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The Impacts of Private Hospital Entry on the Public Market for Elective Care in England

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Abstract

This paper examines the impacts of private hospital entry on publicly funded elective care in England. From 2006, private hospitals were encouraged to enter certain publicly funded markets to compete with existing public hospitals and stimulate quality improvements. Studying elective hip replacements, we compare changes in outcomes across areas that were differentially exposed to private hospital entry, instrumenting hospital entry with the location of private hospitals in the pre-reform period. We find private hospital entry led to a 12% increase in the overall number of annual publicly funded admissions, and an 11% reduction in waiting times, but had no effect on the number of admissions at public hospitals or emergency readmissions. Additional publicly funded admissions were not associated with reduced privately funded volumes, and patients became observably healthier on average. These findings indicate the reform successfully increased publicly funded capacity but did little to improve quality at existing public hospitals.

Keywords: Hospital competition; Private provision; Market entry; Independent Sector Providers.
JEL Classification: I11; I18; L33.

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1 Introduction

Efforts to promote competition between providers have been a common feature across healthcare systems around the world in recent decades. In the English National Health Service (NHS), the introduction of patient choice over providers in the mid-2000s aimed to incentivise competition between hospitals in order to improve the efficiency and quality of healthcare. Previous work has found these reforms were broadly successful, with reductions in mortality as a result of increased competition (Cooper at al., 2011; Gaynor et al., 2013; Gaynor et al., 2016).

An important yet often overlooked component of these patient choice reforms was the introduction of private providers to large parts of the public market for elective healthcare. Private providers entered the market in two stages in the 2000s (Naylor and Gregory, 2009). Starting in 2005, purpose-built and privately owned surgical centres known as Independent Sector Treatment Centres (ISTCs) were introduced to boost public capacity and reduce waiting times. This was followed by the widespread entry of pre-existing private hospitals to the public elective market in the late 2000s. These hospitals were paid the same pre-determined price for providing elective care as existing public hospitals, encouraging competition on quality.

In this paper we examine the impact of the entry of private hospitals on the public market for elective hip replacements, where private providers delivered a fifth of all procedures by 2012/13.[1] We study the impact of private hospital entry on the number of admissions for publicly funded procedures, waiting times and readmission rates for these patients, and substitution from the private market. Our main analysis uses the universe of publicly funded hospital admissions to compare the changes in publicly funded volumes, waiting times and readmissions rates over an 11 year period across fixed areas which were differentially exposed to private hospital entry. To address the potential endogeneity of private hospital entry, we instrument hospital entry with the location of private hospitals prior to the reform. In addition, we carry out a battery of robustness checks, including an analysis of pre-trends in outcomes and controls for other policy changes in the NHS at the time, which leave our findings unchanged.

We find that the introduction of a private hospital increased the total number of admissions for publicly funded hip replacements in the local area and reduced waiting times for patients, but did not reduce readmission rates. We estimate that the entry of a private hospital in the

[1] We focus on hip replacements for three reasons. First, it is a common procedure performed in large volumes by all large public hospitals in England. Second, private hospitals routinely conduct this procedure for private-pay patients and therefore had pre-existing capacity to carry out this surgery. Finally, unlike most other specialties in England, information on the private pay sector is available via a mandatory registry of joint replacements.

local area by the end of the period led to an annual rise of 34 publicly funded hip replacements. This is equivalent to 11.7% of the market mean of 285 publicly funded hip replacements in 2002/03. These additional admissions were accompanied by a reduction in waiting times, with the entry of a private hospital associated with a waiting time reduction of 11.1% (or 27 days in 2002/03), and no overall impact on readmission rates.

We next estimate the impact of private hospital entry on the activity and quality of public hospitals by focusing only on patients treated by public hospitals. Here we find no impact of private hospital entry on the number of elective hip replacements conducted by public hospitals, and therefore no change in revenues hospitals receive from these patients. The estimated reductions in waiting times are also smaller than in our baseline estimates, which included all hospitals. This suggests that much of the benefit from shorter waiting times accrues to patients treated by private hospitals. Again, there is no impact on quality, as measured by emergency readmissions. This is consistent with the entry of private providers increasing the capacity to deliver publicly funded hip replacements, while generating limited competitive pressure for public hospitals to improve (observable) care quality to attract new patients.

Finally, we consider the impact that private hospital entry had on the composition of publicly funded hip replacement patients across all hospitals. To do so, we use novel joint registry data that cover all hip replacements in England, including all private and publicly funded hip replacements between 2008/09 and 2012/13, to explore the impact that private hospital entry and the associated growth in the number of procedures had on the composition of hip replacement patients along two margins.

First, we examine the extent to which this growth represents new procedures or substitution from the private pay sector. Here we find that the entry of private providers to the public elective market was not associated with a reduction in the number of privately funded hip replacements conducted in the local area. This suggests that substitution between these financing streams was limited, and that the increase in publicly funded volumes represent genuinely new procedures that would not have taken place in a given year in the absence of the reform.

Second, we assess how the average characteristics of patients changed following the entry of a private hospital. We find that private provider entry is associated with a small reduction in average patient severity, as measured by two separate health indices in two different datasets. This suggests that the new patients treated as a result of the reform were healthier than existing patients, and may be explained either by reductions in treatment thresholds as capacity

expanded or additional private hospital capacity only being used for low risk patients.[2]

Our paper contributes to two literatures. First, we build upon a small body of work that has examined the impact of private provider entry to elective markets in England (Cooper et al., 2018) and in the US (Courtemanche and Plotzke, 2010; Munnich and Parente, 2018).[3] This literature has focused on the consequences for existing providers following the entry of purpose-built surgical centres. Existing work on reforms in England has focused on the impacts of ISTC entry on the efficiency of incumbent public hospitals (Cooper et al., 2018) and on the patient mix treated at new providers and public hospitals (Street et al., 2010; Bardsley and Dixon, 2011; Chard et al., 2011; Cooper et al., 2018). The subsequent reform that allowed private hospitals to enter the market has received much less attention so far, despite generating a much larger expansion in the number of providers in the market. We therefore contribute to this literature by examining the impact of widespread private hospital entry on the size and shape of the elective market, and the consequences for patient outcomes.

Second, our findings complement the existing evidence on the impact of hospital competition and patient choice on patient outcomes (Kessler and McClellan, 2000; Propper et al., 2004; Cooper at al., 2011; Gaynor et al., 2013; Gaynor et al., 2016). The entry of private hospitals in England played an important role in expanding the choice set of healthcare providers for patients. Understanding the impact of this change as part of the wider set of reforms to healthcare provision is therefore important. Our results suggest that, in the case of the introduction of private hospitals into the NHS, the main benefits to patients accrued from having procedures that were delivered earlier or that would not otherwise have occurred. We find no benefits to patients in terms of improved quality, which is consistent with the reform generating limited competitive pressure for public hospitals to improve observable performance.

From a policy perspective, the role of the private sector in the NHS remains controversial more than a decade on from the original reforms. The opposition Labour Party's 2019 manifesto pledged to reduce the role of private providers, and the extent to which the NHS is included or excluded in any post-Brexit bilateral trade deals is a live political issue. This paper provides empirical evidence on the impact that the growth in private sector involvement had on patients and public hospitals in one area of NHS activity. Such evidence is often missing from current

[2]This may be because the facilities used are not appropriate for low risk patients, or because private hospitals cherry-pick low-risk patients (Bardsley and Dixon, 2011; Chard et al., 2011; Cooper et al., 2018.)

[3]Ambulatory Surgical Centres in the US play a similar role to ISTCs in England, competing with existing hospitals to provide routine procedures.

debates, and we would hope that our results could help policymakers to better understand the trade-offs when considering the role of the private sector in the NHS in future.

The rest of the paper is organised as follows. In Section 2 we describe the institutional setting and the private hospital reforms. Section 3 describes the data and provides descriptive evidence of the impact of private hospital entry. Section 4 sets out our empirical strategy and Section 5 presents out results. Section 6 provides suggestive evidence on the extent of substitution between public and privately funded procedures and changes to patient characteristics as a result of the reform. Section 7 concludes.

2 Institutional Background

The vast majority of health care in England is publicly funded and free at the point of use through the National Health Service (NHS). Secondary or hospital care has traditionally been delivered by publicly owned and operated NHS hospitals (henceforth 'public hospitals').[4] Patients access elective (planned) hospital services, such as hip replacements, through a referral from their primary care doctor or General Practitioner (GP). There are no self-referrals, and patients do not make any copayments. Hospitals are reimbursed by the government for the care they provide to patients, with hospitals receiving per patient payments according to a set of national tariffs.[5] NHS elective care is therefore rationed through waiting times rather than prices. Patients can however choose to pay for treatment privately in a private hospital. This accounted for a fifth of hip replacements in 2002 (Arora et al., 2013).

Historically, the NHS purchased small volumes of care from the private sector on an ad-hoc basis to address short-term capacity constraints.[6] From the mid-2000s, two related reforms formalised and greatly increased the ability of privately owned providers (known collectively as Independent Sector Providers, or ISPs) to compete with incumbent public hospitals for publicly funded patients. The first reform introduced privately-owned surgical centres - known as Independent Sector Treatment Centres (ISTCs) - that were specifically built to treat only publicly funded patients. The second reform then allowed pre-existing private hospitals to enter

[4]These hospitals are often grouped together to form NHS Acute Trusts. For ease of expression we will refer to these trusts as NHS or public 'hospitals' throughout.

[5]Hospital care is grouped into Healthcare Resource Groups (HRGs), which are similar to Diagnosis-related Groups in the US. Prices or tariffs are then set at a national level based on the average cost of providing the associated care. Small adjustments are made for unavoidable local differences in costs and length of stay.

[6]The 'private' or 'independent' sector include both profit-seeking and not-for-profit providers. We do not distinguish between these in our analysis.

the market to compete for publicly funded elective patients with incumbent public hospitals and ISTCs. In this paper, we examine the impacts of the second reform (the entry of pre-existing private hospitals) on the public and private market for elective hip replacements.[7]

ISTCs are privately owned and operated facilities designed specifically to treat public patients for routine procedures. This design reflected the focus of NHS policy in the early 2000s, which aimed to reduce the very long waiting times within the NHS, initially through strict waiting time targets backed with increases in funding.[8] The introduction of ISTCs was intended to allow public hospitals to focus on emergency care and elective cases that required more complex treatment in order to reduce waiting times and address NHS capacity constraints (Naylor and Gregory, 2009). The first contracts for ISTCs were signed in 2003, and public patients were treated from 2005 onwards.[9]

From 2006 onwards, pre-existing private hospitals were also allowed to enter the public elective market.[10] These providers could now compete with existing providers - including both public hospitals and ISTCs - to provide care to publicly funded patients at the same nationally set fixed price that was paid to public hospitals. This reflected a shift in NHS policy in the mid 2000s towards introducing consumer choice and competition between providers. The patient choice reforms of 2006 established a requirement for GPs to offer patients a choice of hospital when referring patients for almost all elective care.[11] New private sector entrants were therefore now intended to increase competition for NHS providers and to foster innovation among providers (Naylor and Gregory, 2009).

