower non-attendance, patient cancellation, and hospital cancellation rates.

In the next section we first briefly describe the booking process with and without C&B and discuss how C&B could have affected referrals, non-attendance, patient cancellations, and hospital cancellations[[5]](#footnote-5) and then present our estimation strategy. Section 3 describes the data, Section 4 has results, and Section 5 discusses their interpretation.

# Methods

## Choose and Book and the referral process

Two features of the referral process help to explain why patients who have been referred to a hospital outpatient department fail to attend. First, there is a non-trivial waiting time between referral and appointment dates.[[6]](#footnote-6) The referral decision depends on the benefits and opportunity costs of attending as estimated at the referral date and patients may subsequently revise their estimates and decide not to attend.[[7]](#footnote-7) Second, the referral decision is made jointly during a consultation between the patient and GP whereas the attendance decision is made by the patient. If the patient’s appointment cost being is weighted more heavily in the attendance decision than in the referral decision this may lead to non-attendance.

If the GP does not use C&B she will write to the hospital outpatient department to request an appointment for the patient. The hospital would then write to the patient with the details of the appointment slot whose timing would be decided by the hospital on receipt of the request letter from the GP. The patient could attempt to change the appointment directly with the hospital by phone or letter, but would not be able to do so over the internet.

When the GP uses C&B she will register the patient on the C&B system, and either book the appointment during the consultation or leave the choice of hospital for the patient to make later. The patient would be given a C&B booking reference and could make the booking or change it at a later date (either on the internet, by telephone, or in the practice).

The effects of C&B are a priori ambiguous. C&B could have increased the information available to patients about alternative outpatient departments, including their waiting times. This could increase or decrease referrals and if patients with better information are less likely to revise their estimates of benefits and costs it could reduce the non-attendance rate. With an appointment made via C&B patients had the opportunity to defer the booking of an appointment until later at home when they could log into the C&B system and make the booking themselves. This may change the nature of the consultation between the GP and patient, leading to a more shared decision making process with more weight on patient preferences.[[8]](#footnote-8) If patient attendance costs were given more weight under C&B this could lead to a reduction in referrals, patient cancellations, and in non-attendance. The ability of patients to more easily cancel appointments could have increased patient cancellations.

Booking costs for general practices probably increased with C&B, especially in its early phase when the software was considered cumbersome and unreliable by many GPs. GPs were financially incentivised to use the C&B system. Between April 2006 and March 2008 they were paid 49p per patient on the list if they agreed to use C&B, and a further 49p per referral if at least 50% were made via C&B. After 2008 payments continued in some Primary Care Trusts (PCTs).[[9]](#footnote-9) These incentive payments may not have offset the additional GP costs of using C&B. This may have led, ceteris paribus, to a reduction in the referral rate for practices which perceived a higher cost of using the new system. Some patients would have had lower booking costs, especially those with better internet access, as the system made it possible for them to confirm or change appointments from home, after their GP had registered their provisional booking. Ceteris paribus this would have lowered the referral threshold, increasing referrals and the non-attendance rate. But some patients may have found it more difficult to access and use the C&B system compared with the previous system in which the GP made the appointment and so faced higher booking costs.

C&B is likely to have increased hospital propensity to cancel outpatient appointments. Hospitals had to make immediate offers of outpatient appointment slots when receiving a request via C&B whereas without C&B they had longer to plan scheduled appointments upon receipt of the request letter from the GP. This would have reduced flexibility in appointment booking and placed greater demands on planning and managing appointment slots. The introduction of C&B also coincided with other changes to hospital IT systems.

The introduction of C&B was part of a package of measures to develop the new internal market in the NHS. In particular, from January 2006 patients had to be given the choice of at least four providers for elective care and in April 2008 patients had the right to choose any willing provider (Dixon et al, 2010). By widening the available choice set the choice reforms of 2006 and 2008 are likely to have increased referrals, and reduced patient cancellations, and the probability of non-attendance.

## Estimation

We estimate Poisson conditional fixed effects count data models for GP practice patient non-attendance (*Nit*), patient cancellation (*Cit*), hospital cancellation (*Hit*), and practice referrals (*Rit*). For example, in our baseline model for patient non-attendance, the expected number of patients not attending and failing to cancel in practice *i* in year *t* is

 

*Nit* is the number of first scheduled appointments that were non-attended in practice *i* (*i* = 1, 2, 3,........, 8449) in year *t* (*t* = 2004, 2005, ......,2009). *Ait* is the number who were referred and attended so that *Nit* + *Cit* + *Ait* is the exposure term – the population at risk of deciding not to attend without cancelling. The coefficient on *ln* (*Nit* + *Cit* + *Ait*) is constrained to be equal to 1.[[10]](#footnote-10) *Xit*is a vector of GP practice covariates;  is a year indicator for year *t*′, with 2004 as the omitted year. *Sj* (*j =* 1, 2,...,10) is a regional (Strategic Health Authority) indicator. *Bit* is the number of referrals made via C&B and *Bit*/*Rit* is the practice C&B utilisation rate.

*θi* is a time invariant unobserved GP practice fixed effect but, as in the linear and logit specifications, there is no incidental parameter problem and maximum likelihood estimates of **β** are consistent even in short panels (Blundell et al, 2002; Cameron and Trivedi, 2015). We use cluster robust standard errors which are valid even if the Poisson property of equidispersion does not hold (Cameron and Trivedi, 2015) and also allow for within practice autocorrelation (Bertrand et al., 2004). Models were estimated using Stata 13.2.

## Identification

There are two potential endogeneity problems in identifying the effect of the C&B rate on referral outcomes and the referral rate. The first is that there may be unobserved practice characteristics influencing both C&B rates and referral outcomes or referral rates. For example, practices with historically high non-attendance rates might have felt they had more to gain by referring patients using the C&B system.

The second potential problem is time varying endogeneity. In particular, there were other policy changes between 2004 and 2009 which might have affected outcomes. A system of prospective pricing for hospital inpatient stays and outpatient appointments, Payment by Results (PbR), was rolled out from 2004/5 (Department of Health, 2012). There were major changes to the contract between the NHS and general practices in April 2004 (Quality and Outcomes Framework – QOF) which incentivised care for particular patient groups and could have influenced referrals for outpatient diagnosis and testing (Roland, 2004; Gillam et al, 2012).

