Improving Performance Through Allocation and Competition: Evidence from a Patient Choice Reform*

Mika Kortelainen[a] ⓡ Liisa T. Laine[b] ⓡ Konsta Lavaste[c] ⓡ Tanja Saxell[d] ⓡ Luigi Siciliani[e]

[a] *University of Turku, Finnish Institute for Health and Welfare*
[b] *University of Missouri, IZA*
[c] *Finnish Institute for Health and Welfare, University of Jyvaskyla*
[d] *Aalto University, VATT Institute for Economic Research, Helsinki GSE*
[e] *University of York*

Abstract

We study the effects of introducing choice and non-price competition into public health care markets with heterogeneous producers. We use a difference-in-differences design based on a regional patient choice reform and comprehensive administrative data on orthopedic surgeries in Finland. We find that the reform led to a reallocation of patients towards large teaching hospitals, increasing concentration in their markets. Waiting times decreased and more patients were operated on in all the hospitals exposed to the reform, with little effect on clinical quality or surgical expenditure. Moving from a regulated allocation mechanism to a market-based approach can improve allocation and hospital performance. (*JEL* I11,L11, I18, L32, L38)

__Acknowledgements:__ We thank Rubaiyat Alam, Saku Aura, Cristina Bratu, Petri Böckerman, Heather Brown, David Cutler, Partha Deb, Michele Fioretti, Geir Godager, Martin Hackmann, Unto Häkkinen, Tor Iversen, David Kaplan, Kaisa Kotakorpi, Laura Lasio, Timothy Layton, Teemu Lyytikäinen, Jennifer Mayo, Jaakko Pehkonen, Tuomas Pekkarinen, Michael Pesko, Carol Propper, Steve Puller, Anders Munk-Nielsen, Adam Sacarny, Henri Salokangas, Stephan Seiler, Markku Siikanen, Lauri Sääksvuori, Otto Toivanen, Janne Tukiainen, Benjamin Ukert, Anthony Yu, and Jouko Verho for their comments and suggestions. We also thank conference and seminar participants at the 13th Nordic Workshop on Industrial Organization, the 16th Berlin IO Day, AEA/ASSA 2024, ASHEcon 2023, Bank of Finland Research Seminar, CEPR Health Economics 2023, EARIE 2023, EuHEA 2024, FINHESS, IHEA 2023, IIOC 2024, Kansas Health Economics Seminar 2024, NHESG meeting 2022, University of Missouri, University of Turku, and VATT Institute for Economic Research. This research was supported by the Academy of Finland (Decision No. 325110), the Yrjö Jahnsson Foundation, the Instrumentarium Science Foundation, and Vakuutustiedon kehittämissäätiö. Author order randomized using Ray and Robson (2018) ⓡ. *Corresponding author: Liisa T. Laine, 615 Locust Street Building, Columbia, MO 65211, USA. Tel: +1-573-882-1335, Email: lainel@missouri.edu.

__Email addresses:__ mika.kortelainen@utu.fi (Mika Kortelainen), lainel@missouri.edu (Liisa T. Laine), konsta.lavaste@thl.fi (Konsta Lavaste), tanja.saxell@vatt.fi (Tanja Saxell), luigi.siciliani@york.ac.uk (Luigi Siciliani)

I. Introduction

In many countries the provision of essential services such as health care and education has traditionally been managed through non-market-based allocation mechanisms. During the past decades, many of these services have been deregulated to adopt market-based allocation mechanisms via introduction of choice and non-price competition among public producers. It remains unclear, however, what kinds of equilibrium effects the adoption of market-based allocation mechanisms may have on patient and producer outcomes and what the resulting competitive interactions of the producers within these markets are.

We provide quasi-experimental evidence on the effects of market-based allocation mechanism on public health care using a major policy change: a regional choice reform for planned surgeries in Finland. The reform was implemented in 2007 in the area of South-West Finland, which comprises approximately one-fifth of the Finnish population. Prior to this reform, a regulated allocation mechanism assigned patients to the closest public hospital within their own health care district. After the reform, patients in the reform area could choose any public hospital in the reform area, leaving patients and hospitals outside the reform area unaffected. We employ nationwide hospital discharge data and a difference-in-differences (DiD) design that uses the reform area with a market-based allocation mechanism as a treatment group and the remaining area with a regulated allocation mechanism as a control group.

The regional reform provides us a novel setting for studying how the introduction of a market-based allocation mechanism affects public hospital choice and performance compared with a regulated allocation mechanism. Moreover, it allows us to provide evidence of what the aggregate effects and equilibrium responses by heterogeneous producers from a reduced-form perspective are. In doing so, our study fills gaps in the literature and complements prior work that has estimated the marginal effects of competition (i.e. continuous treatment or "dose") on hospital performance after choice reforms were implemented simultaneously nationwide, by comparing hospitals in more versus less competitive markets of the reform area (Cooper et al., 2011; Gaynor, Moreno-Serra and Propper, 2013; Moscelli et al., 2018; Brekke et al., 2021; Moscelli, Gravelle and Siciliani, 2021, 2023). While this so-called quasi-DiD approach has been commonly used to evaluate the marginal effects of continuous treatments (Duflo, 2001; Acemoglu, Autor and Lyle, 2004; Finkelstein, 2007), the advantage of our binary DiD approach with an untreated control group, is that it provides a clear causal interpretation of the average treatment effects of the reform instead of the marginal effects of competition.[1]

We find that the regional choice reform affected patients' hospital choices and allocation across several commonly performed planned surgeries: hip replacements, knee replacements, and all orthopedic surgeries. Specifically, the reform led to a reallocation of patients towards large teaching hospitals, increasing concen-

[1]Continuous treatments apply to all units of interest with varying treatment intensity or "dose" and are particularly useful in settings, where untreated control groups are either undesirable or infeasible, including national reforms. However, in the treatment intensity (quasi-DiD) approach, the level treatment effect (i.e. the difference between a unit's potential outcome under treatment dose and its untreated potential outcome) and a causal response (i.e. the difference in a unit's potential outcome with marginal increase in the dose) do not coincide, which complicates interpretation and evaluation (Callaway, Goodman-Bacon and Sant'Anna, 2024).

tration, as measured by the Herfindahl-Hirschman Index, by up to 8 percent in their markets.[2] Notably, there were no hospital entries or exits post-reform.

We then show that hospitals responded to the reform and the resulting change in the competitive environment by improving their performance. We find that waiting times decreased by up to 60 days or 36 percent and more patients were operated on in all the hospitals exposed to the reform on average, although the volume increase was much larger in teaching hospitals. Hospitals also shortened the length of stay for orthopedic surgery by 4.5 hours or 8 percent, with little impact on clinical quality (such as emergency readmissions and revision surgeries), patient mix, or surgical expenditure on average. As the clinical quality did not change much, shorter stays may indicate that hospitals used their resources more efficiently (Cooper, Gibbons and Skellern, 2018). This might have enabled hospitals to increase health care production post-reform.

Finally, we evaluate the aggregate net social benefit of introducing choice and non-price competition for orthopedic surgery, as implied by the estimated increase in hospital volume (in total, an increase of $1,429$ patients or 9 % annually), faster access to medical treatment, and cost savings from shorter stays. Our back-of-the-envelope calculation suggests a net benefit of approximately $4,000$ euros per patient or an aggregate of 70 million euros a year across all hospitals and markets in the reform area.

Our study demonstrates how policies to improve patient choice and non-price competition among producers can improve the functioning of public health care markets, with greater efficiency in health care delivery and patient allocation to hospitals. Thus, we contribute to the large literature on health care competition, as reviewed by Gaynor, Ho and Town (2015) and Handel and Ho (2021). In contrast to the previous literature estimating the marginal effects of competition after patient choice reforms (Cooper et al., 2011; Gaynor, Moreno-Serra and Propper, 2013; Brekke et al., 2021; Moscelli, Gravelle and Siciliani, 2021, 2023; Gaynor, Propper and Seiler, 2016), our novel setting enables us to provide new evidence of the functioning of public health care markets via a comparison of the two allocation mechanisms, regulated and market-based allocation mechanisms.[3] Moreover, our DiD design based on the regional reform allows us to use market concentration as an outcome instead of a variable defining the intensity of competition induced by the reform as used in prior work estimating marginal effects of competition post-reform. We show how improvements in competition conditions due to greater choice can promote market concentration towards larger producers.