Unlike ISTCs, pre-existing private hospitals were allowed to treat publicly and privately funded patients alongside one another (Cooperation and Competition Panel, 2011). Over time, they overtook ISTCs to form the majority of private provision in this public market. By 2012/13,

[7] Throughout the paper, the term 'private hospitals' refers only to healthcare providers who treat privately-funded patients. Where relevant, ISTCs - who treat only public patients - are referred to as a separate provider.

[8] The first waiting times target was introduced in April 2001, with a maximum wait of 18 months between the decision to admit and inpatient admission. The target was reduced by three months each year. In December 2008 a new referral to treatment (RTT) target was introduced, with a maximum wait of 18 weeks between GP referral and inpatient admission. See Propper et al. (2010) for discussion and evidence on the waiting time targets that were implemented from 2000 onwards.

[9] A second round of ISTC contracts were signed in 2006, with patients treated from 2007 onwards in these facilities.

[10] Orthopaedic providers - the focus of this paper - were allowed to enter the market in 2006, but entry for other specialties was limited until 2008.

[11] Patients were initially offered a choice of 4 or 5 hospitals in 2006. The limit on the number of hospitals was then removed in 2008. This replaced a system where patients could state preferences but GPs were under no obligation to actively offer their patients a choice. These reforms were motivated by both the belief that patients valued the choice over their care, and evidence that health care competition (when prices were fixed) could improve quality (Gaynor, 2006).

95 of 119 (79.8%) ISPs operating in the market were pre-existing private hospitals rather than ISTCs, treating 72.5% of ISP patients while also continuing to treat privately funded patients.

Location decisions also varied across the two provider types. ISTCs were originally intended to be located in areas where local hospitals were lacking capacity or struggling to meet waiting time targets, and were frequently located on NHS sites (Naylor and Gregory, 2009). In contrast, virtually all of the private hospitals who entered the market from 2006 onwards were pre-existing private hospitals who now took the decision to treat publicly funded patients alongside their private patients. The location of these hospitals pre-date the announcement of the reforms. Barriers to entry into the private healthcare market in England are high, with relatively few openings and closures of private hospitals (Competition and Markets Authority, 2014) and so the scope to build additional facilities in response to the reform was, at least in the short run, very limited. Private hospital entry was therefore determined by management choices to use spare capacity to treat public patients, but this choice was restricted by the pre-reform location of the private hospitals.

The entry of private hospitals to the NHS elective market could have important implications for public sector capacity and quality of care. However, this policy reform has received relatively little attention in the existing literature, which has instead mainly focused upon the impact of waiting time targets (Propper et al., 2008 and 2010) and patient choice reforms (Cooper at al., 2011; Gaynor et al., 2013; Gaynor et al., 2016). Noticeably, the existing literature that does examine the impacts of private provider entry in England has focused on the impact of the ISTCs rather than the subsequent entry of pre-existing private hospitals to the market (and who now account for a much larger market share than the ISTCs). Cooper et al. (2018) examined the impact of the introduction of the ISTCs on the efficiency and casemix of existing public hospitals, and found that the opening of the ISTCs led to a costlier case-mix for nearby public hospitals but also improved their efficiency as measured by pre-surgery length of stay. These findings are consistent with other existing evidence that finds that patients treated by ISTCs were healthier and wealthier than those treated by public hospitals (Street et al., 2010; Bardsley and Dixon, 2011; Chard et al., 2011).[12] We build on this literature by examining the impacts of the wider introduction of private providers on the NHS elective market.

[12]Some of this sorting of less complex patients towards ISPs is a consequence of government regulations on which patients were eligible, as ISTCs do not have intensive care facilities, and reflects the early objective of the policy to allow public hospitals to focus on sicker patients. However, there remain concerns about the extent that ISTCs further adjusted their eligibility criteria to 'cherry-pick' the least costly patients (Audit Commission, 2008; Bardsley and Dixon, 2011; Cooper et al., 2018).

3 Data

3.1 Hospital records

Data on all publicly funded care comes from the inpatient Hospital Episode Statistics (HES), and covers the period from April 2002 to March 2013. In this paper we focus on publicly funded patients undergoing elective hip replacements.[13] This covers 615,281 patients over our 11 year period of interest, and includes both procedures conducted at public hospitals and publicly funded procedures conducted at ISPs (including both ISTCs and private hospitals). The inpatient data contain detailed information about the patient and the care they received, including their age, sex, GP practice, local area, admission type (emergency or elective) and dates, up to 20 diagnoses, all procedures patients receive, and a hospital identifier.

The data are linked to the precise geographic coordinates for all NHS, ISTC and private hospital sites. Patient locations are given by the centroid of their Middle Super Output Area (MSOA). MSOAs are statistical areas, similar to census tracts, with no administrative jurisdiction. There are 6,781 MSOAs in England, with an average population of 7,800 people in 2012/13.[14]

The introduction of private providers to the public market may also have impacted the private-pay market for hip replacements. As a result, in Section 6 we study whether there is any evidence of substitution between the public and private-pay markets as a result of hospital entry. However, while HES captures all activity that is either provided or funded by the NHS, the data do not contain information on privately financed procedures at private hospitals. We therefore augment HES with records from the National Joint Registry (NJR), an audit of all artificial joints that are used in the procedures. These data contain information on all hip and knee replacements in England regardless of the provider type and how the procedure is funded, and enable us to study overall volumes in both the public and private market. However, the data contain much less detailed information on the patient, and in particular where the patient lives. Whereas HES contains the MSOA of patient residence, the NJR only records the patient's postal district. These postal districts are larger, with 1,993 across England, and so contain more measurement error in distances between hospitals and patients. The data quality prior

[13] Hip replacements include those operations with Office of Population Censuses and Surveys (OPCS) Classification of Interventions and Procedures codes (4th Edition) beginning W37, W38, W39, W93, W94 and W95. Each operation code defines a different type of hip replacement. For a full list of OPCS codes see here: http://www.surginet.org.uk/informatics/opcs.php.

[14] We use 2001 MSOAs throughout. See https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/popu 11-23 for more details.

to 2008/09 is also somewhat poor, with missing procedures and missing information on how procedures are funded. As a result we carry out our main analysis using the more complete HES data where possible.

3.2 Defining hospital markets and exposure to private hospital entry

Our identification of the impact of private hospital entry on the market for publicly funded hip replacements arises from a comparison across areas or hospital 'markets' with differential levels of exposure to private hospital entry. In our baseline results, we define geographical hospital markets by assigning all (potential) patients to their nearest hospital, as measured by the straight line distance between the centriod of the patient's MSOA and the hospital.[15] This yields a 11-year panel of 130 hospital markets. We use this definition as patients typically receive secondary care from their nearest hospital, with 72% of hip replacement patients treated by their nearest hospital in 2002/03. The capacity of the nearest hospital will therefore play an important role in whether patients received a hip replacement, and the waiting time they would face.

We define high exposure areas as markets which contained a private hospital treating public patients in any of its MSOAs in 2012/13.[16] This measure therefore defines high and low exposure areas that are fixed over time, and facilitates a difference-in-difference specification that we set out in Section 4. This is a relatively conservative measure of exposure to private hospitals given that private hospitals entered the market in some areas at a later stage relative to others, and therefore would not expect to be affected by these providers throughout the entire policy period (2006/07 onwards). This is demonstrated by Table 1. The first column shows the total number of private hospitals conducting publicly funded hip replacements in England in each financial year. Until 2006/07, no private hospitals were operating on patients. After this, private hospitals started to enter, with the number of providers expanding much more rapidly from 2008/09. This pattern is mirrored by the percentage of markets that contained private hospitals treating public patients in each year (as shown in the second column), which increased rapidly in the late 2000s, reaching 55.4% by 2012/13.

[15] We use the location of the trust headquarters site in cases where multiple hospitals within the trust conduct elective hip replacements.

[16] This does not include ISTCs, whose presence we control for separately in all subsequent analysis. We include private hospitals conducting at least 20 hip replacements in a year to avoid confusing provider entry with small ad-hoc purchases of care from the private sector. Results are qualitatively unaffected by this restriction.

Table 1: Mean hospital market exposure to private hospitals, 2002/03 - 2012/13

Financial Year	Number of private hospitals treating public patients (1)	% of 'high exposure' markets (2)
2002/03	0	0.0%
2003/04	0	0.0%
2004/05	0	0.0%
2005/06	0	0.0%
2006/07	3	2.3%
2007/08	6	3.8%
2008/09	33	23.1%
2009/10	35	23.8%
2010/11	76	49.2%
2011/12	82	54.6%
2012/13	87	55.4%

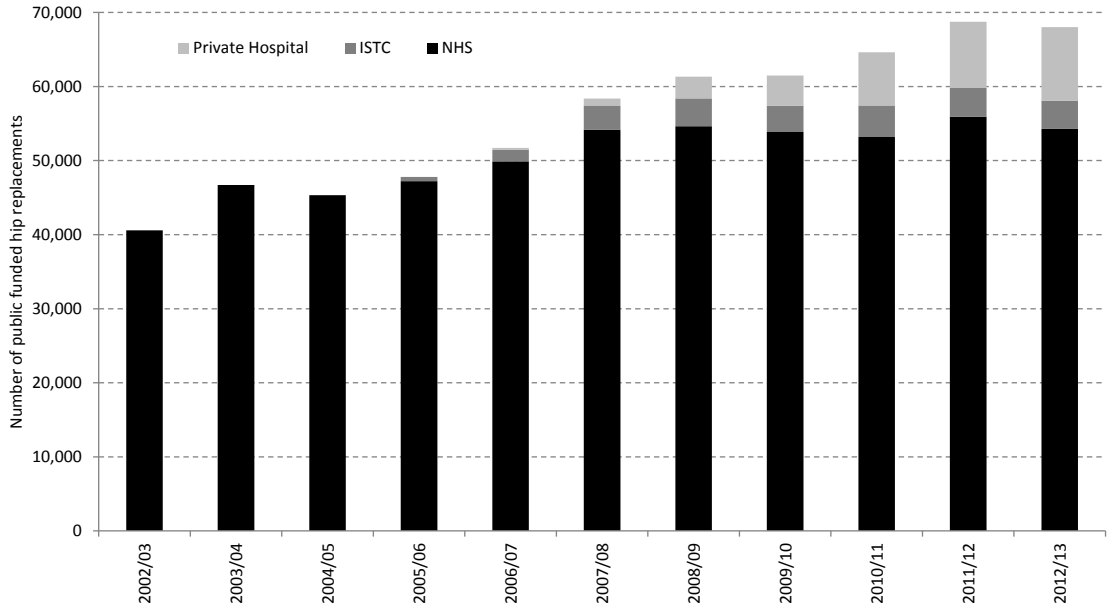
Notes: (1) Column 1 shows the total number of private hospitals in England who conducted at least 20 NHS-funded hip replacements in a given financial year under the Any Qualified Provider scheme; (2) Column 2 shows the percentage of markets that include a private hospital treating at least 20 NHS-funded hip replacement patients within their geographic region; (3) Distances are calculated using straight line distance measures between MSOA centroid and the coordinates of the NHS/private hospital.

3.3 Descriptive evidence of the impact of ISPs

Figure 1 shows the annual number of admissions for publicly funded hip replacements in England between 2002/03 and 2012/13. The number of procedures increased by 67.6% during this period, from 40,592 in 2002/03 to 68,031 in 2012/13. The figure also distinguishes between providers, and shows that the initial increases in admissions were driven by procedures carried out by public hospitals and then by ISTCs. After 2008/09, there was rapid growth in the number of admissions carried out by private hospitals. In 2012/13, public hospitals remained the dominant provider of publicly funded procedures, but private hospitals and ISTCs now provided 14.7% and 5.6% of procedures respectively, from a base of 0% 10 years previously.