Most saliently, from January 2006 all patients had to be offered a choice of at least 4 local hospitals when making an outpatient appointment and from April 2008 patients had a right to be referred to any hospital providing services to NHS patients (Dixon et al, 2010). To help patients make choices the NHS Choices website was introduced in 2007 to provide information on hospitals.[[11]](#footnote-11) The widening of patients’ hospital choice sets is likely to have increased referrals and reduced non-attendance once referred. GPs’ use of C&B was probably correlated with their propensity to offer a wider choice of hospital (Dixon et al, 2010).[[12]](#footnote-12)

The use of year by region fixed effects will also control for common time varying changes in the offer of choice as well as absorbing the effects of policies which varied by year, either nationally or regionally as well as allowing for differential trends in unobserved factors influencing outcomes across practices. We also include time varying GP practice characteristics that may have influenced C&B uptake as well as patient non-attendance. For example, the number of GP practices fell between 2004 and 2009, with a declining proportion of small single handed practices and an increasing proportion of large multi-GP practices. To control for any possible effect of practice size and staffing we include both the practice list size and the number of GPs per patient in the model. We also include time varying indicators of organisational quality of GP practices. We further include the proportion of practice referrals to over 50 specialities in each year to control for policies like prospective pricing and the new practice contract whose effects could vary by speciality.

We allow for any remaining endogeneity in two ways. First, all specifications condition out practice effects so that we use only the variation in C&B uptake within GP practices over time, thereby removing the effects of time invariant factors. The identification strategy in our baseline specification is analogous to a difference in differences estimation, but with a continuous level of treatment i.e. C&B uptake (Gaynor, 2013).

Second, to allow for any time varying unobserved heterogeneity we instrument practice use of C&B with the average annual C&B use in the PCT to which the practice belongs. We use two stage residual inclusion (2SRI) (Terza et al 2008) adding the residual from the linear first stage model of C&B to the second stage Poisson regressions.

Our use of an IV for C&B use will remove any bias in the estimated effects of C&B arising from the omission of correlated factors, such as an increase in choice. But the effect of choice policy is of interest in own right and so in some specifications, we also include a direct measure of the effect of choice policy: the proportion of patients in the practice’s PCT who report that they were aware that they had a right to be offered a choice of hospital when referred.

## Robustness checks

We also undertook robustness checks. We allow the effects of C&B uptake to vary by year, thereby allowing an estimate of its effect in 2005 before the relaxation of constraints on patient choice. We also allow for heterogeneous trends in the outcomes which may be correlated with use of C&B by adding interactions of year dummies and the average 2005-2009 use of C&B by the practice. We investigate the possibility that the effects of C&B might vary depending on the availability of hospitals by estimating models in which we interact the C&B rate with the average distance from the practice to hospitals.

We also used alternative estimation methods: random effects Poisson and population averaged negative binomial. These specifications allowed for unobserved time invariant practice factors by including pre-sample (2003) values of the dependent count variable divided by its corresponding exposure term as an explanatory variable (Blundell et al., 2002).[[13]](#footnote-13)

# Data

## Choose and Book

Data on the number of all first GP practice referrals made using the C&B system to all hospital providers treating NHS patients by month of referral, specialty of referral, hospital of treatment and referring GP practice was obtained from NHS Connecting for Health and the Department of Health’s C&B Service Utilisation Database (HSCIC, 2015). The C&B data cover the period 1January 2005 to 1 January 2010. The year 2005 was a pilot year with selected GP practices and hospitals participating. From 1 January 2006 C&B was launched nationally and available to all GP practices, but the system was not initially in place across all hospitals and specialties. Over time the system was rolled out to most hospital departments and use of C&B by GP practices increased so that by 2009 50% of first GP outpatient appointments were booked with C&B (see Table 1 and Figure 1).

## Hospital Episode Statistics

We linked the database on practice use of C&B to the English Hospital Episode Statistics (HES) Outpatient database of all outpatient appointments in English hospitals treating NHS patients. The HES data is for financial years (1 April to 31 March) and records all outpatient referrals with an appointment date from 1 April 2003 to 31 March 2010. It is possible that some GP practice referrals made via C&B at the end of the 2009 calendar year are not recorded in our HES data because the appointment date was after 31 March 2010. However, in 2010 an 18 week total waiting time target from date of referral to treatment was in place and would help to ensure that the majority of patients referred before 31 December 2009 would have been scheduled to be seen before 1April 2010. We use year by region effects in the empirical analysis and this will allow for under recording of referrals made at the end of 2009.

We use the HES data to derive total annual first referrals made during each of the calendar years 2004 to 2009 for all English general practices which had at least 500 registered patients during the year. We dropped 110 (0.20%) practice-year observations with a record of C&B utilisation but with no referrals recorded in HES. There were also 2,316 (4.13%) practice-year observations where the total recorded C&B first referrals exceeded first referrals recorded in HES.[[14]](#footnote-14)

## Referral outcome measures

We classify attendance outcomes for referrals made during a calendar year into four categories:[[15]](#footnote-15)

*Nit* = number of appointments recorded as not attended with no prior warning;

*Cit* = number of first scheduled GP referred appointments cancelled by patients;

*Hit* = number of first scheduled GP practice referred appointments cancelled by the hospital;

*Ait =* number of first scheduled GP practice referred appointments attended.

In some hospitals the only referral outcomes recorded were that the patient attended or that the outcome was unknown: the hospital recorded no referrals in which the patient failed to attend, or the patient cancelled, or the hospital cancelled. In 2004 8.7% of appointments were in 29 providers that did not record outcomes other than attended or unknown. This mis-recording decreased year on year, until in 2009 1.9% of appointments were at 15 hospitals that only reported attendance or unknown outcomes. When computing practice referral outcomes we exclude referrals to these hospitals from the denominator of the practice non-attendance, patient cancellation and hospital cancellation rates.

##  Practice covariates

We include a large set of time varying practice characteristics in the models (see the summary statistics in Appendix Table A1). These include the number of patients on the practice list, the proportion of patients in 14 age by gender groups, the number of whole time equivalent GPs per patient, the mean age of GPs, the proportion of GPs who are not GP principals, the proportion who qualified in the UK, and the proportion of female GPs. We attribute socio-economic characteristics in small areas (Lower Super Output Areas - LSOAs)[[16]](#footnote-16) to practices using the proportion of practice patients resident in each LSOA. From the Quality and Outcomes Framework we have data on practice disease prevalence of 11 conditions and on smoking prevalence, and 14 measures of practice organisational quality. To allow for differences in the participation of different hospital specialities in C&B we also include the proportions of each practice’s first referrals to 53 specialities. We also measure the mean straight line distances from each GP practice to all NHS and independent sector hospitals.