Our paper thus also contributes to the debates on the causes and consequences of large producers' market dominance (Gaynor, 2016; Autor et al., 2017; Bighelli et al., 2022). On the one hand, large producers' market dominance could result from reduced competition, which can lead to higher health care prices (Gowrisankaran, Nevo and Town, 2015; Cooper et al., 2019) or longer waiting times (Gaynor, Laudicella

[2]Teaching hospitals have competitive advantages over non-teaching hospitals due to their better resources and perceived reputation. Despite their better perceived reputation, we find that teaching hospitals do not have better clinical quality or much higher risk-adjusted costs of care for surgical procedures, similar to the findings by Burke et al. (2019); Silber et al. (2020).

[3]While our paper focuses on health care, we also contribute to the rich literature on the effects of choice reforms and market-based mechanisms in other publicly provided services such as education. Recently, Campos and Kearns (2023) used a similar difference-in-differences design to ours to evaluate the market-level effects of a school choice program in Los Angeles, approximating the general equilibrium–like effects on students' educational outcomes from a reduced-form perspective.

and Propper, 2012) without improvements in quality. On the other hand, it could result from enhanced competition and choice, enabling markets to reallocate economic activity towards larger producers due to their competitive advantages (Van Reenen, 2018; Berry, Gaynor and Scott Morton, 2019; De Loecker and Syverson, 2021; Bighelli et al., 2022). Our results are consistent with the latter conjecture and suggest that pro-competitive choice reforms can improve the functioning of public hospital markets while increasing large hospitals' market dominance.

Finally, our study also links the literature analyzing the impacts of market-based choice reforms with an extensive literature studying the allocation of economic activity across heterogeneous producers in a variety of industries (e.g., Syverson, 2011; De Loecker and Syverson, 2021). Chandra et al. (2016) find that higher-quality hospitals gain more patients and grow more over time, suggesting an important role for competitive reallocation forces in health care markets. Unlike that paper, we use a quasi-experiment to provide novel insights into how introduction of non-price market mechanisms can change allocation and competitive interactions among heterogeneous producers. We find evidence that, while the introduction of patient choice led to a reallocation of patients towards large teaching hospitals with little impact on quality, it decreased waiting times across all hospital types (teaching and non-teaching). The increased competition for patients might have incentivized both teaching and non-teaching hospitals to improve their performance. Our results are thus informative about the effectiveness of market mechanisms in improving producer performance in the presence of regulated prices and overloaded waiting lists in health care systems.

The rest of the paper proceeds as follows. Section II describes the institutional setting. Section III presents the data and descriptive statistics. Section IV describes our DiD approach for estimating the reform's effects using patient-level data and Section V presents the corresponding results. Section VI shows the econometric specification and results from hospital-level analyses. Section VII presents back-of-the-envelope calculations of the implied benefits and costs. Section VIII compares the DiD approach for estimating the reform's effects to the quasi-DiD approach, which estimates the marginal effects of concentration post-reform. The last section concludes.

II. Institutional Setting

II.A. The Finnish Health Care System

Finland has a publicly-financed, decentralized health care system, where all residents are entitled to public health care services via universal public insurance. Public primary care is organized and financed by the municipalities ($N = 326$ in 2010) for their residents by law and it is provided in municipality-owned health centers. Primary care physicians act as gatekeepers for publicly provided non-emergency (planned) specialized health care.

Specialized health care such as planned surgical treatment is provided by public hospitals that are governed by public authorities called hospital (i.e., health care) districts ($N = 20$ in 2010). Each municipality

is a member of one of the hospital districts and participates in governance and financing of that district together with other member municipalities. The hospital districts are responsible for organizing specialized health care services in their region. The public sector provides the majority of hospital care in Finland and the private sector accounts for only 5 percent of hospital activity (Keskimäki et al., 2019).

The Finnish hospital sector consists of heterogeneous producers. There are large university-based teaching hospitals, medium-sized central hospitals, and small regional hospitals. Every hospital district has either a teaching hospital or a central hospital and possibly also one or more regional hospitals. Central hospitals provide services in most specialties while small regional hospitals only provide services for common medical conditions and specialties such as orthopedics. Teaching hospitals, on the other hand, have better resources and expertise to provide services in all specialties and for a broad range of medical conditions. Teaching hospitals also partner with medical schools to provide education and conduct research, contributing to knowledge production and innovation, and they tend to be the early adopters of new technologies (c.f. Skinner and Staiger, 2015). There are five teaching hospitals in Finland, with higher patient volumes and better capacity compared to non-teaching (central or regional) hospitals ($N = 41$) (Karhunen, 2020). Their better resources give teaching hospitals a competitive advantage over non-teaching hospitals.

II.B. Regional Patient Choice Reform and Incentives

We study a regional patient choice reform that was introduced in four hospital districts in South-West Finland in October 2007, comprising approximately one-fifth of the Finnish population, or approximately one million citizens. The regional reform concerned planned (non-emergency) surgeries and it preceded a nationwide choice reform implemented in May 2011. Figure 1 depicts the reform area in shaded, the hospital districts (N=20, of which 4 were in the reform area and 16 in the control area), and the geographical distribution of hospitals (N=46, of which 9 were in the reform area and 37 in the control area) in Finland in 2004–2010.[4] Prior to the reform, patients were typically referred to the closest hospital within their own hospital district (Finnish Government Proposal 90/2010). Patient choice was thus highly restricted and regulated by public authorities, that is, by hospital districts.[5] After the reform, surgical patients who lived in the shaded reform area could choose any public hospital within and across hospital districts in the reform area, leaving patients and hospitals outside the reform area unaffected.

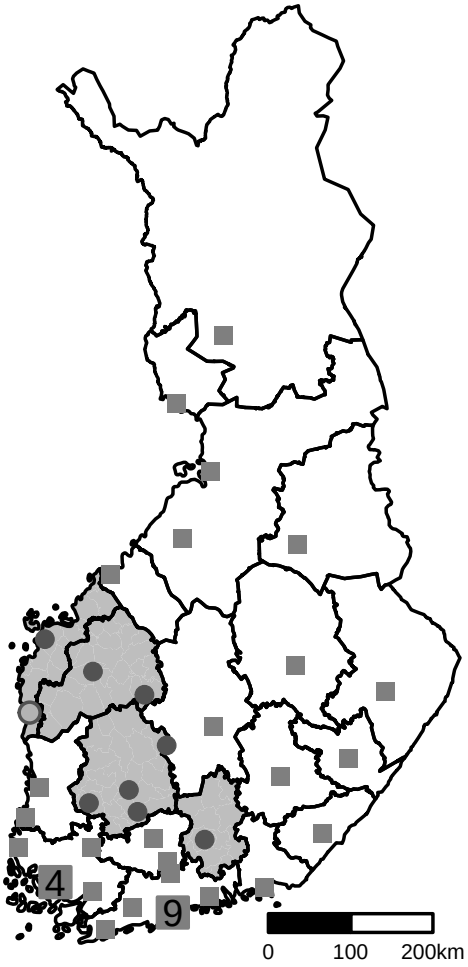
Adoption of market-based allocation mechanisms via introduction of choice and improving hospital performance and timely access to care via increased non-price competition were the central policy goals of the reform (Pirkanmaa Hospital District, 2007). According to our hospital expert interviews, policymakers in hospital districts in the reform area also hoped that patients would substitute to hospitals with shorter waiting times, consequently shifting demand to ease the pressure in overly crowded hospitals. Indeed, hospital

[4]Online Appendix Figure A1 further shows the locations of different hospital types: teaching, central, and regional.

[5]In a few hospital districts in and outside the reform area, physicians were allowed to refer patients to hospitals located outside patients' hospital districts, but only when specific circumstances (such as long travel distance or waiting time) were met. Our results are robust to excluding such cases from the econometric analyses (Section V.C).

waiting times for non-urgent care were long in Finland. For example, in 2007, approximately 13 percent of patients had to wait more than six months for hospital care, which is the national maximum waiting time target set by law in March 2005 (THL, 2012). The reform was inspired by earlier market-oriented patient choice reforms conducted in many other Nordic countries and the United Kingdom (Pirkanmaa Hospital District, 2007). However, unlike these national reforms, the Finnish reform was regional.