This suggests that private hospitals were, at least in part, responsible for increasing the volumes of publicly funded procedures over this period. Figure 2 provides further support of this hypothesis by showing the growth in mean hospital market admissions distinguishing between areas with low and high exposure to private hospitals in 2012/13. Panel A shows the growth in levels and Panel B shows indexed growth relative to 2006/07 (the first year of private hospital entry). Trends in growth appear very similar in low and high exposure areas in the pre-policy period. After 2006/07, volumes grew in high exposure areas at a much quicker rate, particularly following an expansion in private hospital entry in 2008/09. Between 2006/07

Figure 1: The number of publicly funded hip replacements by provider type, 2002/03 to 2012/13

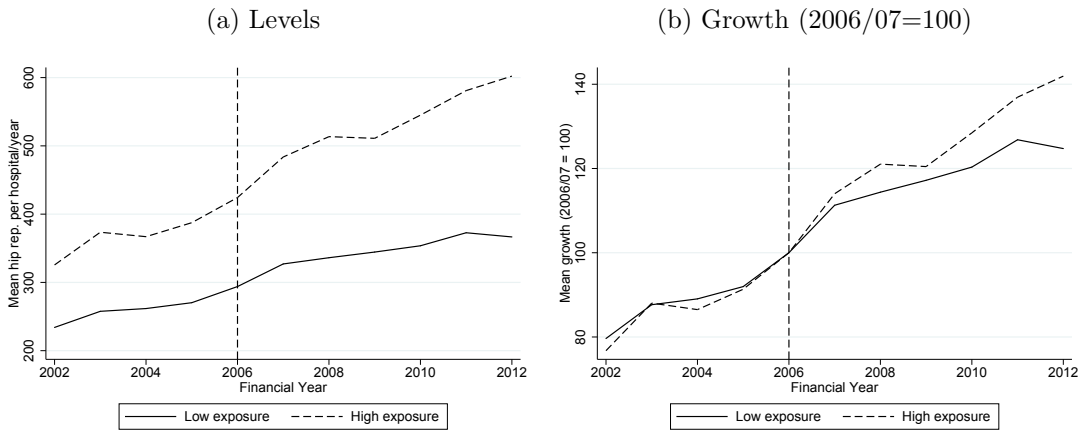


Notes: (1) Hip replacements include those operations with Office of Population Censuses and Surveys (OPCS) Classification of Interventions and Procedures codes (4th Edition) beginning W37, W38, W39, W93, W94 and W95. Each operation code defines a different type of hip replacement; (2) ISTCs are defined as providers operating under ISTC wave 1 or 2 contracts (data provided by Monitor); (3) Private Hospitals are defined as all other providers with a site code beginning with "N".

and 2012/13, admissions increased by 24.7% in areas where no private hospital treated public patients compared to 41.9% in areas with a private hospital active in the public market by the end of the period.

Figure 3 shows the the mean number of publicly funded admissions in each financial year conducted separately by public hospitals and private hospitals across low and high exposure markets. Panel A shows mean hip replacements conducted by public hospitals, and reveals only marginally stronger growth in low exposure relative to high exposure markets. This suggests that private hospitals had only a small impact on the number of admissions at existing public hospitals. By contrast, panel B shows substantially stronger growth in admissions for hip replacements conducted by private hospitals in high exposure markets relative to low exposure markets. This suggests that private hospitals were responsible for much of the growth in hip replacements over time, and these increases were concentrated (but not exclusively) in areas where public hospitals had higher exposure to private hospitals.

Figure 2: Mean publicly funded hip replacements per hospital market, by private hospital exposure in 2012/13



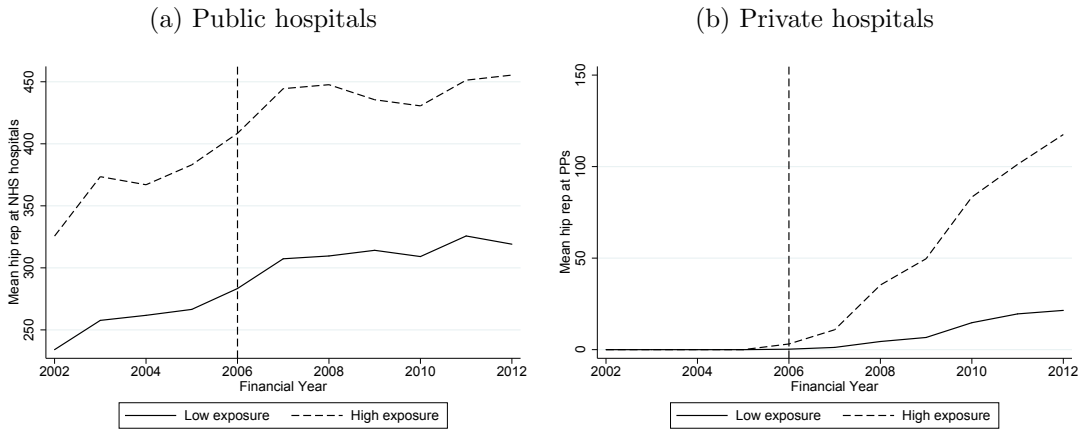
Notes: (1) Volumes include all publicly funded hip replacements (as defined in Figure 1) regardless of whether they were conducted by public hospitals or ISPs; (2) Patients are allocated to their nearest hospital regardless of where the surgery actually takes place; (3) High exposure areas are those with a private hospital treating public patients located within the market in 2012/13, low exposure areas are those without; (4) In Panel B growth figures are relative to 100 in 2006/07; (5) The vertical line (2006) denotes the year in which private hospitals first entered the market.

Panel A of Figure 4 shows a similar pattern for waiting times. It shows log median waiting times for each year of the period in low and high exposure areas. National waiting times fell considerably over this period of time, with parallel falls in low and high exposure areas prior to 2006/07. After the introduction of private providers, waiting times fell more rapidly in high exposure areas. This is consistent with the increase in capacity from these private hospitals contributing to falls in public waiting times. Panel B repeats this exercise for the log 30-day emergency readmission rate. While noisier than the other outcomes, trends prior to the reform are again similar across the high and low exposure areas and no obvious differences in overall patterns can be seen in the post-reform period.

Table 2 displays summary statistics for publicly funded hip replacement patients in 2002/03 and 2012/13. Mean patient age has fallen slightly over the period (from 68.4 to 68.2 years old) while the percentage of patients that are male (40%) has remained unchanged. The mean Charlson Comorbidity Index score has increased over time.[17] Length of stay and waiting times

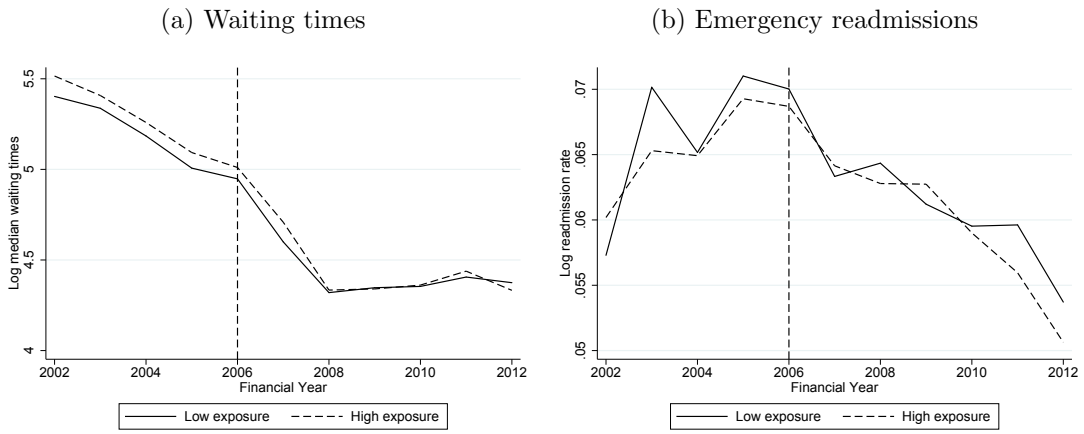
[17]The Charlson Comorbidity index measures the presence of 12 comorbidities (patients score between 0 and 12) with a higher score reflecting worse health. The increase in mean CCI score is the opposite of what we might expect if marginal patients are in better health. However, substantial increases in the number of secondary diagnoses recorded in HES over time by all (public and private) hospitals mean these changes are unlikely to be a genuine reflection of changes in patient health. Another option is to consider the Patient Reported Outcome Measures, which give detailed information about pre and post-operative health. However these data are only available from 2009 and are poorly recorded for private hospitals for the first few years, and are therefore non-randomly missing. We therefore do not use them.

Figure 3: Growth in mean market volume of publicly funded hip replacements (2006/07=100), by provider type and private hospital exposure in 2012/13



Notes: (1) Growth figures relative to 100 in 2006/07; (2) Panel A shows growth in hip replacements conducted by public hospitals, Panel B shows growth in hip replacements conducted by private hospitals; (3) High exposure areas are those with a private hospital treating public patients located within the market in 2012/13, low exposure areas are those without; (4) The vertical line (2006) denotes the year in which private hospitals first entered the market.

Figure 4: Log median waiting times and log 30-day emergency readmissions rates for publicly funded hip replacements between 2002/03 and 2012/13, by private hospital exposure in 2012/13



Notes: (1) In Panel A, waiting time measures the median number of days between the decision to admit a patient for a hip replacement and their admission date; (2) In Panel B, emergency readmissions measure the proportion of patients who experience an emergency inpatient readmission within 30 days of discharge after a publicly funded elective hip replacement; (3) High exposure areas are those with a private hospital treating public patients located within the market in 2012/13, low exposure areas are those without; (4) The vertical line (2006) denotes the year in which private hospitals first entered the market.

have fallen substantially, reflecting wider trends in the provision of NHS care.[18] Median length of stay fell from 9 days to 4 days over the period, and median waiting times fell from from 239 days in 2002/03 to 76 days in 2012/13. Outcomes also improved, with the 30-day emergency readmission rate falling from 6.1% to 5.2%, and the 30-day in-hospital mortality rate falling from 0.2% to 0.1%.

The table also highlights the differences in the patient mix treated by different providers by comparing the characteristics of all patients with those treated by private hospitals in 2012/13. Mean age is similar across the providers, but the Charlson index is lower at private hospitals. Length of stay is the same across providers, but waiting times are considerably lower at private hospitals. Median waiting times for private hospital patients were 35 days compared to an average of 76 days across all patients. Emergency readmission rates (to any public provider of care) are also lower at private hospitals (3.2%). These differences may reflect either differences in casemix or in the quality of the different providers.