## Patient choice

Following the introduction of patient choice in England, the Department of Health commissioned IPSOS/MORI to undertake a quarterly survey of randomly selected first referral patients in each PCTs (Dixon, 2010). We use responses to a question about whether patients were aware that they had a right to a choice of hospital.[[17]](#footnote-17) We aggregated quarterly response rates to calendar years to coincide with our time periods for C&B utilisation. The survey was not undertaken before the change in choice policy in January 2006. Since patients could not have been aware of their, non-existent right to a choice before 2006 we replace the missing values for 2004 and 2005 with zero. In some specifications we also add the interactions of 2006-2009 mean awareness of a right to a choice with year dummies for 2005 to 2009 to pick up potentially time varying effects associated with the mean choice awareness of patients.

## Estimation sample

We were able to match 49,987 practice-years between 2004 and 2009 to 97.8% of HES records for first GP referrals. Excluding practices with populations less than 500 resulted in a loss of 361 (0.72%) observations, and a further 586 practice-years (1.2%) were lost where first referrals recorded in the C&B system exceeded first referrals recorded in HES or where all referrals were to hospitals that did not record non-attendance. We also excluded outlier practices with referral rates of over 50%, annual changes in referral rates of more than 100%, or registered population changes of greater than 25% compared to the subsequent year. In total we excluded 2,531 (5.1%) practice-year observations.

# Results

## Descriptive statistics

**Table 1** shows that under 1% of GP practice referrals were booked using C&B during the pilot year 2005. This increased to 20% in the first year of the national system in 2006 and by 2009, 50% of GP practice first referrals were booked using C&B. There was wide dispersion in utilisation of C&B across practices in 2009 (**Figure 1**) with a near normal distribution apart from the lower tail with a concentration of practices with usage rates below 20% and with 5% of practices with rates of utilisation at or near zero.

In 2006 the proportion of patients reporting being aware of their right to a choice was higher (34%) than the proportion of referrals made using C&B (19%). Both increased over time and in 2009 the proportion aware of their right to a choice was 48% and the C&B rate was 49%. At PCT level awareness and the C&B rate were positively and quite highly correlated, with correlations between 0.48 in 2007 and 0.32 in 2009.[[18]](#footnote-18)

**Figure 2** shows the frequency distribution of patient non-attendance rates across practices for 2009. It is heavily skewed to the right and over 85% of practices had non-attendance rates below 10%.

In 2004 patient non-attendance with no prior warning was the second most likely attendance outcome with around 7% of first scheduled appointments failing to attend. The rate of non-attendance remained fairly constant, apart from a dip to 6.5% in 2008. By contrast the rate of patient cancellations increased from 3.4% in 2004 to 5.4% in 2009. The 2% decline in attendance rates over the period is accounted for by the increase in patient cancellations. Hospital cancellations nearly doubled from 1.7% in 2004 to over 3.3% in 2009.

There was an increase in GP practice referral rates from 158 per 1000 patients in 2004 to 207 per 1000 by 2009, with particularly large increases in 2008 and 2009. In addition to any effect of C&B, this increase in the numbers of scheduled first GP appointments may have been due to the PbR system (Imison and Naylor, 2010). There was a rapid rise in the number of consultant to consultant referrals after 2005 as the PbR system was rolled out, probably because hospitals now had a financial incentive to record them. Some PCTs, which bore the cost of additional referrals, reacted by requiring that the referral had to be routed via the patient’s GP. The introduction of 18 week waiting time targets in 2008 measured from date of referral to admission may also have increased referrals.

## Estimated effects of C&B and patient choice policies

**Table 2** presents results from the conditional fixed effects Poisson model . The reported coefficients are the estimated proportionate change in the outcomes from a one unit (i.e. 1%) increase in the C&B rate. Since the national average C&B rate increased from zero in 2004 to nearly 50% in 2009 we also report the percentage change in the outcome rates from a 50% increase in the C&B rate: Δ%50C&B = 100[exp(50*β*1) − 1].

An increase in use of C&B is associated with a decrease in patient non-attendance at first scheduled outpatient appointment. A 50 percentage point increase in C&B utilisation is associated with a −10.9% (95% CI: −9.8%, – 12.0%) proportionate reduction in the rate of non-attendance. Increased use of C&B is also associated with a reduction in the practice referral rate, though the proportionate reduction (–3%) with a 50% increase in the C&B rate is smaller than for non-attendance. Patient cancellations were also reduced when the practice C&B uptake was increased. Finally, hospital cancellations were much higher when the practice C&B rate is higher: a 50% increase in the C&B rate is associated with a 40% proportionate increase in the hospital cancellation rate.[[19]](#footnote-19)

**Table 3** has the results from a specification in which the effect of C&B varies across years. The marginal proportional effect on non-attendance in participating practices is largest in 2005 (prior to introduction of the patient choice policy) but less precisely estimated than in subsequent years, probably because of the smaller number (2,228) of practices using C&B in this pilot year.

The changes in the coefficient on the C&B rate over time do not suggest that the changes in choice policy in 2006 and 2008 which widened choice sets changed the effect of C&B uptake. The proportional reduction in the GP referral rate due to C&B for participating practices declined over time, suggesting the expansion of patient choice may have increased referrals, but nationally this was more than offset by increasing use of C&B, so that by 2009 we estimate that C&B reduced referral rates by –1.4% (95% CI: –2.5%, –0.4%).[[20]](#footnote-20) The effects of C&B on patient cancellations varied across the years, being positive in some years and negative in others. The effect of C&B on hospital cancellations was always positive, but its magnitude declined sharply over time, suggesting that initially hospitals found it more difficult to handle referrals made by the C&B system. [[21]](#footnote-21)

**Table 4** tests the robustness of our results to different underlying practice trends in their propensities to use C&B. We add an interaction between year dummies and mean practice C&B utilisation over the period 2005 to 2009. Our results are qualitatively unchanged with C&B associated with reductions in non-attendance and referrals. The magnitude of the effects are slightly less negative, and in some years there was evidence that a greater propensity to use C&B on average was associated with significantly higher underlying trends in non-attendance and referrals. Patient cancellations were negatively associated with C&B utilisation, but no longer statistically significant at 5% and hospital cancellations remained positive and statistically significantly associated with C&B uptake.[[22]](#footnote-22)

We examined whether the effects of C&B were affected by the average distance from the practice to all possible referral hospitals. Average distance to hospital is a proxy for the cost of travel and the extent of effective choice for patients. **Table 5** reports results from a model with C&B uptake interacted with indicators for the quintiles of average distance. The effects of C&B on non-attendance, patient cancellations, and hospital cancellations did not differ by distance to hospitals. For referrals, the effect of distance on the effect of C&B is mixed but generally the negative effect of C&B is smaller at higher distance quintiles.