Figure 1: Patient Choice Reform Area and Hospital Locations



Notes: Borders indicate hospital districts in 2007 and the shaded area constitutes the 2007 reform area. The reform area includes four hospital districts, which comprise approximately one-fifth of the Finnish population, or approximately one million citizens. Finland is approximately the size of Germany, but with 1/15 of the population ($\sim$ 5.4 million citizens in 2010). The dots in the figure indicate reform area hospitals (the dot with an empty middle marks a hospital which closed down in the pre-reform period) and the squares control area hospitals. The large squares mark the capital region, which had 9 hospitals, and the Turku region, which had 4 hospitals. In total, there were $N = 9$ hospitals in the reform area and $N = 37$ hospitals in the control area. The figure includes all public hospitals that performed planned surgeries (excluding municipality-owned hospitals), although some of them did not perform hip and/or knee replacement surgeries.

Patients access planned surgical treatment by a referral from their primary care physicians, and patients' hospital choices are guided by these physicians. The financial incentives for physicians associated with

hospital referral decisions are minimal, because public primary care physicians are salaried employees of municipalities rather than hospital districts. Private primary care physicians are also able to make referrals to public hospitals, but the receiving hospitals' specialists make the final decision on whether it is necessary for the patient to undergo the procedure or not.[6]

Finnish public hospitals are reimbursed for the services produced from their patients' municipalities of residence and the money follows the patients. Each hospital district sets the reimbursement rates of their own hospitals administratively, and bases these on administered prospective payments using diagnosis-related groups (DRGs) (Kautiainen, Häkkinen and Lauharanta, 2011).[7] DRG systems incentivize hospitals to control costs while increasing activity levels by providing them with a predetermined, flat reimbursement rate for operating patients within a single DRG category based on their average, rather than actual, costs. In DRG systems, hospitals, however, have incentives to cream-skim and compete for profitable patients whose reimbursement is expected to be above the actual costs (Ellis, 1998).

Health insurance reduces patients' financial consequences related to their hospital choice. In Finland, patients' co-payments for publicly provided health care services are moderate, capped by national legislation, and do not vary much between hospital districts (Hetemaa et al., 2018). For example, in 2008, the maximum co-payment for a surgery was 83.90 euros (Finnish Government Decree 464/2008), which at the time corresponded to 4 percent of the monthly disposable cash income of a median household.[8] Hence we do not expect hospital co-payments to affect patients' hospital choices to a great extent. However, more significant monetary costs can result for patients from traveling to a distant hospital because (i) the Finnish population is spread out over a large geographical area, (ii) the distances between hospitals are long, and (iii) public insurance covers travel costs based on the cheapest mode of transport to the nearest hospital, regardless of the actual mode of transport or hospital choice (Paltta, 2008).

Although public hospitals are not profit maximizers in the same way as private for-profit hospitals are, they can face significant pressures to perform financially well and compete for patients by using non-price strategies (e.g. Gaynor, Moreno-Serra and Propper, 2013; Gaynor, Ho and Town, 2015). Because money follows patients through municipality reimbursements in Finland, hospitals' can increase their revenues by attracting more patients.[9]

Given that administered co-payments are almost fixed, the way hospitals can do this is by improving the quality of care or shortening waiting times. Moreover, to shorten waiting times, hospitals can increase supply and make health care delivery more productive and efficient (OECD, 2020). The patient choice reform

[6] A typical treatment episode for an orthopedic surgery proceeds as follows: (i) a primary care physician diagnoses the condition, helps in choosing a hospital, and writes a referral; (ii) the patient meets a specialist at the hospital, who makes the final treatment decision; (iii) the patient undergoes a surgery and in-patient care at the hospital; (iv) the patient receives post-operative care (in the same or different hospital) or is discharged; and (v) follow-up checks are performed.

[7] All of the reform area hospital districts reimbursed DRG tariffs either exclusively or combined with a fee-for-service model during our study period 2004—2010. We are not aware of any major changes in the hospital reimbursement systems during the study period.

[8] €83.90/(€28,400/12 months) ≈ 0.04 (Statistics Finland, 2010).

[9] Hospitals can attract patients, for example, from outside their own hospital districts after the choice reform.

brought about a substantial shift in hospitals' ability to attract and compete for patients, with potential efficiency gains in health care production (Gaynor, Moreno-Serra and Propper, 2013; Longo et al., 2019).

Patients' ability to choose their hospital, and thereby the intensity of non-price competition, depends on the available information that the patients and their referring physicians can use when making their choice (Brown et al., 2023). There is publicly available information on hospital performance outcomes in Finland, although no specific patient review system similar to the one maintained by the English National Health Service is provided.

Hospital districts publish information on hospital-level waiting times by specialty on their own websites. Nationwide statistics on hospital-level waiting times are also collected for common procedures such as hip and knee replacements (THL, 2012)—the surgeries we study—and the statistics were available already at the beginning of our study period. In terms of clinical quality information, the Finnish Institute for Health and Welfare (THL) publishes information on the outcomes of hip and knee replacements, acute myocardial infarction (AMI), and stroke patients at hospital or hospital district level at regular time intervals, for example in 2007 (THL, 2021). We are not aware of any major changes in public information provision during our study period. In addition to this public information, patients and their referring physicians can receive other information from unofficial sources such as colleagues, family, and peers. Patients can also learn about the choice reform from their referring physicians, unofficial sources, and the news (Finnish Broadcasting Company, 2007).

III. Data

We use nationwide patient-level hospital discharge data that contains the universe of public hospital admissions and discharges in Finland in 2004–2010. We create three samples for our analyses using the information on medical procedures produced by hospitals. The first two samples include planned hip and knee replacement surgeries. We study hip and knee replacement surgeries because we expect scope for choice and producer competition as a result of the choice reform in them: they were among the most common planned surgeries and were available in all types of hospitals. To get a more comprehensive picture of the choice reform, we also study the third sample containing all planned orthopedic surgeries. The sample also includes planned hip and knee replacement surgeries, which account for approximately 16 percent of the observations in the sample.[10] Orthopedic surgeries have also been analyzed in prior work on hospital competition or performance (Moscelli, Gravelle and Siciliani, 2021; Godøy et al., 2024).

In total, our samples contain 45 hospitals during the observation period, including in total 29,625 observations for the samples of hip replacement surgeries, 35,884 observations for knee replacement surgeries, and 418,109 observations for all orthopedic surgeries. We focus on patients aged 18—74 years at the time

[10]Online Appendix Table A1 shows the observation shares of hip and knee replacements and other common orthopedic surgeries. The most common orthopedic surgery is surgery for knee meniscus that requires small cuts and is less invasive than hip and knee replacements.

of hospital admission.[11] Moreover, we have excluded from the data a small share (1–2 percent) of patients who obtained orthopedic surgery across reform and control area borders. We match each observation with administrative data from Statistics Finland on the patient's date of death, demographics, and residence location at the end of each year. Next we discuss the construction of the main variables, leaving the more detailed sample and variable description to online Appendix Section A1. In the remainder of this section, we provide the descriptive statistics.

III.A. Measures of Hospital Choice

We construct four outcome variables related to hospital choice and allocation among surgical patients. Our first choice variable indicates if the patient was operated on in a teaching, rather than a non-teaching, hospital. Teaching hospitals are larger, have more resources, and have a better perceived reputation compared to non-teaching hospitals (Section II.A; Silber et al. 2020; Newsweek and Statista 2021).

Our second choice variable is the distance traveled, which is the straight-line distance between each patient's residence location and the location of the hospital where the patient was operated on. The third choice variable indicates if the patient was operated on in their nearest hospital and our fourth choice variable indicates if the patient was operated on outside their hospital district of residence.