Table 2: Patient characteristics and outcomes in 2002/03 and 2012/13, by provider

	2002/03		2012/13			
	All		All		Private hospital	
	Mean	SD	Mean	SD	Mean	SD
Mean age	68.4	11.9	68.2	11.5	68.0	10.7
Male	0.4	0.5	0.4	0.5	0.4	0.5
Charlson index	0.2	0.5	0.4	0.8	0.3	0.6
Median length of stay (days)	9.0	7.5	4.0	4.8	4.0	1.5
Median wait time (days)	239.0	168.5	76.0	67.2	35.0	101.7
30-day readmission (%)	6.1	23.9	5.2	22.2	3.5	18.5
30-day mortality (%)	0.2	4.0	0.1	3.1	0.1	3.0
Observations	40,592		68,031		9,974	

Notes: (1) In 2002/03, all NHS-funded patients were treated by NHS providers; (2) Charlson Comorbidity index measures the presence of 12 comorbidities (patients score between 0 and 12) with a higher score reflecting worse health; (3) Wait time measures the time (in days) between the consultant's decision to admit for surgery and the admission date; (4) 30-day readmission rates measure the % of patients who had an emergency readmission in the 30 days after they were discharged following their hip replacement; (5) The 30-day mortality rate refers to in-hospital mortality only (including the initial hospital spell and any subsequent readmission).

[18] Propper et al. (2008) and Propper et al. (2010) show that the majority of these falls in waiting times were due to the introduction of national waiting time targets.

4 Empirical Strategy

The descriptive evidence in the previous section suggests that the introduction of private hospitals to the public elective market had meaningful impacts on the number of admissions for publicly funded hip replacements and waiting times for these procedures. However, a variety of other changes may have taken place in different areas over time that may be conflated with the introduction of these providers. Understanding these impacts is important in understanding how private provider entry affected the overall market for publicly funded hip replacements, and its consequences for competition, public hospital performance and patient outcomes.

To estimate the impact of private hospital presence on the number of admissions, waiting times and outcomes for patients undergoing a publicly funded hip replacement we use a difference-in-difference framework, comparing changes in outcomes over time between areas with low and high exposure to these private hospitals by the end of the period. We estimate the following specification:

$$Y_{mt} = \beta_0 + \beta_1(E_m * post_t) + \beta_2 X_{mt} + \gamma_m + \lambda_t + \epsilon_{mt} \quad (1)$$

Y_{mt} is the outcome for patients living in market m in year t, including the number of admissions for publicly funded hip replacements (including all procedures conducted at public hospitals, ISTCs and private hospitals), median waiting times and the 30-day emergency readmission rate. E_m is a binary variable that takes the value of one if a private hospital that treated publicly funded patients in 2012/13 was physically located in the market, and zero otherwise. This is interacted with $post_t$, a binary variable that takes the value of one in years when private hospitals could treat publicly funded patients (2006/07 onwards). Our coefficient of interest is β_1, the impact of private hospital exposure by the end of the period on the market outcome for publicly funded patients. As noted above, we expect this to be a conservative measure of the impact of exposure to private hospitals as some markets may only have been exposed to private market entry in the final years of the reform period.

We include market (γ_m) and time (λ_t) fixed effects to control for permanent differences across markets and national time trends respectively. To control for contemporaneous shocks or trends that affect the outcomes in the area, and which are correlated with private hospital exposure, we also include a rich set of area level time-varying characteristics in X_{mt}. In all specifications these include: the age composition of the local population; the number of admissions for fractured

neck of femur and acute coronary syndrome to capture population need[19]; and the number of house sales and median house price to account for changes in economic conditions.[20] When examining the impact on waiting times and patient outcomes we also include direct controls for the characteristics of hip replacement patients as the introduction of new providers may have changed the attributes of patients undergoing treatment. This includes mean age, the proportion of patients who are male, and the mean Charlson score. The error term ε_{mt} is robust to heteroskedasticity and clustered at the market level.

X_{mt} also captures ISTC presence in the market. We measure this by including an analogous measure to our private hospital exposure: a binary variable that takes the value of one if an ISTC treated patients in 2012/13, and zero otherwise, interacted with a dummy variable that takes the value of one in years when ISTCs could treat publicly funded patients (2005/06 onwards, the year before private hospitals were allowed to enter). ISTCs may impact our outcomes of interest (for example, if they increase admissions) and their location may also be (negatively) correlated with private hospital entry if ISTCs were launched in areas where private hospitals were unlikely to enter the market. Controlling for their presence could therefore be important to avoid bias in our estimates. Given the aims of the policy, the coefficient on ISTC location - with ISTCs intended to be set up in areas with high waiting times - is likely to be endogenous. We therefore report these coefficients where appropriate to provide comparison with our estimated impacts of private hospital entry but do not claim these estimates capture causal impacts. We discuss these results in more detail in Appendix B.

The identifying assumption is that, conditional on our controls, exposure to private hospitals is otherwise uncorrelated with unobservable determinants of the outcomes. One threat to this assumption is any period-specific shock that differentially affected low and high private hospital exposure areas during this period. In particular, the decision of private hospitals to enter specific markets is likely to be related to other factors in the local area that may also determine the outcomes that we are interested in. This includes the decisions made by local NHS policymakers

[19]Fractured neck of femur and acute coronary syndrome are emergency conditions that typically affect older people, although the average age of patients is slightly higher than for elective hip replacements. As admissions are nearly always an emergency, admission rates should reflect patient need and be uncorrelated with the introduction of private providers, which only treat elective cases. Fractured neck of femur typically results in an emergency hip replacement, which uses the same surgeons and resources as elective hip replacements. Higher rates of fractured neck of femur admissions could therefore indicate both higher need in the population, as conditions such as osteoporosis increase the need for both elective and emergency hip replacements, and greater demand on local orthopedic units from emergency patients, which could result in longer waiting times for elective patients.

[20]Population need characteristics are calculated using HES. Information on house sales and prices comes from the Office for National Statistics (http://www.ons.gov.uk/ons/rel/regional-analysis/house-price-statistics-for-small-areas/1995-2013/index.html)

and providers when choosing whether and how much to expand local NHS capacity. For example, private providers may have chosen to enter markets where public investment in building NHS capacity was lower as they could profit from the larger (unmet) demand for publicly funded care in these areas. If this was the case, then our estimates on the impacts of private hospital presence on our outcomes would be downward biased as we would mistakenly attribute the impact of NHS funding decisions to private provider entry. Similarly, if NHS policymakers chose to invest less in areas in which private hospitals were known to be willing to operate, then estimates would also be biased downwards. In both cases, we would expect our analysis to understate the impact of private hospitals on the number of admissions, waiting times reductions and changes to readmission rates.

We address this concern by implementing an instrumental variables strategy, using the location of pre-existing hospital sites prior to the reform to instrument for private hospital presence in the public market by the end of the period. We construct this instrument in the following way. First, we create a dummy variable equal to one if a private hospital existed in the area in 2004 (prior to the policy period), and zero otherwise. Second, we interact the private hospital dummy with the $post_t$ dummy variable that takes the value of one in all years in which private hospitals were allowed to treat public elective orthopaedic patients (2006/07 onwards) and zero otherwise. This yields a time-varying variable for each financial year that indicates whether a pre-existing hospital site was located in the market and was allowed to treat public patients. We then instrument our private hospital exposure measure, $E_m * post_t$, with this variable.

For this instrument to be valid, pre-existing hospital sites should be correlated with the location of private hospital entry during the reform period (the relevance condition), and otherwise be unrelated to our outcomes of interest (the exclusion condition). Our instrument should fulfil both criteria. Private hospitals wishing to enter the public market require medical facilities in order to treat public patients. Almost all of these hospitals were built prior to the reforms, with public patients now treated alongside existing private patients. Historical presence of a private hospital should therefore be a very strong predictor of private hospital presence in the public market, and so fulfil the first criterion.

We use the location of private hospital sites in 2004 - before private hospitals were allowed to enter the NHS market for elective procedures. Our instrument should therefore fulfil the exclusion restriction, as we use only private hospitals that already existed prior to the decision

to allow private entry to the public market, and not any that could have opened in response to the reform. Furthermore, there are high barriers to entry and expansion into the private healthcare market in the UK (Competition and Markets Authority, 2014), and the stocks and locations of hospitals are relatively fixed in the short-term. This makes it unlikely that private hospitals would open specifically in areas where NHS volumes or waiting times were changing in a specific way immediately prior to the reform.

In Section 5.2 we consider two further threats to identification: the potential existence of non-parallel trends in our outcomes between areas which did and did not contain private hospitals in 2004, and any period-specific shocks that could differently affect areas with and without pre-existing private hospitals. In both cases, we show that our results are robust to these concerns.

5 Results

5.1 Baseline results

Table 3 shows the results of the analysis when using the number of publicly funded admissions for hip replacements as our outcome of interest. Column 1 reports the estimates from the fixed effects specification set out in equation 1. It shows a positive and statistically significant relationship between admissions and exposure to a private hospital by the end of the period: the presence of at least one private hospital treating public patients in the market by 2012/13 is associated with an annual increase of 26.6 procedures. This is equivalent to 9.3% of the mean number of admissions (285) in 2002/03.

As outlined above, we would expect this coefficient to be an underestimate of the true impact of private provider presence on publicly funded admissions if private hospitals chose to enter areas where publicly funded admissions would have increased more slowly in the absence of private provider entry. We therefore instrument the presence of private providers in 2012/13 with the location of private hospital sites in 2004. These sites were established prior to the implementation of the policy and should be independent of other policy decisions made during the reform period.

Column 2 reports the results from the first stage, where we regress our private hospital exposure measure on our time-varying instrument (private hospital location in 2004 interacted with a post-reform period dummy variable). This shows that there is a strong, positive rela-

tionship between private hospital location in 2004 and private hospital entry by 2012/13. The instrument is very strong, with a first stage F-stat of 87.2.[21] The strength of the instrument is not surprising, given that private hospitals that entered the market were principally existing private medical medical facilities, with very limited scope for opening additional facilities in the short run.

Table 3: Estimates of the impact of private hospital exposure in 2012/13 on volumes of publicly funded hip replacements, 2002/03 - 2012/13

	Volumes	Priv Hosp * Post	Volumes	Volumes (NHS only)
	OLS	OLS	IV	IV
	(1)	(2)	(3)	(4)
ISP in 2012/13 * Post	26.60***		33.75***	-0.76
	(8.96)		(13.00)	(14.85)
Priv Hosp in 2004 * Post		0.63***		
		(0.067)		
Hospital FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Number of hospitals	130	130	130	130
First stage F-stat	-	87.2	87.2	87.2
Observations	1,430	1,430	1,430	1,430
R-Squared	0.751	0.743	0.750	0.500

Notes: (1) ISP is a dummy variable that takes the value of one if a private hospital located in the hospital market treats public funded hip replacement patients in 2012/13; (2) Post is a dummy variable that takes the value of one in the post-reform period (2006/07 onwards); (3) All specifications control for the age-sex profile of the local population, number of emergency FNOF and ACS admissions of residents in the area, house sales and prices, an ISTC dummy (equal to one if an ISTC treated public patients in 2012/13) interacted with a dummy variable that takes the value of one from 2005/06 onwards (the first year of ISTC entry), and a full set of year and hospital market fixed effects; (4) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

Column 3 shows the results from the second stage. The estimates indicate that private hospital entry by 2012/13 increased the annual number of publicly funded admissions for hip replacements by 33.8, or 11.7% of the mean number of admissions in 2002/03. This estimate is statistically significant at the 1% level and is slightly higher than the OLS estimates. This suggests that private hospitals entered markets with otherwise slower growth in publicly funded admissions.