In **Table 6** we examine the implications of potential endogeneity of C&B, instrumenting practice use of C&B with the mean C&B uptake in the PCT. We also allow directly for choice policy in some specifications by adding a measure of the extent to which patients were aware of their right to a choice of hospital. In *panel a* we repeat the results from the baseline specification in Table 2 with uninstrumented C&B and with no measure of choice policy. *Panel b* has the results when add the residuals from the first stage C&B model to second stage model. The estimated effect of C&B on non-attendance and on hospital cancellations are similar to those in the uninstrumented model in *panel a* and the first stage residual is statistically insignificant, suggesting that C&B was not endogenous for these outcomes. C&B is endogenous for referrals and for patient cancellations and the negative effect of C&B is three to four times larger than in the uninstrumented model in *panel a*.

In *panels c* and *d* we add a measure of awareness of choice to the uninstrumented and instrumented models in *panels a* and *b*. The C&B residual is again statistically insignificant in the non-attendance and hospital cancellation models in *panel d* implying that the appropriate model for these outcomes measure is the uninstrumented model in *panel c*. Comparing *panel c* and *panel a* we see that the inclusion of the choice awareness measure does not change the effect of C&B. *Panel c* suggests that greater awareness of choice reduced non-attendance and hospital cancellations.

The C&B residual is statistically significant for referrals and patient cancellation in *panel d*. Increases in C&B reduce referrals and patient cancellations (as in the model without the choice measure in *panel b*). Increases in awareness of choice increase referrals and reduce patient cancellations, presumably because with greater choice the expected net benefit from a referral is increased.

When corrected for endogeneity the negative C&B effect on referrals becomes several times larger. This may be due to the correlation induced from having the number of referrals as the denominator for the practice C&B utilisation rate which would reduce the estimated magnitude of the C&B coefficient if we do not control for endogeneity.[[23]](#footnote-23)

**Figure 3** shows the national impact of the introduction of C&B on non-attendance rates from 2005 to 2009 estimated from specification (Table 3) with time varying effects of C&B. The red line plots the percentage difference between the average non-attendance rate in year *t* and the average non-attendance rate in 2004 before the introduction of C&B. The black dashed line plots the equivalent counterfactual difference with a zero C&B rate in all years. By 2007 the reduction in the national non-attendance rate due to C&B was over 7% and this had increased to over 12% by 2009.

**Figure** **4** shows the national impacts of the introduction of C&B and choice policy on GP referrals, independently of each other from 2005 to 2009. The graph used estimated coefficients from the 2SRI IV model in Table 6 *panel d*, which allows for the effect of the patient awareness of choice policy and endogeneity of C&B. The solid red line plots the percentage difference between the average referral rate in year *t* relative to the baseline year 2004 due to the uptake of C&B, assuming the associated patient choice policy had not been implemented (that is awareness of choice remained zero from 2006 onwards); the dotted brown line shows the percentage change in referrals attributed to the effect of the introduction of the patient choice policy in 2006, assuming that C&B had not been implemented; and the black dashed line plots the equivalent counterfactual had C&B and patient choice not been introduced i.e. a zero C&B and choice awareness in all years. By 2007 the reduction in national referrals due to the uptake of C&B was nearly -7.6%. This reduction was offset by a 6% referral increase due to an increased awareness of choice of hospital. By 2009 with an uptake of C&B and awareness of choice of around 50%, C&B had decreased referrals by 11.4% while choice policy had increased referrals by 7.7%.

# Discussion

The electronic Choose and Book system for general practice referrals to hospital outpatient departments was introduced in 2005. We investigated its effects using models with practice fixed effects, year by region effects, and a large set of time varying covariates, including practice and patient characteristics and the mix of outpatient specialities, for over 7700 English practices from 2004 to 2009. We find that practices which increased their use of the C&B system had a reduction in the proportion of referred patients failing to attend. They also reduced their referral rates. The results are qualitatively robust to alternative specifications which allowed for differential trends for practices with a higher propensity to utilise C&B and for endogeneity from unobserved year specific GP practice shocks affecting C&B utilisation and non-attendance. There was evidence of significant C&B endogeneity bias for referrals, probably induced by referrals being the denominator of the C&B rate. Using the PCT mean C&B rate as an instrument, we find that increased use of C&B reduced referrals.

We also included a time and PCT varying patient choice policy variable, which enables us to separate out the contribution of the effects of the increased patient awareness of their right to be offered a choice of hospital from use of C&B. We find that patient awareness of choice reduced patient non-attendance, but did not change the effect of C&B. This suggests the electronic booking system’s facility to schedule more convenient appointments, to actively involve patients in the referral decision, location and timing and the reduction in referral thresholds were as or more important than awareness of choice in reducing non-attendances. By contrast, a greater awareness of choice lead to a significant increase in referrals, suggesting that patients were offered larger choice sets and so could choose providers better suited to them.

An increase in use of C&B and, to a greater extent, an increase in awareness of choice were both associated with fewer patient cancellations, perhaps because they enabled patients to make a better initial choice of hospital. C&B increased hospital cancellations while patient choice awareness reduced them. This is consistent with hospital administrators finding appointment scheduling harder when an increasing proportion of appointments were made further in advance via the C&B system.[[24]](#footnote-24) Hospitals operating in areas with greater choice awareness would face competitive pressures to attract patients and hence improve appointment scheduling.

The estimated magnitudes of the C&B effects on non-attendance are similar to the effects of other policies designed to reduce patient non-attendance. A meta-analysis of randomised controlled trials of Short Messaging Service (SMS) text message reminders in the days prior to scheduled first appointments found an estimated improvement in the odds ratio of attending of 1.48 (Guy et al, 2011). Given the 2009 attendance rate of 87.6% this implies an increase in the attendance rate of 4.45 percentage points to 92.05%. The non-attendance and cancellation rates in 2009 were 7% and 5.4% respectively. From Table 6, *panel d* a 50% increase in C&B utilisation was associated with a -8.92% decrease in non-attendance to 6.38%, and a -8.38% reduction in cancellations to 4.95%, which is equivalent to a 1.07 percentage point increase in the attendance rate. This is smaller than the effect found for SMS interventions in a randomised controlled trial setting, where compliance with the intervention was likely to be close to 100% (C&B with 100% compliance would increase attendance by 2.06 percentage points).