III.B. Measures of Hospital Performance

Clinical quality measures. We consider several indicators of care quality to measure hospital performance. First, we construct an indicator of whether the surgical patient had an emergency readmission within 30 days of discharge. Emergency readmissions are a commonly used metric of hospital quality (Benbassat and Taragin, 2000; Varkevisser, van der Geest and Schut, 2012; Gupta, 2021; Moscelli, Gravelle and Siciliani, 2021). We also conduct additional analyses using more detailed measures of clinical quality for hip and knee replacements such as revision surgeries and mechanical complications and infections in the prosthesis (Section V.B).[12]

Waiting time. In addition to clinical quality, waiting time is another commonly studied aspect of hospital performance (Propper, Burgess and Gossage, 2008; Moscelli, Gravelle and Siciliani, 2021, 2023). We measure waiting time by the number of days that the patient is on the waiting list for surgery.[13] Waiting times delay access to medical treatment and can depend on how efficiently hospitals organize their health care production (Section II.B).

[11] We do not have detailed information on the residence location of patients over 74 years of age, and our data contains only a few patients under 18 years of age. The previous literature on patient choice reforms also focuses on patients under 75 years of age (Gaynor, Moreno-Serra and Propper, 2013).

[12] We also study the quality of *emergency* care, which was not targeted by the reform, in order to evaluate the spillover effects of the reform (Section V.C).

[13] The patient is placed on the waiting list when a specialist has made the final decision on surgery. In most cases, waiting times are recorded comprehensively in the discharge data. However, some hospitals record waiting times less comprehensively (online Appendix Section A1), and our results are robust for excluding these hospitals from our samples (Section V.C).

Measures of efficiency and resource use. Measuring performance based on hospital efficiency (how well resources are utilized to achieve the output) is generally difficult because of the lack of high-quality information on quality and costs (Cooper, Gibbons and Skellern, 2018). Even though our discharge data is detailed in other dimensions, it does not include comprehensive information on costs or the physical and human resources used. Therefore, we follow the previous literature and use length of stay as a proxy for hospital efficiency (Robinson et al., 1988; Gaynor, Moreno-Serra and Propper, 2013; Cooper, Gibbons and Skellern, 2018; Moscelli, Gravelle and Siciliani, 2021); to the extent that clinical quality does not change, a shorter stay indicates faster discharge, and thereby lower costs and less resources used for the same patient outcomes. Moreover, we separately analyze a coarse measure of annual hospital operating expenditure (e.g., purchases of labor and material inputs) for all surgeries collected from all individual hospitals by the Finnish Institute for Health and Welfare (Section VI). In the discharge data, planned orthopedic surgeries represent more than 20 percent of all planned surgeries, although their share of hospital costs might be very different.

III.C. Measures of Hospital Volume and Market Structure

We measure hospital volume by the number of patients. We also measure market structure at the hospital level using the Herfindahl-Hirschman Index (HHI), which is based on patient market shares and allocations to each hospital (Gaynor, Moreno-Serra and Propper, 2013). In the first step, we calculate a HHI value for each municipality by taking the sum of the squared patient market shares of hospitals using data on patients from that municipality only. In the second step, we calculate the hospital-level HHI values by taking a weighted average of the values of the municipal-level HHI, where each municipality is weighted according to its share of the hospital's total patient volume. Because we use market shares in this calculation, the HHI varies between 0 and 1, and hospitals located in highly concentrated markets (high hospital-level HHI) also have high market shares (correlation approximately 0.9). The hospital-level HHI measure captures the average degree of concentration in markets where the hospital operates and allows large hospitals to operate in a greater market area in comparison to smaller hospitals. We refer to this HHI calculated from observed hospital choices as the *actual* HHI and we calculate it separately for each estimation sample.

III.D. Patient and Surgery Type Covariates

Our main covariates are patient's age and sex at the time of admission in addition to the patient's surgery type, because many possible covariates (such as financial position or staffing) may be endogenous. We also estimate models using two additional covariates as a robustness check (Section V.C). The first is an indicator for a weekend admission (equal to one if admitted on Saturday or Sunday), as staff may be more limited at weekends. The second is the number of past emergency admissions each patient had within one year prior to surgery, as a proxy for severity and morbidity (case mix).

III.E. Descriptive Statistics

Table 1 reports the descriptive statistics of hospital choice outcomes during our full observation period for the samples of hip replacements, knee replacements, and all orthopedic surgeries (Panels A–C). The first three columns refer to all patients in each of these samples, followed by the descriptive statistics split for patients receiving care from hospitals in the reform and control areas. In each sample, approximately one fourth of the patients resided in areas affected by the reform.

Table 1 shows that patients in the reform and control areas differed in terms of their hospital choice outcomes. The hip and knee replacement patients were more likely to be operated on in a teaching hospital in the reform than in the control area (55–56 versus 36–40 percent). They also traveled longer distances, 34–37 kilometers in the areas affected by the reform, as opposed to 28–29 kilometers in the control area. Moreover, the hip and knee replacement patients were typically operated on in the nearest hospital and this probability was lower in the reform than in the control area (81–84 versus 87 percent). The most notable difference in the sample of all orthopedic surgeries is that only 29 percent of reform area patients were operated on in a teaching hospital, while the same was true for as many as 46 percent of control area patients.

Table 1 also shows that hospital volumes were larger in the reform than in the control area in the samples of hip and knee replacements, whereas the reverse was true in the sample of all orthopedic surgeries. Moreover, the hospital-level means of actual HHI indicate a high degree of market concentration at the level of 0.69–0.90, with fairly high variation across hospitals and/or over time (SD 0.09–0.16).

Table 2 reports the descriptive statistics of our patient-level hospital performance outcomes in addition to the patient characteristics. Hospital performance was similar between the reform and control areas in terms of the clinical quality outcome, the probability of 30-day emergency readmission (6–11 percent), and length of stay (2–7 days). In contrast, waiting times were 5–10 percent longer in the reform area than in the control area (136–194 versus 129–184 days). Waiting times and length of stays also varied by sample and were longer for hip and knee replacements (155–186 and 7 days) than for all orthopedic surgeries (130 and 2 days).

Patient characteristics (age and sex) were similar in the reform and control areas. Only the average number of pre-surgery emergency admissions was smaller in the reform than in the control area, suggesting that hospitals in the reform area operated less severe patients. In Section IV, we address the differences between the reform and control areas and test the plausibility of the parallel trends assumption in our econometric approach.

Hospitals are also heterogeneous in their volumes and other aggregated performance outcomes.[14] Large teaching hospitals had much larger volumes than non-teaching hospitals, including medium-sized central

[14] Online Appendix Tables A5 and A6 further show that teaching hospitals were very similar in terms of their mean performance and patient composition, respectively, between reform and control areas.

Table 1: Descriptive Statistics of Choice Outcomes and Market Concentration

	All			*Reform*			*Control*		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Panel A. Hip replacement surgeries									
Teaching hospital	0.44	0.50	29,625	0.55	0.50	6,974	0.40	0.49	22,651
Distance (km)	30.55	39.23	29,625	37.21	43.60	6,974	28.50	37.55	22,651
Nearest hospital	0.85	0.35	29,625	0.81	0.39	6,974	0.87	0.34	22,651
Different hospital district	0.03	0.18	29,625	0.07	0.26	6,974	0.02	0.15	22,651
Hospital volume	36.94	35.14	802	62.27	46.13	112	32.83	31.17	690
Actual HHI	0.87	0.12	802	0.87	0.09	112	0.87	0.13	690
Panel B. Knee replacement surgeries									
Teaching hospital	0.41	0.49	35,884	0.56	0.50	8,276	0.36	0.48	27,608
Distance (km)	29.25	37.61	35,884	34.29	39.57	8,276	27.74	36.87	27,608
Nearest hospital	0.86	0.34	35,884	0.84	0.37	8,276	0.87	0.33	27,608
Different hospital district	0.03	0.17	35,884	0.06	0.23	8,276	0.02	0.15	27,608
Hospital volume	44.30	39.64	810	73.89	59.08	112	39.55	33.23	698
Actual HHI	0.89	0.12	810	0.90	0.10	112	0.88	0.12	698
Panel C. All orthopedic surgeries									
Teaching hospital	0.43	0.49	418,109	0.29	0.45	72,532	0.46	0.50	345,577
Distance (km)	27.99	39.66	418,109	29.40	35.25	72,532	27.70	40.52	345,577
Nearest hospital	0.84	0.37	418,109	0.77	0.42	72,532	0.85	0.35	345,577
Different hospital district	0.04	0.20	418,109	0.04	0.21	72,532	0.04	0.19	345,577
Hospital volume	466.64	489.34	896	370.06	263.68	196	493.68	532.78	700
Actual HHI	0.76	0.14	896	0.69	0.16	196	0.78	0.12	700

Notes: The table reports descriptive statistics for 18–74-year-old patients undergoing an orthopedic surgery in 2004–2010. Distance to the hospital (km) is continuous and the other choice outcomes, including teaching hospital, nearest hospital, and different hospital district, are binary (0/1). Hospital volume (number of patients) and actual HHI are calculated at the hospital-quarter level. The HHI is measured on a 0–1 scale, where a higher value indicates more market concentration.