Column 4 repeats this analysis using admissions for hip replacements at public hospitals only. The coefficient is negative, but is small in magnitude and not statistically significantly

[21] We report the Kleibergen-Paap Wald rk F statistic in all cases.

different from zero. This is in direct contrast to the overall increases in publicly funded admissions. Private hospitals are therefore likely to be treating new patients rather than simply taking patient numbers from incumbent hospitals. This result is very similar to the findings of Courtemanche & Plotzke (2010), where entry of ambulatory surgical centres in the US resulted only in very small reductions in volume in local incumbent hospitals, and which were nowhere close to offsetting the activity undertaken by the new centres.

Table 4 repeats the analysis for the log of median waiting times and readmission rates at the hospital market level.[22] We might expect waiting times to fall as private hospitals enter the market, either due to increases in capacity reducing waiting lists for publicly funded patients or through public hospitals trying to lower waiting times to compete with private hospitals for patients. Column 1 indicates that the presence of a private hospital by 2012/13 was associated with a 6.0% reduction in median waiting times but this relationship is not statistically significant.

Table 4: Estimates of the impact of private hospital exposure in 2012/13 on log median waiting times and emergency readmissions for hip replacement patients, 2002/03 - 2012/13

	ln(median waiting time)			ln(readmissions)		
	All OLS	All IV	NHS only IV	All OLS	All IV	NHS only IV
	(1)	(2)	(3)	(4)	(5)	(6)
ISP in 2012/13 * Post	-0.055	-0.111*	-0.072	0.002	0.004	0.005
	(0.036)	(0.066)	(0.061)	(0.002)	(0.004)	(0.004)
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of hospitals	130	130	130	130	130	130
First stage F-stat	-	87.2	87.2	-	87.2	87.2
Observations	1,430	1,430	1,430	1,430	1,430	1,430
R-Squared	0.863	0.862	0.868	0.140	0.138	0.102

Notes: (1) ISP is a dummy variable that takes the value of one if a private hospital located in the hospital market treats public funded hip replacement patients in 2012/13; (2) Post is a dummy variable that takes the value of one in the post-reform period (2006/07 onwards); (3) All specifications control for the age-sex profile of the local population, number of emergency FNOF and ACS admissions of residents in the area, house sales and prices, and a full set of year and hospital market fixed effects; (4) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

As before, if private hospitals chose to enter in areas where waiting times were not expected to fall as quickly in the absence of the reform then the OLS estimates would underestimate the

[22] We calculate log outcomes as $\ln(1+y_{mt})$ to account for any zeros in the dependent variable.

impact of private hospital entry on waiting times. We therefore repeat our IV analysis. Column 2 shows the results for median waiting times for all publicly funded patients admitted for a hip replacement. The presence of a private hospital in the market by 2012/13 is now associated with a 11.1% reduction in median waiting times, and is statistically significant at the 10% level.[23] This is equivalent to a reduction of 27 days in 2002/03.

Column 3 repeats this analysis only for patients treated at a public hospital. The sign of the coefficient is again negative. However, it is smaller in magnitude than the reduction in waiting times for all publicly funded patients. It is also no longer statistically significantly different from zero. The majority of the gains for patients in terms of reduced waiting times therefore accrue to patients treated by private hospitals.

In Appendix Table B1, we also report the coefficients on ISTC presence from the same regressions described above. As for private hospitals, the OLS estimates show a negative association between ISTC presence and waiting times, but the magnitude of this coefficient is much larger than the comparable estimate for private hospitals, and is statistically significant at the 1% level. However, these results should not be treated as causal: unlike private hospital sites, ISTCs were specifically built in areas with long NHS waiting times. During this period, areas with longer waiting times would also been likely to receive additional funding or other interventions in order to reduce waiting times. The results therefore indicate that areas where ISTCs were established did successfully reduce their waiting times faster than areas without ISTCs, but we cannot distinguish whether this is due to the introduction of an ISTC or due to other factors.[24]

Columns 4-6 of Table 4 consider the impacts on readmission rates. The policy aimed to improve quality of care by stimulating competition on quality between existing public hospitals and newly entered private hospitals. Previous evidence from the NHS suggests that increased competition among public hospitals led to quality improvements (Cooper et al., 2011; Gaynor et al., 2013; Gaynor et al., 2016). Cooper et al. (2018) find that the entry of ISTCs led to improvements in efficiency as measured by falls in pre-operative length of stay at nearby public hospitals. However, a number of commentators raised concerns that private providers could perform lower quality work than public hospitals and also reduce staff availability (Royal College of Surgeons of England, 2006; Pollock and Godden, 2008).[25] As a result, the entry of

[23]The interpretation of the estimated coefficient is $\triangle y = 100(e^{\beta 1} - 1)$.

[24]This is consistent with Cooper et al. (2018), who in an appendix note that waiting times fell more quickly in areas with ISTCs but that these results cannot be interpreted as causal impacts of the ISTC reform.

[25]Most of this criticism was due to the early experience of patients treated by ISTCs rather than pre-existing

private hospitals could have plausibly had either a negative or positive effect on care quality. We therefore repeat the analysis for the log of 30-day emergency readmissions following a hip replacement to examine whether private hospital presence had any impact on patient outcomes. Columns 4 and 5 show the OLS and IV estimates for all publicly funded patients respectively. Column 6 repeats the IV analysis only for patients treated in public hospitals. In both cases the coefficient is not statistically significantly different from zero. We also repeated this analysis using 30 day in-hospital mortality and find no significant impacts.[26] This suggests that the introduction of private hospitals did not lead to either increases or decreases in quality on these measures. This is consistent with results for volumes and waiting times, where there is little evidence that public hospitals lost patient volumes as a result of private hospital entry.

Taken together, these results show that markets with higher exposure to private hospitals experienced stronger growth in admissions for publicly funded hip replacements than markets with lower exposure and faster reductions in waiting times. However, there was no accompanying impact on emergency readmission rates. The direction of the change in results between the OLS and IV estimates suggest that private providers entered markets that would have experienced smaller increases in capacity in the absence of the policy, although the differences in the size of the estimates is not particularly large. As a result, the OLS estimates appear to slightly underestimate the impact on admissions and waiting times. For public hospitals, results are consistent with private providers exerting very limited competitive pressure on the public incumbents. There are no statistically significant impacts on volumes at public hospitals and consequently therefore no changes in revenue. Nor is there any evidence of quality improvements or attempts to match waiting times at private hospitals, which might indicate that public hospitals had reacted to protect their existing volume. If public hospitals did adjust care quality in response to the entry of private providers, they did so in ways that would be hard to observe to either researchers or patients.

5.2 Robustness checks

There may still be a number of remaining threats to identification. We now examine these threats in detail and set out a range of robustness checks to test our results.

Our identifying assumption that exposure to private hospitals is uncorrelated with the un-

private hospitals but the same concerns exist for both sets of providers

[26] Results not shown but available upon request.

observable determinants of the outcomes in our error term could be violated by the existence of non-parallel trends in outcomes across areas with and without pre-existing private hospitals during the period prior to the reform. A visual examination of Appendix Figures A1-A3 suggests there were no obvious differences in the pre-reform period in any of our outcomes of interest. Here we examine these trends more formally, by regressing the outcomes on our time-varying controls, market and time fixed effects, and a set of interactions between private hospital presence in 2004 and year dummy variables (excluding 2006, the first year of the reform).

Table 5 shows the results. In all cases, there is no evidence of any pre-trends, with no statistically significant coefficients on the interaction terms prior to 2006. However, there are statistically significant differences in the period after the reform. The impacts on the number of admissions increase over time, with particularly large growth in the effect on volumes in areas with private hospitals in the last 2 years (the period when many private hospitals had entered the public market). The magnitude of waiting times reductions increased up to 2009/10 before plateauing in the final years. There are no statistically significant impacts on readmissions in any year and all coefficients are very small in magnitude.

A second threat to identification is any period-specific shocks that differentially affected areas with and without pre-existing private hospitals over the period of interest. These shocks could take the form of different trends in demands in areas with and without private hospitals, or the wider impacts of the choice reforms that took place at the same time as private providers were allowed to enter the public market.

To address concerns about different trends in demand across areas we carry out two robustness checks. First, we repeat the IV analysis including a full interaction between our control variables and time-dummies. This controls for time-trends in a variety of elements of demand for hip replacements in the local area. Columns 1-3 in Table 6 shows the results of this exercise. Our main results are qualitatively unchanged by the inclusion of these time trends.

Second, we can also consider whether there is evidence of differences in demand trends across areas with and without private hospitals by examining whether our outcomes vary across areas with pre-existing private hospitals who didn't enter the public market, and areas where there were no private hospitals in the first place. To do this, we estimate an augmented version of equation 1, replacing our exposure measure (E_m) with a variable that sorts markets into three categories: (i) areas without a private hospital in 2004, (ii) areas with a private hospital in 2004 that had not entered the public market by 2012/13, and (iii) areas with a pre-existing

Table 5: Estimated impacts of private hospital exposure by financial year, 2002/03 - 2012/13

	Volume	ln(med wait)	ln(readmit)
	(1)	(2)	(3)
Trends in pre-reform period			
Priv hospital in 2004 * 2002/03	7.87	0.08	-0.002
	(11.23)	(0.06)	(0.005)
Priv hospital in 2004 * 2003/04	12.93	0.03	-0.007
	(10.27)	(0.05)	(0.006)
Priv hospital in 2004 * 2004/05	2.47	0.01	-0.0011
	(9.47)	(0.04)	(0.004)
Priv hospital in 2004 * 2005/06	-9.91	0.01	0.001
	(8.15)	(0.02)	(0.004)
Trends in post-reform period			
Priv hospital in 2004 * 2007/08	15.12*	0.01	-0.005
	(9.04)	(0.03)	(0.004)
Priv hospital in 2004 * 2008/09	20.65*	-0.02	0.002
	(11.06)	(0.05)	(0.005)
Priv hospital in 2004 * 2009/10	22.10	-0.09*	-0.003
	(14.29)	(0.05)	(0.005)
Priv hospital in 2004 * 2010/11	27.27	-0.07	0.001
	(16.67)	(0.05)	(0.005)
Priv hospital in 2004 * 2011/12	44.39**	-0.06	0.002
	(17.57)	(0.05)	(0.004)
Priv hospital in 2004 * 2012/13	42.42**	-0.07	0.004
	(18.65)	(0.06)	(0.004)
Area controls	Yes	Yes	Yes
Patient controls	No	Yes	Yes
Year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes
Number of hospitals	130	130	130
Observations	1,430	1,430	1,430
R-Squared	0.752	0.860	0.146

Notes: (1) Priv hosp is a dummy variable that takes the value of one if a private hospital was located in the hospital market in 2004; (2) All specifications control for the age-sex profile of the local population, number of emergency FNOF and ACS admissions of residents in the area, house sales and prices, and a full set of year and hospital market fixed effects; (3) Patient controls include the mean age, gender and Charlson Comorbidity Index score of patients undergoing an elective hip replacement; (4) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

Table 6: Estimates of the impact of private hospital presence on outcomes under alternative specifications, 2002/03 - 2012/13