We do not have the data to attempt a cost-benefit analysis of C&B but the magnitudes of the estimated effects of the introduction of C&B are likely to be economically significant. Patients failed to attend 7% or 832,263 of the 11,870,043 first referrals recorded in 2009. C&B was used to make 50% of the appointments in this year and we estimate that in the absence of C&B there would have been 72,160 (8.7%) more non-attended appointments and 1,081,747 (9.11%) fewer referrals, independently of the introduction of patient choice. The introduction of the patient choice policy was associated with an increase in referrals of 752,093 assuming that the policy was responsible for a 50% increase in awareness of choice of provider to patients in 2009. About 30% of first GP referrals do not result in hospital admissions, tests or onward referral to another consultant. This suggests that some of the referrals not made as a result of C&B may have been medically unnecessary, especially as these marginal referrals would have been those perceived by the patient and GP to be of low net benefit. The increase in hospital cancellations would have increased the administrative costs. Over 90% of hospital cancelled appointments are rescheduled so that hospital cancellations are less likely to result in patients not being seen, but patients could be delayed as a result or their appointment cancellations or could have made unnecessary visits to the hospital.

Our results demonstrate that there was a marked change in referral rates and in the rates of patient non-attendance once referred associated with changes in use of C&B within practices over time. We also find effects of choice policy on non-attendance, patient cancellations, hospital cancellations, and referrals. Changes the decision making process over referrals and attendance have an economically important effects on attendance and referrals. Given the concern about welfare loss from non-attended appointments and recent proposals to introduce patient charges for missed appointments (Watt, 2015), our study suggests there is scope for further reducing non-attendance and hospital referrals by expanding the use of electronic booking systems and facilitating patient choice in referral decisions to improve the appropriateness of referrals. Widening provider choice reinforced the reductions in patient non-attendance and cancellations, while increasing referrals suggesting choice improved access to specialist care.

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**Figure 1: Distribution of GP practice Choose and Book utilisation rates for first outpatient referrals in 2009**



**Figure 2: Frequency distribution of GP practice non-attendance rates for first scheduled outpatient appointments in 2009.**



*Notes*. Denominator for non-attendance rate is total referrals minus hospital cancellations.

**Figure 3: Relative trends in national non-attendance rates across GP practices with and without the introduction of C&B in 2005.**



*Notes*. The denominator for the non-attendance rate is total referrals minus hospital cancellations. Non-attendance is non-attendance without notice. The solid red line uses results the non-attendance model in Table 3 and plots the estimated percentage difference between the non-attendance rate in year *t* and 2004 as −1 where *Bt*/*Rt* is the national average C&B rate in year *t*, *wjt* is the proportion of practices in SHA *j* in year *t*, and  is the estimated region *j* effect in year *t*. The dashed black line plots the counterfactual percentage difference between year *t* and 2004 with a zero C&B rate in all years as−1.

**Figure 4: Relative trends in referrals with and without the introduction of C&B in 2005 and patient choice policy in 2006.**

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*Notes*. The denominator is the practice list. The solid red line uses results from the IV model in Table 6 *panel d* and plots the estimated percentage difference between the referral rate in year *t* and 2004 as $exp\left(\hat{β}\_{1}\left(B\_{t}/R\_{t}\right)+\sum\_{j}^{}w\_{jt}\hat{β}\_{3jt}\right)-1$ where  is the instrumental variables estimate of the C&B effect, *Bt*/*Rt* is the national average C&B rate in year *t*, *wjt* is the proportion of practices in SHA *j* in year *t*, and  is the estimated region *j* effect in year *t*. Similarly for the patient choice effect the dotted brown line plots the estimated percentage change from 2004 baseline estimated as $exp\left(\hat{β}\_{2}C\_{t}+\sum\_{j}^{}w\_{jt}\hat{β}\_{3jt}\right)-1$ where is the estimated effect of the awareness of choice and *Ct* is the national average reported awareness of choice in year *t.* The dashed dark blue line plots the counterfactual percentage difference between year *t* and 2004 with a zero C&B and zero awareness of choice as −1.

**Table 1. Descriptive statistics 2004 – 2009**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Variable** | **2004**MeanStd. Dev.[Min, Max] | **2005**MeanStd. Dev.[Min, Max] | **2006**MeanStd. Dev.[Min, Max] | **2007**MeanStd. Dev.[Min, Max] | **2008**MeanStd. Dev.[Min, Max] | **2009**MeanStd. Dev.[Min, Max] |
| **Non attendance rate** | 0.071 | 0.071 | 0.069 | 0.068 | 0.065 | 0.070 |
|  | 0.051 | 0.048 | 0.041 | 0.037 | 0.035 | 0.037 |
|  | [0, 0.55] | [0, 0.625] | [0, 0.750] | [0, 0.556] | [0, 0.486] | [0,1] |
| **Patient cancellation rate** | 0.034 | 0.035 | 0.036 | 0.042 | 0.048 | 0.054 |
|  | 0.048 | 0.046 | 0.043 | 0.047 | 0.051 | 0.051 |
|  | [0,0.5] | [0, 0.4] | [0, 0.333] | [0, 0.222] | [0, 0.429] | [0, 0.25] |
| **Hospital cancellation rate** | 0.017 | 0.017 | 0.021 | 0.024 | 0.025 | 0.033 |
|  | 0.026 | 0.026 | 0.027 | 0.030 | 0.028 | 0.033 |
|  | [0, 0.333] | [0, 0.345] | [0,0.25] | [0, 0.286] | [0, 0.5] | [0, 0.215] |
| **Attendance rate** | 0.895 | 0.894 | 0.895 | 0.890 | 0.887 | 0.876 |
|  | 0.074 | 0.067 | 0.059 | 0.058 | 0.060 | 0.059 |
|  | [0.194, 1] | [0.375, 1] | [0.250, 1] | [0.333, 1] | [0.429, 1] | [0,1] |
| **Referral rate** | 0.158 | 0.162 | 0.163 | 0.169 | 0.191 | 0.207 |
|  | 0.044 | 0.042 | 0.043 | 0.044 | 0.049 | 0.057 |
|  | [0.002, 0.492] | [0.005, 0.047] | [0.001, 0.483] | [0.029, 0.493] | [0.036, 0.47] | [0.002, 0.499] |
| **C&B rate** | 0 | 0.745 | 19.159 | 38.389 | 45.578 | 49.233 |
|  | 0 | 2.556 | 17.054 | 24.093 | 23.548 | 22.729 |
|  | [0, 0] | [0, 49.582] | [0, 99.315] | [0, 100] | [0, 100] | [0, 100] |
| **Aware of right to choice1** | 0 | 0 | 34.34 | 39.97 | 48.13 | 53.37 |
|  | 0 | 0 | 5.15 | 5.85 | 6.60 | 7.58 |
|  | [0, 0] | [0, 0] | [23.56, 49.38] | [27.87, 53.97] | [33.10, 63.78] | [37, 68] |
| **List size** | 6382 | 6416 | 6509 | 6603 | 6710 | 6716 |
|  | 3836 | 3872 | 3908 | 3958 | 4011 | 4152 |
|  | [557, 35956] | [559, 36388] | [518, 36884] | [501, 37613] | [541, 38717] | [504, 39919] |
| **Number of practices** | 7909 | 8015 | 8004 | 7820 | 7794 | 7914 |

*Notes*. The denominator for non-attendance, patient cancellation, and attendance rates is referrals minus hospital cancellations; for the hospital cancellation rate and the C&B rate it is referrals; and for the referral rate it is the practice list size. Figures are for calendar years.