Table 2: Descriptive Statistics of Quality, Length of Stay, Waiting Time and Patient Characteristic Measures

	All			*Reform*			*Control*		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
Panel A. Hip replacement surgeries									
Emergency readmission within 30 days	0.08	0.27	29,625	0.07	0.26	6,974	0.08	0.28	22,651
Length of stay (days)	7.14	7.54	29,625	6.89	6.97	6,974	7.21	7.70	22,651
Waiting time (days)	154.74	141.15	23,481	165.74	152.12	6,394	150.62	136.59	17,087
Age	62.29	9.00	29,625	62.53	9.01	6,974	62.22	9.00	22,651
Female	0.52	0.50	29,625	0.51	0.50	6,974	0.53	0.50	22,651
Pre-surgery emergency admissions	0.40	1.16	29,625	0.32	0.99	6,974	0.42	1.21	22,651
Panel B. Knee replacement surgeries									
Emergency readmission within 30 days	0.11	0.31	35,884	0.11	0.32	8,276	0.11	0.31	27,608
Length of stay (days)	6.77	5.96	35,884	6.58	5.28	8,276	6.82	6.14	27,608
Waiting time (days)	186.42	173.46	28,269	194.32	188.13	7,541	183.54	167.72	20,728
Age	64.06	7.43	35,884	64.57	7.23	8,276	63.91	7.48	27,608
Female	0.65	0.48	35,884	0.66	0.47	8,276	0.65	0.48	27,608
Pre-surgery emergency admissions	0.38	1.09	35,884	0.32	0.91	8,276	0.40	1.13	27,608
Panel C. All orthopedic surgeries									
Emergency readmission within 30 days	0.06	0.24	418,109	0.06	0.23	72,532	0.06	0.25	345,577
Length of stay (days)	2.23	6.11	418,109	2.55	5.90	72,532	2.16	6.15	345,577
Waiting time (days)	130.20	146.29	294,233	135.68	148.24	56,368	128.90	145.80	237,865
Age	51.87	13.70	418,109	52.90	13.80	72,532	51.66	13.67	345,577
Female	0.52	0.50	418,109	0.52	0.50	72,532	0.53	0.50	345,577
Pre-surgery emergency admissions	0.59	1.40	418,109	0.49	1.24	72,532	0.61	1.43	345,577

Notes: The table reports descriptive statistics for 18–74-year-old patients undergoing an orthopedic surgery in 2004–2010. Length of stay (days), waiting time (days), age (years) and pre-surgery emergency admissions (count) are continuous and the other variables, including emergency readmission within 30 days and female, are binary (0/1). Waiting time is missing for some patients, which is depicted as a smaller number of observations.

hospitals and small regional hospitals (92–1,282 versus 30–416 and 16–217 patients per quarter on average, respectively; online Appendix Table A2). Even though teaching hospitals are generally considered higher-quality and more expensive (Burke et al., 2019; Silber et al., 2020), their risk-adjusted readmission rates (clinical quality) and surgical expenditure per patient did not differ much from those of non-teaching hospitals (online Appendix Tables A3 and A4). This finding is consistent with the evidence for common medical and surgical conditions in other settings (Burke et al., 2019; Silber et al., 2020). Teaching hospitals, however, had shorter mean length of stay for hip and knee replacements than in non-teaching hospitals (online Appendix Table A3). Mean waiting times were also shorter in teaching hospitals compared with medium-sized non-teaching hospitals (e.g., 153–197 versus 177–211 days for hip and knee replacements).[15] Shorter waiting times combined with better resources and a perceived reputation for quality can be relevant factors that increase the patient's likelihood of choosing a teaching instead of a non-teaching hospital post-reform.

IV. Baseline Econometric Approach for Estimating Choice Reform Effects

The patient choice reform may affect hospital choices and performance by increasing substitution and non-price competition across hospitals. Thus, we begin by estimating the effects of the reform on related patient outcomes, using administrative patient-level data and a difference-in-differences (DiD) approach.[16] We use the reform area as a treatment group and the remaining areas of the country as a control group. Specifically, we employ the following baseline specification:

$$y_{imht} = \beta_1 \text{Treated}_h + \beta_2 \text{Treated}_h \times \text{Post}_t + \mathbf{X}'_{it}\gamma + \lambda_t + \mu_m + \varepsilon_{imht}, \tag{1}$$

where y_{imht} is the outcome related to hospital choice or performance for patient i living in municipality m and operated on by hospital h in period (quarter) t. Treated_h is a binary indicator for the treatment group equal to one if hospital h was located in the reform area.[17] Post_t is a binary post-reform indicator equal to one after the fourth quarter of 2007 (Q4/2007). We include quarter fixed effects λ_t to control for time-varying national-level shocks or trends, such as legislative changes, shifts in physician referral practices, and evolving clinical guidelines. We also include fixed effects for the patient's municipality of residence, μ_m, to control for persistent differences between municipalities (and also between the reform and control areas), for example, in patients' location, preferences, or morbidity.[18]

[15] Mean waiting times were, however, even shorter in regional hospitals. This could reflect lower demand rather than greater efficiency in regional hospitals compared to other hospitals.

[16] Similar to Braghieri, Levy and Makarin (2022), for example, our estimated effects capture both direct individual-level effects as well as possible indirect general equilibrium—such as competition—effects in the reform area.

[17] The results remain intact if we define the treatment group indicator based on the patient's home location.

[18] We include fixed effects for patients' home municipalities rather than for hospitals in the baseline specification. Municipality fixed effects are more relevant for choice outcomes because they reflect patients' location. For example, given their location, patients can decide whether to choose a hospital in another hospital district. Hospital fixed effects are, however, more relevant for hospital performance outcomes because hospitals determine performance for their own patients. The results for hospital performance outcomes are robust for including hospital fixed effects (Section V.C).

$\mathbf{X}_{it}$ includes patient-specific control variables: age, sex, and fixed effects for the patient's surgery type. We use a minimal set of patient characteristics (age and sex) as control variables in our baseline analysis to avoid the bad control problem (Angrist and Pischke, 2009). We also show the robustness of the results to controlling for the patient's pre-existing health status or morbidity (Section V.C). We cluster standard errors at the level of the patient's municipality of residence ($N = 326$) to account for the possibility of within-area correlation in unobservables among patients located in the same geographical area.

The coefficient of interest β_2 identifies the average treatment effect of the choice reform on the patient outcome, using variation across regions in the adoption of the patient choice reform and the assignment to separate treatment and control groups. The key identifying assumption is that the reform did not have indirect spillover effects to the untreated control area. Such spillover effects could arise if the reform led to the reallocation of patients from the control area to the reform area. In our setting, such reallocation is unlikely, however. Choice opportunities remained unchanged and regulated allocation mechanism was still used in the control area post-reform (Section II.B). Moreover, obtaining care across reform and control area borders was very uncommon (1–2 percent of all observations) throughout our observation period and we excluded these observations from our samples (Section III).

Another key identifying assumption is that in the absence of policy adoption, patient outcomes would have evolved under parallel trends in the reform and control areas. To examine potential pre-existing trends and the dynamic effects of the choice reform graphically, we estimate the following binary treatment event study specification with 6-month time intervals calculated from the adoption of the reform in October 2007:

$$y_{imht} = \delta_1 \text{Treated}_h + \text{Treated}_h \times \sum_{l=-7}^{+5} \delta_{2,l} \mathbb{1}[l = t] + \mathbf{X}'_{it}\tau + \lambda_t + \mu_m + \varepsilon_{imht}. \quad (2)$$

The coefficients for the pre-reform period $\delta_{2,l}$, $l < -1$ capture a possible pre-existing trend in the outcome variable, whereas the coefficients $\delta_{2,l}$, $l > -1$ for the post-adoption periods capture the dynamic effect of the choice reform in each of these periods. We use the same set of controls and fixed effects as in specification (1) and follow the standard practice by normalizing the coefficients for the indicators "one period before policy adoption" to zero, $\delta_{2,-1} = 0$.