	Volume IV (1)	ln(med wait) IV (2)	ln(readmit) IV (3)	Volume IV (4)	ln(med wait) IV (5)	ln(readmit) IV (6)
ISP presence						
ISP in 2012/13 * Post	26.79*	-0.160*	0.003	31.58**	-0.106	0.005
	(14.48)	(0.084)	(0.005)	(14.47)	(0.068)	(0.004)
Pre-reform HHI						
HHI * Post				31.96	-0.077	-0.022***
				(22.72)	(0.119)	(0.007)
Area controls	Yes	Yes	Yes	Yes	Yes	Yes
Patient controls	No	Yes	Yes	No	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls x Year FE	Yes	Yes	Yes	No	No	No
Hospital FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of hospitals	130	130	130	130	130	130
Observations	1,430	1,430	1,430	1,430	1,430	1,430
R-Squared	0.785	0.875	0.244	0.747	0.859	0.152

Notes: (1) ISP is a dummy variable that takes the value of one if a private hospital located in the hospital market treats public funded hip replacement patients in 2012/13; (2) Controls in all specifications are the same in Table 3; (3) Patient controls include the mean age, gender and Charlson Comorbidity Index score of patients undergoing an elective hip replacement; (4) Columns 1 - 3 include SHA-specific time-trends; (5) HHI in market m is the weighted average of the HHI of all MSOAs included in the market area, using the share of market m hip replacement patients who live in each MSOA as weights, for the period between 2002/03 and 2004/05. (6) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

private hospital treating public patients in 2012/13.[27] Table 7 shows the results for each of our outcomes. The estimates show a negative and statistically insignificant relationship between volumes and areas with a private hospital that had not entered the market (relative to volumes in areas with no private hospital). Similarly, there is no significant impact on waiting times or readmission rates. In contrast, the estimated impact of the entry of a private hospital entering the public market is consistent with our previous results. This suggests that the results are robust to concerns surrounding demand shocks during this period, including concerns that NHS policymakers may purposely have invested differently in areas where private hospitals existed before the reform.

We also examine the extent to which the wider patient choice reforms may explain our results. The patient choice reforms took place during an overlapping period, with elective patients offered a choice of at least four providers in 2006 and any publicly funded provider

[27] 30 of the 100 markets with private hospitals in 2004 had no private hospitals treating public patients in 2012/13.

in 2008. If private hospitals were introduced in areas with greater numbers of pre-existing alternative public hospitals - and therefore greater choice - then any changes in outcomes may be caused by patient choice rather than the introduction of a private hospital into the market. We therefore examine whether our results are affected by controlling for the local pre-reform level of competition. To control for competition in the local area we calculate the Herfindahl-Hirschman Index (HHI) for each public hospital in the period between 2002 and 2004, and interact this measure with a dummy variable that takes the value of one during the reform period (2006/07 onwards) and zero otherwise.[28] If our results are driven by the choice reforms then we would expect the inclusion of a measure of potential choice to substantially attenuate our results. Columns 4-6 of Table 6 show the results for each of our outcomes of interest. The results are again substantially unaltered. The only difference is that the estimate on waiting times is no longer statistically significant as a result of being slightly smaller in magnitude.

Table 7: Estimates of the impact of ISPs and private hospital presence, 2002/03 - 2012/13

	Volume OLS (1)	ln(med wait) OLS (2)	ln(readmit) OLS (3)
ISP presence in 2012/13			
(Priv hosp & no ISP) * Post	6.66	-0.026	0.0006
	(10.60)	(0.054)	(0.0032)
Any ISP * Post	29.81***	-0.068	0.0018
	(10.55)	(0.045)	(0.0024)
Area controls	Yes	Yes	Yes
Patient controls	No	Yes	Yes
Year FE	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes
Number of hospitals	130	130	130
First stage F-stat	165.8	165.8	165.8
Observations	1,430	1,430	1,430
R-Squared	0.751	0.863	0.140

Notes: (1)'Priv hosp & no ISP' is a dummy variable that takes the value of one if there was a private hospital in the area in 2004 and no private hospital treating public patients in 2012/13; (2) Any ISP is a dummy variable that takes the value of one if a private hospital was treating public patients in 2012/13; (3) All specifications control for the age-sex profile of the local population, number of emergency FNOF and ACS admissions of residents in the area, house sales and prices, and a full set of year and hospital market fixed effects; (4) Patient controls include the mean age, gender and Charlson Comorbidity Index score of patients undergoing an elective hip replacement; (5) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1. (6) Reported F-stat is the Cragg-Donald Wald F statistic (multiple endogenous regressors).

[28] We calculate the HHI for each MSOA in market m, and take the weighted average HHI for market m using the share of m's patients who live in each MSOA as weights. We use the pre-reform HHI data (2002/03 to 2004/05) to remove any endogenous effects of the introduction of the private provider on the level of competition in the area, and include only public hospitals.

6 Mechanisms

Our estimates indicate that the entry of private hospitals to the public market led to increases in the number of publicly funded hip replacements. Ideally, we would like to identify who benefits from the reform and who the 'new' patients are. This is difficult as we do not observe the identity of the marginal patient. However, we can provide suggestive evidence on two margins. First, we can examine whether these additional procedures represent an overall expansion in the number of hip replacements that take place nationally each year (irrespective of funding source), or whether these procedures simply represent a switch from patients who would have previously paid for a hip replacement privately. Second, as care is rationed at least in part on need, we would expect patients further down the waiting list to be healthier on average. We therefore examine whether patients are observably healthier on average than they would have been in the absence of private hospital entry.

To examine these margins we use data from the National Joint Registry (NJR), which is a registry of all joint replacements in England, including hips, regardless of funding source.[29] This means we have information on the volumes of both privately and publicly funded procedures. Individual level patient data for privately financed care is very unusual in England, and this coverage is an important strength of the data. These data will also allow us to examine whether our previous results are robust when using a different dataset for a similar analysis.

However, the data also have two weaknesses which make them unsuitable for our main analysis. First, the geographic information for each patient is less detailed than in HES. While HES contains the MSOA of each patient, the NJR only records the patient's postal district. These postal districts are much larger than MSOAs, with 1,993 across England compared to 6,781 MSOAs. As a result, there is greater measurement error when assigning postal districts to their nearest hospital. Despite this, both the NJR and HES data produce similar volumes of publicly funded hip replacements over the period between 2008/09 and 2012/13: Appendix Figure A4 shows aggregate volumes in the NJR are slightly above those recorded in HES, but they show a similar trend in growth from 2009/10 onwards. We also show in Appendix Figure A5 that there is a strong positive correlation (0.87) between annual NHS volumes in the two datasets.

[29]The registry now covers hip, knee, ankle, elbow and shoulder joint replacements and contains more than 2.9 million records, making it the largest such database in the world. See https://www.hqip.org.uk/national-programmes/joint-replacement-surgery-the-national-joint-registry for more details.

Second, the NJR data quality prior to 2008/09 is poor, with a lot of missing information on how procedures are funded. As a result, the data do not include the pre-reform period. This precludes the exact empirical design that we previously used as we no longer have time variation in when private hospitals were allowed to operate. In this section we therefore instead exploit the exact timing of private hospital entry to the public market within hospital market areas to identify the impact of private hospital entry on both publicly and privately funded hip replacements (rather than studying fixed treatment and control groups as in our baseline analysis). To do this we estimate the following equation:

$$Y_{mt} = \beta_0 + \beta_1 E_{mt} + \beta_2 X_{mt} + \gamma_m + \lambda_t + \epsilon_{mt} \tag{2}$$

where Y_{mt} is the volume of publicly or privately funded hip replacements for patients living in market m in year t (regardless of their actual location of treatment), and E_{mt} is a time-varying binary measure that takes the value of one if an ISP was located in the market in year t, and zero otherwise. We again include market and time fixed effects. The coefficient of interest β_1 now represents the association between private hospital entry and the contemporaneous number of admissions for publicly and privately funded hip replacements in the local area. All standard errors are clustered at the hospital market level.

One consequence of this research design is that we can no longer use pre-existing hospital location to instrument private hospital entry. This is because the location of these hospitals does not vary over time, and would therefore be absorbed by the inclusion of area fixed effects. From our previous results, this suggests that we are likely to slightly underestimate the impact of private hospital entry on the number of publicly funded admissions in our OLS results. For privately funded admissions, we would expect the opposite effect: if private hospitals enter public markets in areas where private admissions are falling for other reasons, this would generate a negative correlation between private admission volumes and private sector entry to the public market which is not driven by entry to the public sector. As a result, we would expect to see a larger (more negative) estimated coefficient on private hospital entry than the true effect. These results should therefore be viewed as suggestive evidence rather than definitive causal impacts.

Table 8 shows the results. In column one the outcome is the volume of publicly funded hip replacements as recorded by HES. The estimates indicate that the presence of a private hospital in the local public market in a given year is associated with an increase of 28.9 publicly funded

hip replacements. This result is statistically significant at the 1% level and is consistent with the difference-in-difference results shown in Column 1 of Table 3.

Table 8: Estimates of the impact of private hospital exposure on hip replacement volumes by data and funding source, 2008/09 - 2012/13

	Volume of hip replacements			
	NHS (HES)	NHS (NJR)	Private (NJR)	All (NJR)
	(1)	(2)	(3)	(4)
ISP market presence				
Any ISP	28.87***	22.12***	2.52	24.64***
	(8.24)	(8.45)	(2.28)	(8.53)
Controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes	Yes
Number of hospitals	130	130	130	130
Observations	650	650	650	650
R-Squared	0.430	0.498	0.175	0.444

Notes: (1) The outcome in column 1 is the volume of NHS-funded hip replacements as recorded by HES, while the outcome in columns 2-4 are the volume of NHS-funded, privately-funded and total hip replacements respectively as recorded in the NJR; (2) All specifications control for the age-sex profile of the local population, number of emergency FNOF and ACS admissions of residents in the area, house sales and prices, and a full set of year and hospital market fixed effects; (3) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

In column two we repeat this analysis using the volumes of publicly funded hip replacements as recorded in the NJR as the outcome. The estimates indicate that the presence of a private hospital operating in the local public market was associated with an increased NHS volume of 22 hip replacements. The results are slightly less precise (but remain significant at the 1% level) but are consistent with the results using HES data in column one. Again, the result is consistent with our results in Section 5, but this time using an alternative data set.[30]

In column three we use the number of privately funded admissions for hip replacements as the outcome. In contrast to strong association with public volumes, we do not find any statistically significant relationship between private hospital presence in the public market and the number of private admissions. If there was substitution between funding sources due to private hospital entry into the public market then we would expect to find a negative coefficient. However, the estimated coefficient is small and positive, and is not statistically significant different from zero.

[30]These results can also be seen as an additional robustness check for our baseline results, with estimation using a separate data source providing qualitatively unchanged results.

This suggests that any substitution between public and privately funded hip replacements is minimal.

Combining the volume of public and private hip replacements gives a measure of the total number of hip replacements carried out in England in each year. In column four we use total volumes as the outcome. The results indicate that private hospital entry to the public market was associated with an increase in the total size of the hip replacement market, with the presence of a private hospital in the local area increasing total annual number of admissions for a hip replacement by 24.6 (statistically significant at the 1% level). This compares to a mean volume of 527 in 2008.