1 Sample size is 152 PCTs

**Table 2. Practice Choose and Book rate and non-attendance, GP referrals, patient cancellation, and hospital cancellation rates.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Non-attendance** | **GP referrals** | **Patient cancellation** | **Hospital cancellations** |
| **C&B rate** | -0.0023 | -0.000613 | -0.00087 | 0.0068 |
|  | [0.00012]\*\*\* | [0.000071]\*\*\* | [0.00034]\* | [0.00044]\*\*\* |
| Observations | 46690 | 46692 | 46493 | 45711 |
| GP practices | 8263 | 8264 | 8207 | 8054 |
| **∆%50 C&B rate**  | -10.877 | -3.020 | -4.237 | 40.156 |
| Std. Error | [0.554]\*\*\* | [0.344]\*\*\* | [1.610]\*\* | [3.105]\*\*\* |
| 95% CI | [ -11.964, -9.791] | [-3.694, -2.347] | [-7.392, -1.081] |  [34.071, 46.241] |

*Notes*. Estimates from conditional fixed effects Poisson models. Years: 2004 to 2009. All models also contain year and SHA interactions, practice list size, proportion of list in 13 age/gender groups, patients per whole time equivalent GP, average GP age, proportion female GPs, proportion GPs qualified in UK, proportion of non-principal GPs, 15 QOF practice quality indicators, disease prevalence and patient deprivation, proportion of referrals to 53 separate specialities. Full results are in Appendix Table A2. Coefficients are the proportionate change in the dependent variable from a one unit (1%) change in the C&B rate. ∆%50CB rate = 100[exp(β150) − 1] is the percentage change in the outcome rate due to a 50% increase in the C&B rate. Robust standard errors in square brackets allow for clustering within GP practices.

\*: p < 0.05; \*\*: p< 0.01; \*\*\*: p < 0.001

**Table 3. Time varying associations with C&B rate**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Non-attendance** | **GP referrals** | **Patient cancellation** | **Hospital cancellations** |
| **C&B rate 2005** | -0.0035 | -0.00196 | 0.0125 | 0.0287 |
|  | [0.0014]\* | [0.00075]\*\* | [0.005]\* | [0.0045]\*\*\* |
| **C&B rate 2006** | -0.0010 | -0.00106 | -0.0025 | 0.0084 |
|  | [0.0002]\*\*\* | [0.00010]\*\*\* | [0.0005]\*\*\* | [0.0006]\*\*\* |
| **C&B rate 2007** | -0.0020 | -0.00076 | -0.0019 | 0.0082 |
|  | [0.0001]\*\*\* | [0.00008]\*\*\* | [0.0004]\*\*\* | [0.0006]\*\*\* |
| **C&B rate 2008** | -0.0030 | -0.00055 | 0.0002 | 0.0063 |
|  | [0.0002]\*\*\* | [0.00009]\*\*\* | [0.0004] | [0.0005]\*\*\* |
| **C&B rate 2009** | -0.0025 | -0.00029 | -0.0003 | 0.0051 |
|  | [0.0002]\*\*\* | [0.00011]\*\* | [0.0005] | [0.0006]\*\*\* |

*Notes*. Estimates from conditional fixed effects Poisson models. Years: 2004 to 2009. All models also contain year and SHA interactions, total practice list size, proportion of list in 13 age/gender groups, patients per whole time equivalent GP, average GP age, proportion female GPs, proportion GPs qualified in UK, proportion of non-principal GPs, 15 QOF practice quality indicators, disease prevalence and patient deprivation, proportion of referrals to 53 separate specialities. Same number of observations as in Table 2 models. Coefficients are the proportionate change in the dependent variable from a one unit change in the explanatory. Robust standard errors in square brackets allow for clustering within GP practices.

\*: p < 0.05; \*\*: p< 0.01; \*\*\*: p < 0.001

**Table 4. Allowing for heterogenous trends by mean C&B uptake (2005-9).**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|   |   | **Non-attendance** | **GP referrals** | **Patient cancellation** | **Hospital cancellations** |
| **C&B rate** |  | -0.001646 | -0.000967 | -0.000207 | 0.007864 |
|   |  | [0.000159]\*\*\* | [0.000082]\*\*\* | [0.000394] | [0.000536]\*\*\* |
| C&B rate mean\_2005-9 2005 | 0.029094 | 0.010422 | -0.010257 | -0.039964 |
|   |  | [0.003519]\*\*\* | [0.001969]\*\*\* | [0.006637] | [0.009594]\*\*\* |
| C&B rate mean\_2005-9 2006 | 0.029063 | -0.017791 | -0.004225 | -0.019919 |
|   |  | [0.004603]\*\*\* | [0.002786]\*\*\* | [0.010879] | [0.016362] |
| C&B rate mean\_2005-9 2007 | 0.018821 | 0.00967 | 0.01004 | 0.005729 |
|   |  | [0.005819]\*\* | [0.003506]\*\* | [0.015564] | [0.020930] |
| C&B rate mean\_2005-9 2008 | -0.004787 | 0.074529 | 0.016885 | -0.015891 |
|   |  | [0.006266] | [0.003500]\* | [0.017751] | [0.023139] |
| C&B rate mean\_2005-9 2009 | 0.011181 | 0.088912 | 0.022476 | -0.003634 |
|   |   | [0.006341]  | [0.003534]\*\*\* | [0.017533] | [0.023901] |

*Notes*. Estimates from conditional fixed effects Poisson models. Years: 2004 to 2009. All models also contain year and SHA interactions, total practice list size, proportion of list in 13 age/gender groups, patients per whole time equivalent GP, average GP age, proportion female GPs, proportion GPs qualified in UK, proportion of non-principal GPs, 15 QOF practice quality indicators, disease prevalence and patient deprivation, proportion of referrals to 53 separate specialities. Same number of observations as in Table 2 models. Coefficients are the proportionate change in the dependent variable from a one unit change in the explanatory. Robust standard errors in square brackets allow for clustering within GP practices.