V. Baseline Results

V.A. Effects on Hospital Choice and Allocation

We first investigate how the regional choice reform affected hospital choices and patient allocation. We present the results from estimating the baseline DiD specification (1) using patient-level data for hip replacements, knee replacements, and all orthopedic surgeries in Panels A–C of Table 3, respectively.

We find that the reform led to the reallocation of patients towards large teaching hospitals (Column 1 of Table 3). Specifically, the probability of choosing a teaching, instead of a non-teaching, hospital increased by

5–6 percentage points (10–14 percent in comparison to the pre-reform mean) for hip and knee replacements. We also find a positive but somewhat smaller effect (an increase of 2 percentage points or 3 percent) for all orthopedic surgeries, which also include a large number of less-invasive surgeries and surgeries with relatively short length of stays (see Table 2).[19]

Figure 2 presents the event study estimates for the probability of choosing a teaching hospital from estimating specification (2). We find that this probability began to increase half a year after the implementation of the reform in every sample. The lag in the effects may result from waiting times for planned surgery and patients or physicians adjusting to the new choice system. The event study estimates reveal very little evidence of pre-trends in the choice outcome, providing supporting evidence for the credibility of our research design.[20]

We also find that the reform, which expanded patients' choice of hospitals within and across hospital districts, induced patients to choose more distant hospitals (Column 2 of Table 3, online Appendix Figure A3).[21] Depending on the sample, the travel distance increased by approximately 2–5 kilometers or 6–16 percent compared to the pre-reform mean distance. The DiD point estimate is statistically significant at the 5 percent level for all orthopedic surgeries, and at the 10 percent level for hip replacements, while not statistically significant for knee replacements.

We also tested whether the probability to be operated on in the nearest hospital changed after the reform. The DiD parameter estimates are, however, statistically significant only for knee replacements (Column 3 of Table 3 and online Appendix Figure A4), indicating a 4 percentage point (5 percent) increase.[22] In contrast, we find evidence that a larger share of patients chose a hospital beyond their own hospital district after the reform (Column 4 of Table 3 and online Appendix Figure A5). The magnitude of the DiD point estimates (Table 3) ranges from 1 to 3 percentage points (24–83 percent at the sample mean), although the coefficient estimate for knee replacements is not statistically significant. In sum, the reform impacted hospital choice and patient reallocation by inducing patients to travel longer distances and across hospital district borders to obtain orthopedic surgery at large teaching hospitals.

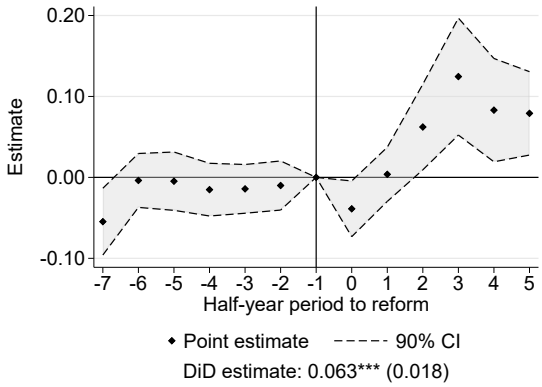
[19] For less-invasive surgeries, patients might prefer convenience over expected quality. In this case, patients might be more willing to choose the nearest (non-teaching) hospital, instead of a possibly more distant teaching hospital. Consistent with this, we find that the point estimate for the choice of teaching hospital is no longer statistically significant and the probability of choosing the nearest hospital increases when we exclude hip and knee replacements from the sample of all orthopedic surgeries (online Appendix Table A7).

[20] The pre-treatment coefficients are also quite precisely estimated, especially for hip and knee replacements. Thus it is quite unlikely that pre-existing trends that produce meaningful bias in the treatment effects estimates would not be not detected with substantial probability (c.f. Roth, 2022).

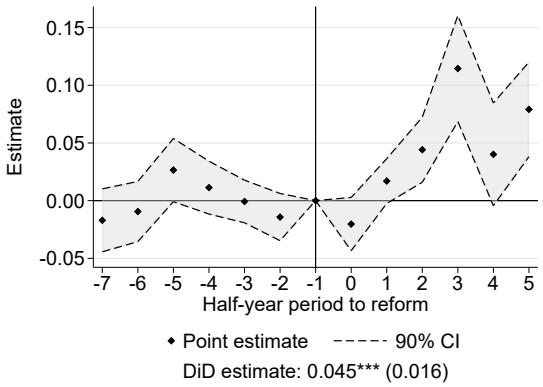
[21] However, according to our data, the travel distance decreased after the reform for patients living in some hospital district border areas.

[22] Note that the nearest hospital could also be located outside the patient's own hospital district, especially if they live near the district's border area.

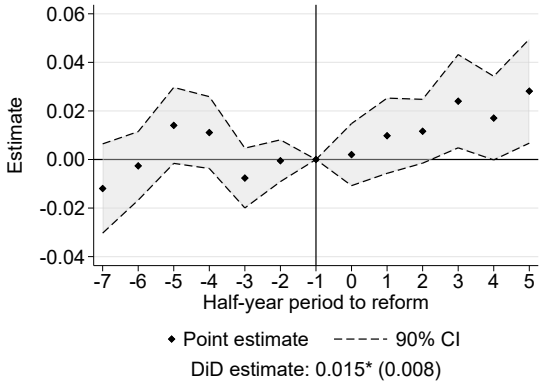
Figure 2: The Effect of the Reform on the Probability of Surgical Patients Being Operated On In a Teaching Hospital



Panel A. Hip replacements



Panel B. Knee replacements



Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in percentage points) shown in Column 1 of Table 3.

Table 3: The Effects of the Reform on Hospital Choice and Allocation Outcomes

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.063***	4.651*	0.008	0.030**
	(0.018)	(2.385)	(0.020)	(0.012)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.460	29.847	0.864	0.036
N	29,625	29,625	29,625	29,625
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.045***	1.725	0.042**	0.013
	(0.016)	(1.820)	(0.020)	(0.011)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.436	28.953	0.870	0.033
N	35,884	35,884	35,884	35,884
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.015*	2.063**	0.020	0.010*
	(0.008)	(0.993)	(0.015)	(0.005)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.434	28.046	0.838	0.041
N	418,090	418,090	418,090	418,090
Surgery type FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$).
[a] Equals one if the patient was operated on in a teaching (university) hospital.
[b] Distance from the patient's residence to the hospital in kilometers.
[c] Equals one if the patient was operated on in the nearest hospital.
[d] Equals one if the patient was operated outside their hospital district of residence.

V.B. Effects on Hospital Performance

Table 4 displays the results on the effects of the choice reform on our patient-level hospital performance measures: the quality of care, waiting time, and length of stay. Column 1 shows that the reform had little effect on care quality, as measured by the 30-day emergency readmission probability, for hip replacement (Panel A), knee replacement (Panel B), and all orthopedic surgery patients (Panel C). The point estimates are small in magnitude and not statistically significant. The corresponding event study estimates are shown in online Appendix Figure A6 and they confirm that almost none of the post-reform point estimates are statistically different from zero.