Taken together, these results suggest that the introduction of private hospitals to the public elective market led to an increase in the overall size of the market for hip replacements in England. The additional admissions for publicly funded procedures do not appear to represent financial transfers from the government to patients who would have previously financed their own treatment. Instead, the additional procedures are genuinely new procedures that would not have taken place (at least in a given year) in the absence of private sector entry. This is also consistent with the aggregate trends in Appendix Figure A4, which shows only a small decline in privately financed procedures during a period which publicly funded procedures grew sharply.

Given that care is in part rationed on the basis of need, new patients (who now receive hip replacements when previously they would not) should be slightly healthier than patients who would have received a hip replacement even in the absence of the reform. While we do not observe who the marginal patient is, changes in the characteristics of 'new' patients should have a small effect on the characteristics of the average patient. We can therefore test whether private hospital entry to the public market is associated with reductions in observable measures of patient severity.

Table 9 shows the results of this exercise. In columns one and two we use the HES data to estimate our IV specification to examine the impact of private hospital presence on the mean Charlson score and mean age of publicly funded patients respectively. In both cases the coefficient is negative, suggesting that patients are less severe on average, but is only significant in the case of the Charlson score. The estimates indicate that publicly funded patients in areas with private hospitals operating by the end of the period had 0.04 fewer severe comorbidities than patients in areas where they did not, or about 10% fewer severe comorbidities than those

Table 9: Estimated association between private hospital presence and publicly funded patient characteristics

	Mean Charlson	Mean Age	Healthy (ASA grade)
	HES	HES	NJR
	IV	IV	OLS
	(1)	(2)	(3)
Private hospital presence in 2012/13			
ISP * Post	-0.0438**	-0.229	
	(0.0188)	(0.226)	
Time-varying hospital presence			
ISP in year t			0.00960*
			(0.00574)
Area controls	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of hospitals	130	130	130
First stage F-test	87.2	87.2	-
Observations	1,430	1,430	650
R-squared	0.687	0.129	0.215

Notes: (1) 'ISP' is a dummy variable that takes the value of one if a private hospital located in the hospital market treats public funded hip replacement patients in 2012/13; (2) 'ISP in year t' is a dummy variable that takes the value of one if a private hospital located in the hospital market treats public funded hip replacement patients in year t; (3) All specifications control for the age-sex profile of the local population, number of emergency FNOF and ACS admissions of residents in the area, house sales and prices, and a full set of year and hospital market fixed effects, and column (3) includes an additional control for the ASA grade of private hip replacement patients in the local area. (4) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

in these control areas.

Given concerns that the HES data does not accurately record comorbidities, we would also like to examine patient severity in a separate data source.[31] To this end, in column three we use the NJR data to estimate our fixed effects specification using the proportion of publicly funded patients in the area who were rated as 'healthy' on the American Society of Anesthesiologists (ASA) classification.[32] Again, we find evidence of improved health among patients: private hospital presence in a given year is associated with an additional 1% of publicly funded patients being rated as 'healthy' prior to the surgery. This relationship is significant at the 10% level. This means that both analyses, using two distinct data sources, indicate that patients have

[31]In the previous results, we address concerns that comorbidites have been recorded more accurately by all hospitals in HES over time by including year fixed effects. However, if private hospitals were slower to record comorbidities then we could overstate the impact of private hospital entry on average patient severity using this measure.

[32]The ASA scale grades patients into 6 categories based on a number of risk factors. Patients ranked as 'ASA 1' are considered to be a normal, healthy patient (Doyle and Garmon, 2019). The NJR reports the ASA grade as recorded by the surgeon prior to surgery for each patient but not the underlying risk factors.

become observably less severe as a result of private hospital entry.

Taken together, the results in this section provide suggestive evidence that private hospital entry to the public market was accompanied by a genuine expansion in the number of elective procedures. Privately financed admissions did not fall sharply in areas where private hospitals entered the public market, and patients became healthier on observable measures in these areas. Such findings are consistent with an expansion in the overall market for elective hip replacements enabling less severe patients to receive a hip replacement when in the absence of the reform they would not have received this treatment.

7 Discussion

Moves to increase the role of patient choice and promote competition between healthcare providers have been a common feature of healthcare policy across the developed world in recent years. These reforms aimed to improve efficiency among providers and to improve the quality of care provided to patients. An important component of such reforms has been the entry of new providers to compete with existing hospitals. However, despite the potential implications of such reforms relatively little is understood about the impacts of this provider entry on the structure of the elective market, incumbent providers and patient outcomes.

In this paper, we study the impacts of the entry of private hospitals on the publicly funded elective market for hip replacements. We exploit variation in the exposure to provider entry across geographic areas and the location of pre-existing private hospitals to study the impact of private hospital entry on the number of publicly funded admissions, the waiting times and readmission rates of public patients, and the size of the privately funded market.

We find that private hospital entry led to a sizeable increase in the local capacity to provide publicly funded elective care. The entry of a private hospital was associated with a 12% increase in the annual volumes of publicly funded hip replacements, and an 11% reduction in waiting times for those that had the procedure. However, the competitive impacts on incumbent public providers appear to be muted: the caseload of existing providers did not fall when exposed to private hospital entry, and quality as measured by readmission rates was not reduced. The growth in the overall size of the market, and the lack of an impact on incumbent public hospitals, is consistent with the conflicting aims of NHS policies in the 2000s. The focus on reducing waiting times and increasing activity, backed by relatively generous funding settlements for the

NHS, created an environment where the markets for elective healthcare could expand quickly. This made it harder to achieve the objective of using competitive pressure from private entrants to improve the quality in public hospitals, as public hospitals could replace patients who chose private hospitals with those next on the waiting list.

We also examined the effects on the private market. Using a novel dataset on privately funded hip replacements, we analysed the separate impacts of private hospital entry on the size of the public, private and total market for elective hip replacements. Using these data, we corroborated our finding that private provider entry into the public market increased the number of publicly funded admissions, while having no observed impact on the size of the private market. Examining the impact of entry on observable measures of severity for public patients also suggested that average patient severity has decreased. Taken together, this evidence suggests that the reform expanded the market for hip replacements, and treated more, and increasingly healthy, patients.

These findings have important policy implications. For public healthcare systems, our results show that it is possible to use the private sector to increase capacity over a relatively short period. However, the introduction of private entrants alone will not be sufficient to drive improvements in quality and efficiency in incumbent hospitals. Policymakers must think carefully about the impact that entry may or may not have on incumbent incentives. The pattern of our results, with the entry and expansion of new providers increasing the market size and relatively little impact on incumbent volumes, are very similar to ambulatory surgery centers in the US (Courtemanche & Plotzke, 2010), despite large differences in how healthcare is organised and paid for across the two countries. Changes in the location of healthcare facilities will affect the volume and pattern of use, and policymakers may wish to take this into account when making decisions.

For the UK, the role of private hospitals and the private sector more generally within the NHS remains politically controversial. We provide some empirical evidence around one area where use of the private sector has grown over the past two decades, and the implications of that for patients and public hospitals. In an environment where the NHS budget is growing more slowly and there are ever increasing pressures from an ageing population, policymakers will need to trade off the additional capacity and lower waiting times enabled by allocating greater resources to private sector hospitals, against competing demands from within the publicly owned health system.

In any case, meeting the challenges of providing additional care in future is unlikely to be met through a large expansion in the purchase of private capacity alone. While our research examined one specific example of an expansion in the supply of publicly funded healthcare, it is unclear how the impacts of private hospital entry could differ from an expansion in supply through building new or expanding existing public hospitals. Developing further knowledge about the relative cost and benefits of these different approaches to expanding supply should therefore be a priority for future work in this area.

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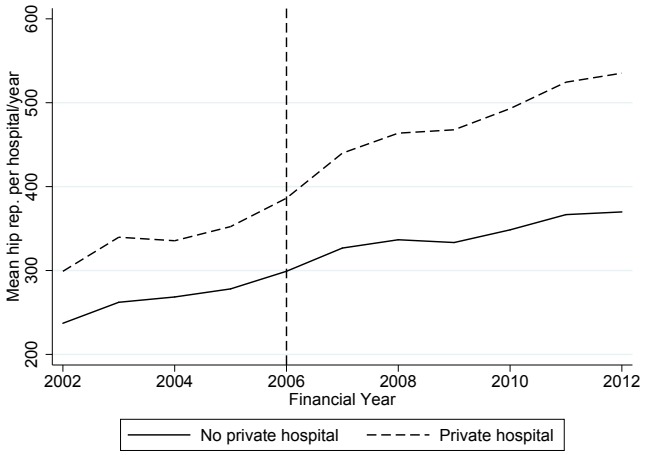
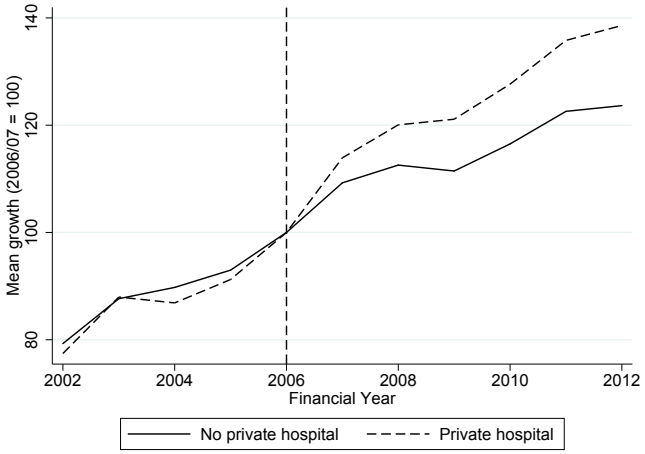
A Online Appendix: Additional Figures and Tables

Figure A1: Mean publicly funded hip replacements per hospital market, by the presence of a private hospital in 2004

(a) Levels



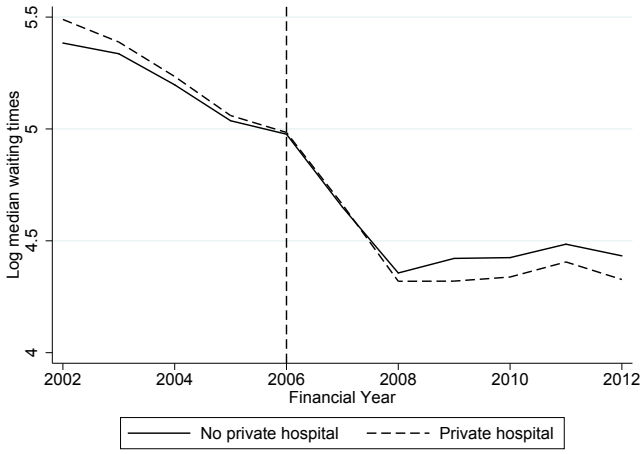
(b) Growth (2006/07=100)



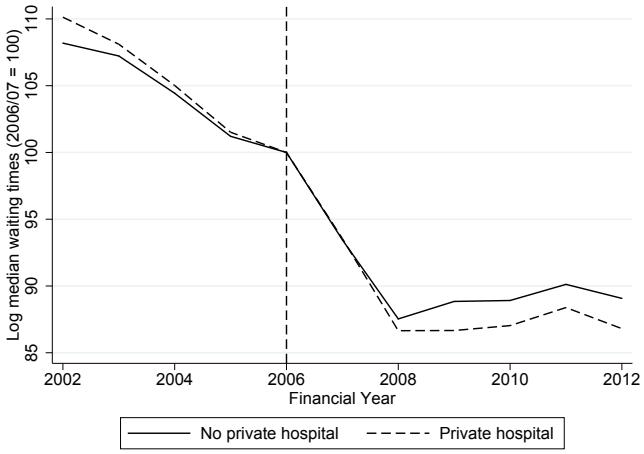
Notes: (1) Volumes include all publicly funded hip replacements (as defined in Figure 1) regardless of whether they were conducted by public hospitals or ISPs; (2) Patients are allocated to their nearest hospital regardless of where the surgery actually takes place; (3) Private hospital areas are those which contained a private hospital in 2004; (4) In panel B growth figures are relative to 100 in 2006/07; (5) The vertical line (2006) denotes the year in which private hospitals first entered the market.