\*: p < 0.05; \*\*: p< 0.01; \*\*\*: p < 0.001

**Table 5. Heterogenous C&B effects by average distance to hospital.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | **Non-attendance** | **GP referrals** | **Patient cancellation** | **Hospital cancellations** |
| **C&B rate** |  | -0.002182 | -0.000731 | -0.001552 | 0.006064 |
|  |  | [0.000182]\*\*\* | [0.000105]\*\*\* | [0.000520]\*\*\* | [0.000674] \*\*\* |
| **C&B rate \* Avg distance\_2nd qtile** | -0.000127 | -0.000022 | -0.000202 | 0.000193 |
|  |  | [0.000216] | [0.000122] | [0.000622] | [0.000801] |
| **C&B rate \* Avg distance\_3rd qtile** | -0.000272 | 0.000795 | 0.000061 | 0.001605 |
|  |  | [0.000217] | [0.000120]\*\*\* | [0.000608]\*\*\* | [0.000841] |
| **C&B rate \* Avg distance\_4th qtile** | -0.000113 | 0.001983 | 0.000236 | 0.000342 |
|  |  | [0.000215] | [0.000130]\*\*\* | [0.000583] | [0.000818] |
| **C&B rate \* Avg distance\_5th qtile** | -0.000092 | 0.000464 | 0.00047 | 0.00125 |
|  |  | [0.000215] | [0.000117]\*\*\* | [0.000624] | [0.000916] |

*Notes*. Estimates from conditional fixed effects Poisson models. Years: 2004 to 2009. All models also contain year and SHA interactions, total practice list size, proportion of list in 13 age/gender groups, patients per whole time equivalent GP, average GP age, proportion female GPs, proportion GPs qualified in UK, proportion of non-principal GPs, 15 QOF practice quality indicators, disease prevalence and patient deprivation, proportion of referrals to 53 separate specialities. Same number of observations as in Table 2 models. Coefficients are the proportionate change in the dependent variable from a one unit change in the explanatory. Robust standard errors in square brackets allow for clustering within GP practices.

\*: p < 0.05; \*\*: p< 0.01; \*\*\*: p < 0.001

**Table 6. Allowing for endogeneity of C&B rate and for choice**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|   | **Non-attendance** | **GP referrals** | **Patient cancellation** | **Hospital cancellations** |
| **a: No IV, choice measure not included:**  |
| **C&B rate** | -0.0023 | -0.000613 | -0.00087 | 0.0068 |
|  | [0.00012]\*\*\* | [0.000071]\*\*\* | [0.00034]\* | [0.00044]\*\*\* |
| **b: 2SRI, choice measure not included** |
| **C&B rate** | -0.0020398 | -0.0017466 | -0.0029152 | 0.0056067 |
|  | [0.0002504]\*\*\* | [0.0001452]\*\*\* | [0.0006251]\*\*\* | [0.000758]\*\*\* |
| **C&B rate residual**  | -0.0003565 | 0.0015386 | 0.0048426 | 0.001573 |
|  | [0.0002814] | [0.0001646]\*\*\* | [0.0007568]\*\*\* | [0.0009119] |
| **c: No IV, with choice awareness measure** |
| **C&B rate** | -0.002264 | -0.000631 | -0.000573 | 0.006882 |
|  | [0.000126]\*\*\* | [0.000072]\*\*\* | [0.000335] | [0.000441]\*\*\* |
| **Choice awareness** | -0.001214 | 0.000491 | -0.010917 | -0.004309 |
|   | [0.000454]\*\* | [0.000276] | [0.001262]\*\*\* | [0.001761]\* |
| **d: 2SRI, with choice awareness measure** |
| **C&B rate** | -0.00187 | -0.00191 | -0.00175 | 0.00603 |
|  | [0.00026]\*\*\* | [0.00015]\*\*\* | [0.00065]\*\* | [0.00077]\*\*\* |
| **C&B rate residual**  | -0.00053 | 0.00170 | 0.00157 | 0.00116 |
|   | [0.00029] | [0.00017]\*\*\* | [0.00079]\* | [0.00093] |
| **Choice awareness** | -0.00141 | 0.00123 | -0.01032 | -0.00392 |
|   | [0.00047]\*\* | [0.00028]\*\*\* | [0.00138]\*\*\* | [0.00176]\* |

*Notes*. Second stage estimates from conditional fixed effects Poisson models. All models also contain year and SHA interactions, total practice list size, proportion of list in 13 age/gender groups, patients per whole time equivalent GP, average GP age, proportion female GPs, proportion GPs qualified in UK, proportion of non-principal GPs, 15 QOF practice quality indicators, disease prevalence and patient deprivation, proportion of referrals to 53 separate specialities. Coefficients are the proportionate change in the dependent variable from a one unit change in the explanatory. First stage C&B model: linear with practice fixed effects and including the mean PCT C&B rate as an IV, plus all second stage exogenous explanatories; sample: 46833 observations from 8405 practices. First stage F statistics: panel b: 5878; panel d: 6873 ; Bootstrapped (250 replications) robust standard errors in square brackets allow for clustering within GP practices.