Column 2 in Table 4 and Figure 3 show the estimated effects on waiting times. We find that in every sample, waiting times decreased dramatically post-reform. The waiting time estimates are precise, and similarly to the results for other outcomes and samples, there is only little evidence of pre-trends for hip replacements and all orthopedic surgeries. However, in the sample of knee replacements, waiting times started to decrease more quickly in the reform area than in the control area already in the pre-reform period. Based on raw data patterns (online Appendix Figure A2), this is caused by a national law change that introduced a maximum waiting time target of 6 months at the beginning of our observation period (Q1/2005). Even though our econometric approach captures national-level shocks such as law changes through time fixed effects, the introduction of the maximum waiting time target may have disproportionately affected long

Table 4: The Effects of the Reform on Quality of Care, Waiting Time, and Length of Stay

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.004	-71.524***	-0.140
	(0.007)	(11.977)	(0.307)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.080	183.757	8.044
N	29,625	23,481	29,625
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.002	-97.614***	-0.375
	(0.009)	(18.255)	(0.288)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.103	229.671	7.528
N	35,884	28,269	35,884
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.001	-18.535**	-0.187***
	(0.003)	(7.844)	(0.047)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.062	150.935	2.340
N	418,090	294,198	418,090
Surgery type FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

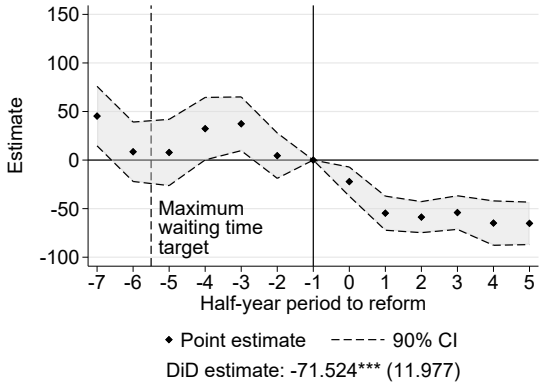
Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of patient's home municipality ($N = 326$).
[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in a smaller N compared to the other columns (see online Appendix Section A1.4 for more details).
[c] Number of days between admission and discharge.

waiting times for knee replacements in the reform area.

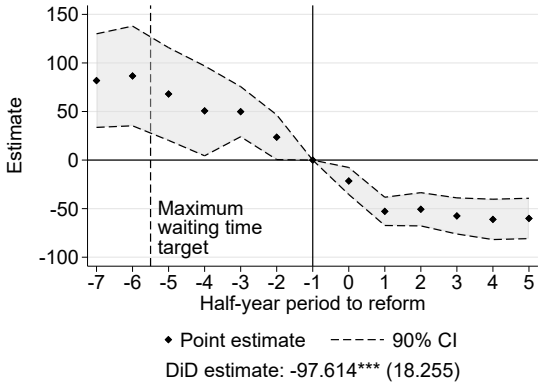
To isolate the effect of the patient choice reform from that of the maximum waiting time target, we use data from periods when waiting times were already adjusted to this law change, Q4/2006–Q4/2010 (Table 5). We find that the post-reform decrease in waiting times was substantial even if the period affected by the waiting time target is excluded: 36 percent (in comparison to the pre-reform mean) for hip and knee replacements, and 23 percent for all orthopedic surgeries. Based on the results and raw data patterns, the patient choice reform was effective in reducing waiting times below the 6-month maximum for waiting times set by national legislation. Our results suggest that the two policies—maximum waiting time target and choice reform—can act as complementary policy tools in addressing overloaded waiting lists in public hospitals. In Section VI, we study the mechanisms behind the reduction in waiting times after the choice reform and show that the reduction coincides with a large increase in hospital volume and supply.

Hospitals may reduce the length of stay in order to improve efficiency and to free up resources to operate more patients with shorter waiting times. We find that the estimates for length of stay are not statistically significant for hip and knee replacements (Column 3 of Table 4, Figure 4). On the other hand, for all orthopedic surgeries, the length of stay decreased by 8 percent from the pre-reform mean. The reform might have incentivized hospitals to reduce the length of stay for patients needing relatively less invasive orthopedic surgery, because their health is less likely to deteriorate due to shorter stays compared to patients in need of major surgery such as a hip or knee replacement. To the extent that clinical quality did not change,

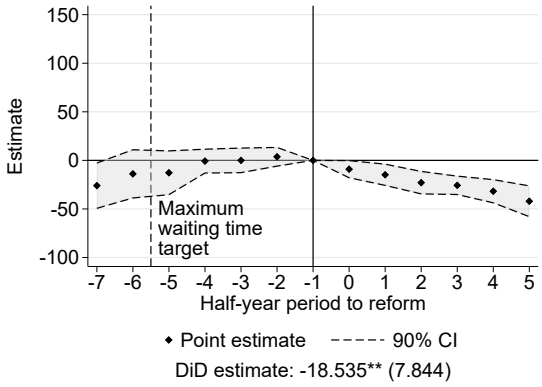
Figure 3: The Effect of the Reform on Waiting Times of Planned Surgery Patients



Panel A. Hip replacements



Panel B. Knee replacements



Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in number of days) shown in Column 2 of Table 4. The dashed line indicates the introduction of the maximum waiting time target that guarantees medical treatment within 6 months.

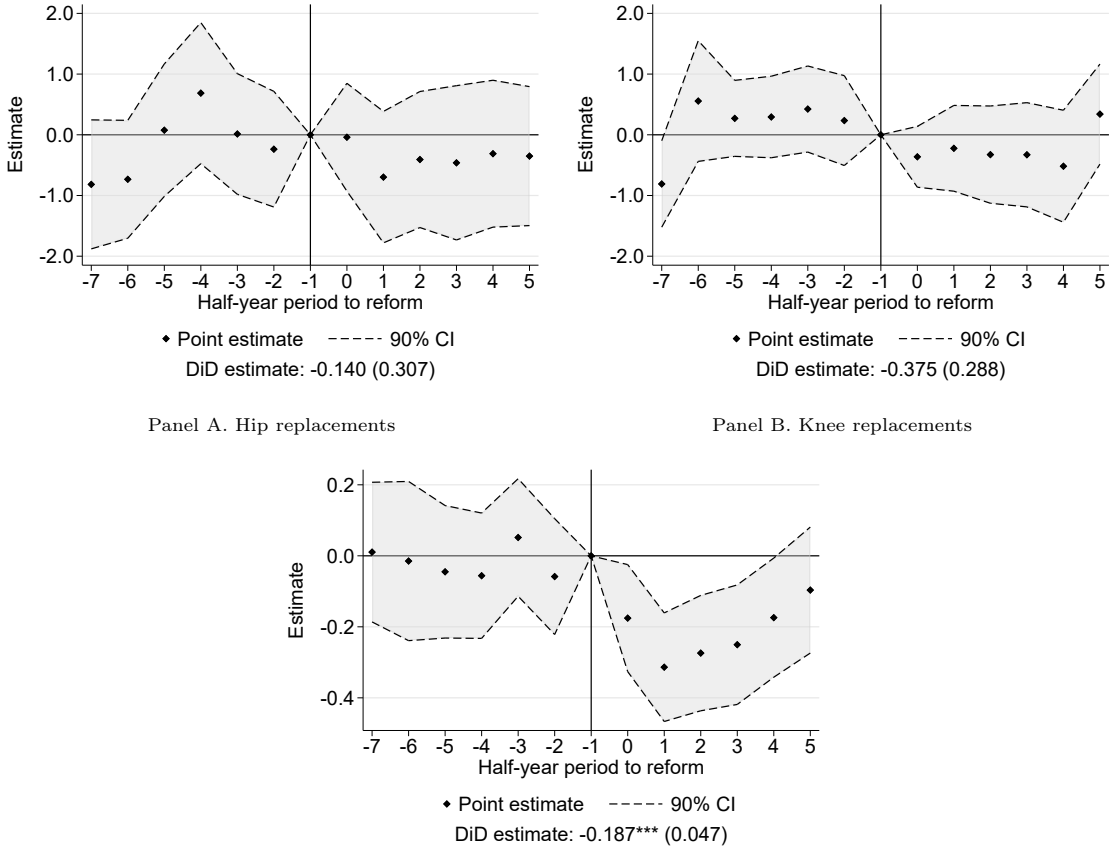
Table 5: The Effect of the Choice Reform on Waiting Time Estimates After Adjusting to the Introduction of the Maximum Waiting Time Target

	Hip replacements		Knee replacements		All orthopedic surgeries	
	Whole time period	After target	Whole time period	After target	Whole time period	After target
	(1)	(2)	(3)	(4)	(5)	(6)
$\text{Treated}_h \times \text{Post}_t$	-71.524***	-51.192***	-97.614***	-58.931***	-18.535**	-27.368***
	(11.977)	(8.580)	(18.255)	(10.895)	(7.844)	(6.092)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	183.757	140.893	229.671	165.659	150.935	120.628
N	23,481	14,858	28,269	18,304	294,198	187,211
Surgery type FEs	✓	✓	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Outcome in all columns is waiting time in days. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$). Columns 1, 3, and 5 re-display baseline estimates from Column 2 of Table 4. Columns 2, 4, and 6 display estimates using data from Q4/2006–Q4/2010 only.

as indicated by our earlier results on emergency readmissions, shorter stays indicate improved efficiency post-reform.