Figure A2: Log median waiting times for publicly funded hip replacements between 2002/03 and 2012/13, by private hospital presence in 2004

(a) Levels



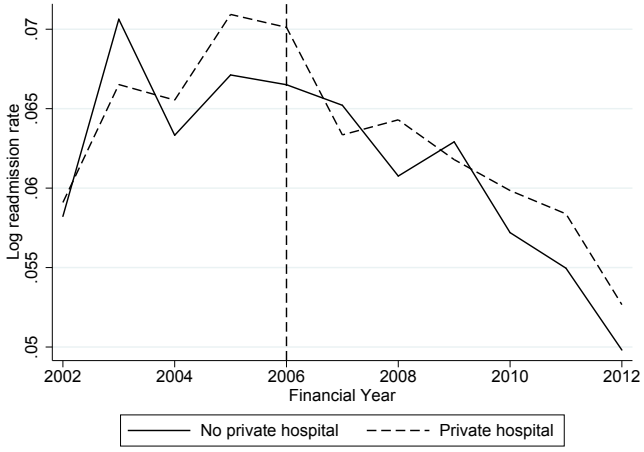
(b) Growth (2006/07=100)



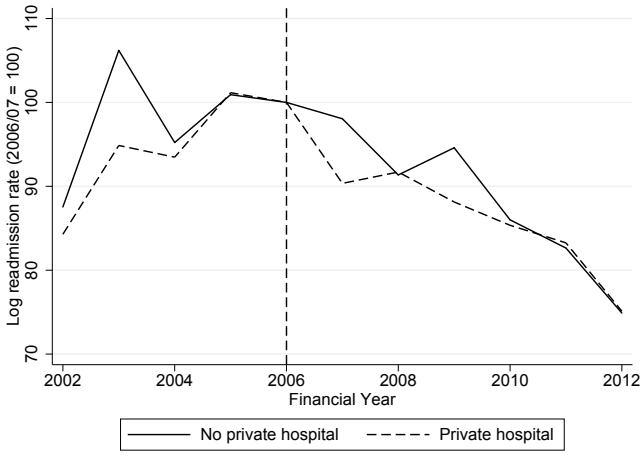
Notes: (1) Changes relative to 100 in 2006/07; (2) Waiting times measures the median number of days between the decision to admit a patient for a hip replacement and their admission date; (3) Private hospital areas are those which contained a private hospital in 2004; (4) The vertical line (2006) denotes the year in which private hospitals first entered the market.

Figure A3: Log 30-day emergency readmissions rates for publicly funded hip replacements between 2002/03 and 2012/13, by private hospital presence in 2004

(a) Levels

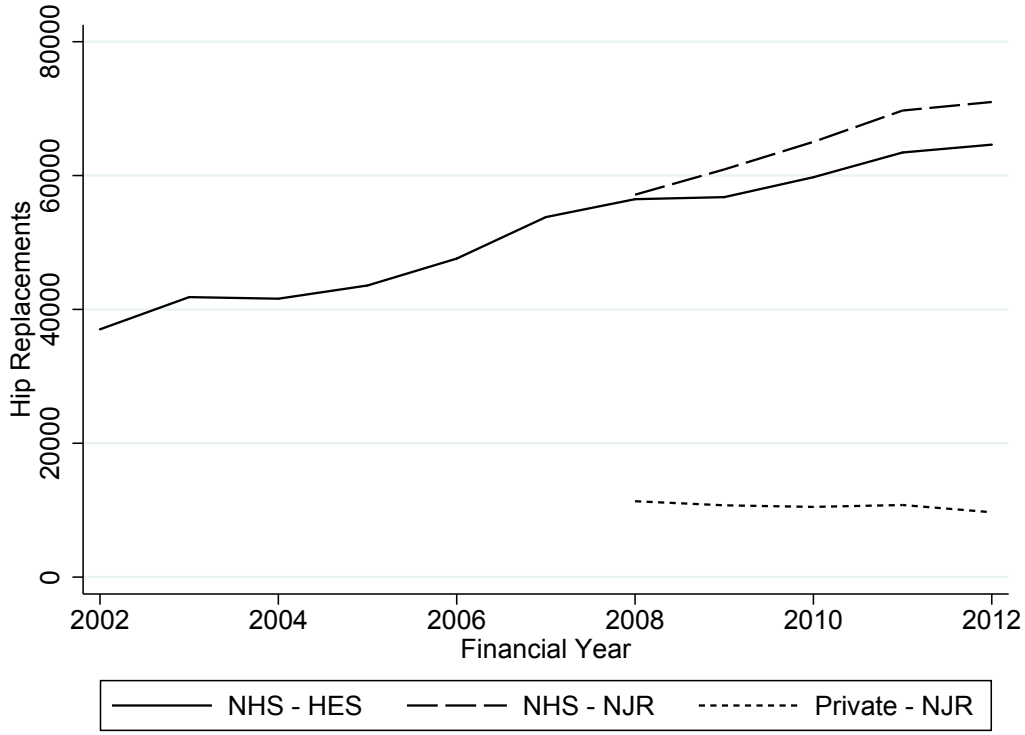


(b) Growth (2006/07=100)



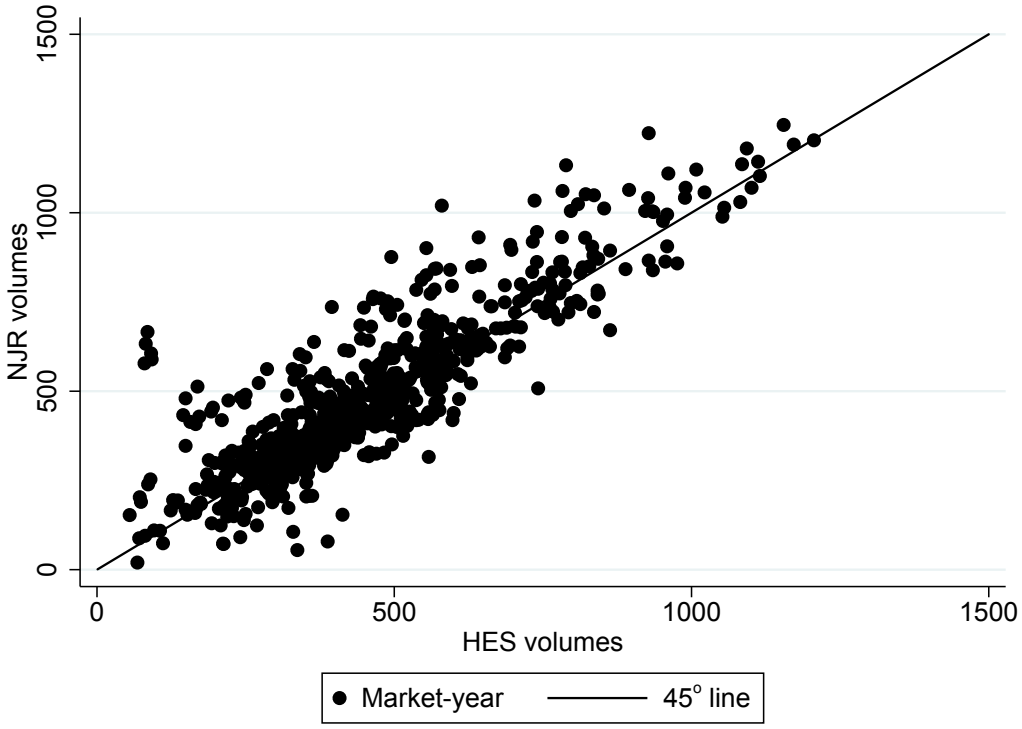
Notes: (1) Changes relative to 100 in 2006/07; (2) Emergency readmissions measures the proportion of patients who experience an emergency inpatient readmission within 30 days of discharge after a publicly funded elective hip replacement; (3) Private hospital areas are those which contained a private hospital in 2004; (4) The vertical line (2006) denotes the year in which private hospitals first entered the market.

Figure A4: Hospital market annual volumes of hip replacements, by dataset and funding stream 2008/09 to 2012/13



Notes: (1) NHS-HES reports all publicly funded hip replacements recorded in HES; (2) NHS-NJR reports all publicly funded hip replacements recorded in the NJR; (3) Private-NJR reports all privately funded hip replacements recorded in the NJR.

Figure A5: Hospital market annual volumes of publicly funded hip replacements recorded in the National Joint Registry and Hospital Episode Statistics, 2008/09 to 2012/13



Notes: (1) Each observation is a hospital market and year combination (N=650).

B Online Appendix: The relationship between ISTCs and public patient outcomes

Appendix Table B1 shows the coefficients associated with the interaction between a dummy variable that takes the value of one when an ISTC treated public patients in the market in 2012/13, and a dummy variable that takes the value of one in years when ISTCs were allowed to operate in the market (2005/06) onwards. These coefficients are from the same regressions displayed in column 3 of table 3, and columns 2 and 5 of table 4.

Table B1: Estimated association between ISTC presence and selected outcomes, 2002/03 to 2012/13

	Admissions	ln(med wait)	ln(readmissions)
	IV	IV	IV
	(1)	(2)	(3)
ISTC * Post05	28.29**	-0.238***	-0.000
	(12.36)	(0.055)	(0.004)
Area controls	Yes	Yes	Yes
Hospital FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Number of hospitals	130	130	130
Observations	1,430	1,430	1,430
R-squared	0.687	0.129	0.215

Notes: (1) 'ISTC' is a dummy variable that takes the value of one if an ISTC located in the hospital market treats public funded hip replacement patients in 2012/13; (2) 'Post05' is a dummy variable that takes the value of one in all years from 2005/06 onwards (the period when ISTCs could operate in the public market); (3) Controls are the same as in Table 3 (column 1) and Table 4 (columns 2 and 3); (4) Private hospital presence is instrumented with pre-existing hospital sites (from 2004); (5) All specifications clustered at the hospital market level, *** p< 0.01, ** p<0.05, * p<0.1.

Column 1 shows the estimated association between ISTC presence and the number of admissions for publicly funded hip replacements. The coefficient is positive and statistically significantly different from zero. It is slightly smaller than the estimated impact of private hospital presence on publicly funded volumes. Column 2 shows the estimated association with waiting times. The coefficient is negative and statistically significant at the 1% level. This suggests that waiting times fell more quickly in areas where ISTCs were established than in areas where they were not. However, ISTCs were intended to be located in areas with high waiting times at the beginning of the period, and so this coefficient may partly include the impact of other

measures taken to reduce waiting times in the local area. In column 3, the dependent variable is 30-day emergency readmission rate. As with private hospital entry, the coefficient is small in size and not statistically significantly different from zero.