\*: p < 0.05; \*\*: p< 0.01; \*\*\*: p < 0.001

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1. Some patients referred by their GP and seen by an outpatient consultant may have subsequent outpatient appointments made by the outpatient consultant. We exclude outpatient appointments cancelled by hospitals from the denominator in computing the patient cancellation rate. [↑](#footnote-ref-1)
2. NHS England estimate missed outpatient appointments had an average cost of £108 in 2012/13, implying that missed first GP referral appointments would have cost £80 million, It is unclear whether this allows for overbooking. https://www.england.nhs.uk/2014/03/05/missed-appts. [↑](#footnote-ref-2)
3. Male gender, age, low socioeconomic status, waiting time, and distance have been found to be associated with higher non-attendance rates (Hamilton et al 2002; Corfield et al, 2008; Sola-Vera et al, 2008; Hon et al, 2005; Lee et al, 2005). Reminders by telephone, text message, and post reduce non-attendance rates, (Guy et al, 2011; Gurol-Urganci et al, 2013). [↑](#footnote-ref-3)
4. The NHS spent £280 million on the C&B system up to 2012 (Department of Health, 2013). Norway, Denmark, Finland, and the Netherlands have also invested in electronic referral and booking systems and health information technology to facilitate patient referral and support information exchange, and wider patient choice of treatment provider (Naserias, 2015). The US Health Information Technology for Economic and Clinical Health Act of 2009 provided $27 billion for incentive payments and investment in health information technology (Blumenthal and Tavenner, 2010). [↑](#footnote-ref-4)
5. Appendix C provides a theory model of the process and the impact of C&B. [↑](#footnote-ref-5)
6. In 2011 50% of patients waited more than 30 days. (Care Quality Commission. The Survey of Adult Outpatient Services 2011, NHS England, 2011. <http://www.qualitywatch.org.uk/indicator/waiting-times-outpatient-appointments>). [↑](#footnote-ref-6)
7. Even without new information hyperbolic discounting (Laibson, 1997) may lead to non-attendance. For example, suppose that the waiting time for an appointment is *t*, that the benefit *b* from attending (better future health) occurs some time *s* after attending, and that the cost of attending is *c*. Then the appointment will be booked at date 0 if and only if *δ*(*t+s*)*b* > *δ*(*t*)*c* where *δ* is the discount factor applied to future benefits and costs. The booked appointment will be attended at date *t* if and only if *δ*(*s*)*b* > *c*. With hyperbolic discounting *δ*(*τ*) = *βe-rτ*, where *β* ∈( 0,1) if *τ* > 0 and *δ*(0) = 1, the patient will fail to attend the booked appointment if *be-rτ* > *c* > *βe-rτ*. [↑](#footnote-ref-7)
8. See O’Connor et al (2004) for a review of evidence on the effect of shared decision processes on choice of treatment. [↑](#footnote-ref-8)
9. The 152 PCTs received capitated budgets from the Department of Health and are responsible, inter alia, for delivery of primary care services in their area. [↑](#footnote-ref-9)
10. In models of hospital cancellations exposure is *Nit + Cit + Hit + Ait* and in models of referrals it is the practice list size *Lit*. [↑](#footnote-ref-10)
11. Other countries which have introduced web based information systems to facilitate greater choice of hospital include Norway in 2001 (Kjerstad and Kristiansen, 2005), Denmark in 2003, and Sweden in 2005 (Ranerup, 2008). [↑](#footnote-ref-11)
12. The evaluation of Choice policy by the Kings Fund (Dixon et al, 2010, p.41) noted that “GPs, in particular, conflated patient choice with Choose and Book, in part because it is through this system of booking that the policy of patient choice is ‘enacted’”. [↑](#footnote-ref-12)
13. Fixed effects negative binomial models suffer from the incidental parameter problem or require implausibly strong assumptions (Cameron and Trivedi, 2015). [↑](#footnote-ref-13)
14. The error is due to (i) a failure in HES to record GP practice codes (ranging between 3% and 5% of records for referred patients in each year, but concentrated in a small sub-set of GP practices) and (ii) inaccurate date of referral. [↑](#footnote-ref-14)
15. 0.45% of appointments in hospitals recording the full range of outcomes had an unknown outcome. 0.37% of appointment records did not distinguish whether the appointment was a first or follow up appointment. We assumed that they were first appointment if the organisation referral code (*reforg*) in HES matched a valid GP practice code, and included them in the four outcome categories. [↑](#footnote-ref-15)
16. There were 32,482 LSOAs with a minimum population of 1000 and a mean population of 1500. [↑](#footnote-ref-16)
17. The question was “Q1. Before you visited your GP, did you know that you now have a choice of hospitals that you can go to for your first hospital appointment? [↑](#footnote-ref-17)
18. The low correlation in 2009 was due to greater sampling variability as only 594 responses per PCT were obtained on average compared to over 2000 in previous years. [↑](#footnote-ref-18)
19. In additional robustness checks we found that results are qualitatively robust across the estimation methods (see Table B1, Supplementary Material Appendix). The Poisson random effects model, which includes the prior year 2003 outcome as an explanatory, is closest to our baseline conditional Poisson fixed effects model reported in Table 2, with very similar coefficients and smaller standard errors. The population averaged negative binomial has larger effects except for hospital cancellations where the effect is negative, though small and insignificant, rather than positive as with the other estimators. The Poisson random effects and negative binomial population averaged models also show that the variance exceeds the mean so that it is necessary to allow for over dispersion in computing the standard errors. We do so by using robust standard errors clustered on practices. [↑](#footnote-ref-19)
20. We compute the effect of C&B in year t as 100[exp(β1t where *β1t* is the coefficient on the year *t* C&B rate and *Bt*/*Rt* is the average referral rate. [↑](#footnote-ref-20)
21. We also allowed the effect of C&B to vary across the 10 SHA regions. Results are reported in Table B3 in the online appendix. The estimated effects of C&B on non-attendance were negative across all 10 regions, but not statistically significant in the South West, which had the largest uptake of C&B. The West Midlands and South Central regions experienced the largest relative reductions in non-attendance of -18.6% and -15.5% respectively. There were more varied impacts on referral rates across the SHAs. There was a significant (at 5%) negative effect only in 6 of the 10 SHAs. There were also mixed effects on patient cancellations across the SHAs: patient cancellations increased significantly as a result of C&B in 2 of the SHAs and decreased significantly in three of them. Hospital cancellations increased in all SHAs. [↑](#footnote-ref-21)
22. Table B2 in the online appendix provides a test of differential ‘pre-trends’ in referral outcomes between 2003 and 2005 across practices based on their average uptake of C&B between the years 2005 and 2009. The trend in non-attendance was significantly higher in 2005 for practices that had higher C&B utilisation rates between 2005 and 2009. If this differential trend persisted in later years it would bias our findings towards finding no effect. For patient referrals in the years 2004 and 2005 (relative to 2003) trends in referral rates were significantly lower amongst practices with higher utilisation of C&B, which could bias our estimates towards finding a more negative effect if these trends persisted. [↑](#footnote-ref-22)
23. We thank an anonymous referee for this suggestion. We also followed another suggestion to use the one year lag of C&B utilisation as an instrument in the patient referral model. The results using the lag C&B rate as well as the PCT mean rate were nearly identical. The lag C&B rate was quite a strong IV (F-stat = 33.99), but weaker than the PCT mean. The estimated effect of C&B was -0.00194 and of choice awareness was 0.0011. An over-identification test for the validity of the lag C&B rate could not reject the null hypothesis that the use of C&B in the previous period affected patient referrals in the next period, assuming that the PCT mean rate to be a valid instrument.

 [↑](#footnote-ref-23)
24. An increase in scheduling errors and re-appointment was noted in the implementation of the electronic booking system supporting the Norwegian ‘Free-Choice-Of-Hospital’ policy introduced in 2001 (Lotherington and Obstfelder, 2006). [↑](#footnote-ref-24)