Figure 4: The Effect of the Reform on Length of Stay of Planned Surgery Patients



Panel A. Hip replacements

Panel B. Knee replacements

Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in number of days) shown in Column 3 of Table 4.

Emergency readmissions may not, however, be sensitive enough to capture changes in all clinical quality attributes. To address this concern, we also estimated the effects of the reform on more detailed measures for hip and knee replacements: indicators for revision surgery, mechanical complication in the prosthesis, and infection or inflammation in the prosthesis (Urquhart et al., 2010; Mäkelä et al., 2011; Bayliss et al., 2017; Fleischman et al., 2019). The results in online Appendix Table A8 show that the revision probability increased by 0.7 percentage points or 23 percent for knee replacement surgeries, indicating a decrease in quality post-reform. In contrast, the point estimates for the other quality outcomes and samples are not statistically significant, similar to the findings for emergency readmissions.

V.C. Robustness Checks and Spillover Effects to Emergency Care

We conduct a number of robustness checks (online Appendix Section A4). We begin by testing whether our results are sensitive to the inclusion of additional controls in the baseline specifications. For choice-related outcomes, we add controls for staffing and morbidity (indicator for weekend admission, and the number of pre-surgery emergency admissions). For the hospital performance outcomes, we also add hospital fixed effects to control for time-invariant hospital-level factors such as their average patient mix. The results do not change much (Tables A9 and A10).

We also study the robustness of our results regarding our baseline samples. First, although there was no hospital entry or exit post-reform, one small hospital in the reform area closed down during the pre-reform period and we excluded it from our baseline estimations.[23] The baseline results are robust to the exclusion of all patients living in municipalities near the closed-down hospital (Tables A11 and A12). Second, in a few hospital districts, patients had the opportunity to obtain referrals to hospitals outside of their own hospital district under specific circumstances, such as long travel distance. Our results are robust to the exclusion of these hospital districts from the econometric analyses, and in some cases this exclusion improves the precision and increases the magnitude of our estimates compared to the baseline estimates (Tables A13–A16). Third, some hospitals had a joint hospital identifier in the data and cannot be distinguished from each other. This creates some measurement error in our outcomes related to travel distances and the indicator of choosing the nearest hospital, which are calculated based on the location of the largest hospital under the joint identifier. When we exclude hospitals with joint identifiers from the sample, we generally find larger effects compared to the baseline estimates (Tables A17 and A18).

To address potential bias from missing values in waiting times, we re-estimated the results regarding waiting times (i) without hospital districts in which more than 30 percent of waiting time values were missing, (ii) without surgeries for which more than 30 percent of waiting time values were missing, (iii) without one reform area hospital which did not report its waiting times in Q1/2008–Q4/2009, and (iv) using data for the years 2006 and 2010 only, when the share of missing values was generally low. The re-estimated results are similar or even larger than our baseline results (Table A19).

The choice reform for planned non-emergency surgeries might also have spillover effects on *emergency* care that was not targeted by the reform. To test for this possibility, we follow the prior work (Kessler and McClellan, 2000; Cooper et al., 2011; Gaynor, Moreno-Serra and Propper, 2013) and estimate the effects of the reform on emergency care clinical quality and length of stay for acute myocardial infarction (AMI), stroke, and hip fracture patients.[24] Complementing our baseline results, the DiD estimates in online Appendix Table A20 show no other statistically significant effects than a decrease in stroke patients' emergency readmissions

[23]The exclusion may generate some bias because it removes most of the patients from the nearby area in the pre-closure period, but not in the post-closure period.

[24]In addition to revealing possible spillover effects, the benefit of analyzing the outcomes of emergency patients is that it mitigates patient selection into hospitals based on quality and/or morbidity (emergency patients are usually operated on in the nearest hospital) (Kessler and McClellan, 2000; Moscelli et al., 2018).

(4 percentage points or 22 percent).

VI. Hospital-Level Analyses and Heterogeneity

VI.A. Hospital Volume, Concentration, and Mean Performance

Next, we analyze the effects of the pro-competitive choice reform from the hospital's perspective. We study the effects on hospitals' patient volumes and market concentration. In addition, we provide evidence of how heterogeneous producers interact and respond to the change in the competitive environment post-reform. We estimate the following specification using hospital-quarter-level data:

$$\begin{aligned} y_{ht} =& \beta_1 \text{Treated}_h \times \text{Post}_t + \beta_2 \text{Post}_t \times \text{Teaching}_h \\ &+ \beta_3 \text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h + \mathbf{X}'_{ht}\gamma + \lambda_t + \eta_h + \varepsilon_{ht}, \end{aligned} \tag{3}$$

where y_{ht} is the outcome for hospital h and period (quarter) t, and Teaching_h is the teaching hospital indicator. η_h are hospital fixed effects, which absorb time-invariant hospital-level factors such as Treated_h, Teaching_h, their interaction, hospital location, and average patient mix. The treatment and post-reform indicators (Treated_h and Post_t) are the same as in the patient-level specification (equation (1)). Covariates $\mathbf{X}_{ht}$ are also the same, but transformed to the hospital-level means in quarter t. The coefficient β_1 shows the effect of the reform in non-teaching hospitals and β_3 shows the potentially heterogeneous effect in teaching hospitals compared to non-teaching hospitals. For the specification estimating the average hospital-level effects (without heterogeneity), we set $\beta_2, \beta_3 = 0$.[25] We cluster the standard errors at the hospital district level (N = 20).

Table 6 shows the effects of the patient choice reform on hospital volumes and market concentrations, as measured by the number of patients and actual hospital-level HHI. The results for the average effects are shown in Columns 1 and 3, while the heterogeneous effects are shown in Columns 2 and 4. We find that hospital volume increased by 9–35 percent on average after the reform (Column 1). The increase was statistically significant for knee replacements and all orthopedic surgeries and not statistically significant for hip replacements. In every sample, hospital volumes increased disproportionally in teaching hospitals (Column 2). For hip and knee replacements, this increase was 19–29 patients per quarter.[26] In relative terms, it corresponds to an increase of 55–72 percent compared with the mean volume of all hospitals (35–41 patients per quarter) and 21–28 percent compared with the mean volume of teaching hospitals (92–105 patients per quarter, see online Appendix Table A2).

The DiD estimates do not display any statistically significant effect on the actual HHI on average (Column 3). The average treatment effect, however, masks considerable heterogeneity in the effects across different

[25] More specifically, we estimate the following specification: $y_{ht} = \beta_1 \text{Treated}_h \times \text{Post}_t + \mathbf{X}'_{ht}\gamma + \lambda_t + \eta_h + \varepsilon_{ht}$.
[26] The sum of the coefficients on $\text{Treated}_h \times \text{Post}_t$ and $\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$: $\beta_1 + \beta_3$.

types of hospitals and their markets (Column 4). The point estimates for non-teaching hospitals suggest that concentration decreased by 1–4 percent in their markets, although the estimates are not statistically significant. In contrast, reflecting the disproportionate increase in teaching hospitals' volumes, concentration in their markets increased by 4–8 percent after the choice reform and the estimates are statistically significant.

Table 6: The Effects of the Reform on Hospital Volumes and Market Structure

	Hospital volume[a]		Actual HHI[b]	
	DiD (1)	Heterogeneity (2)	DiD (3)	Heterogeneity (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	4.272	0.118	-0.016	-0.039
	(2.694)	(1.872)	(0.027)	(0.029)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		19.215***		0.111**
		(5.318)		(0.045)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	35.021	35.021	0.883	0.883
N	802	802	802	802
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	14.277***	9.886***	-0.018	-0.033
	(3.897)	(2.454)	(0.034)	(0.042)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		19.532***		0.093*
		(4.181)		(0.053)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	40.640	40.640	0.899	0.899
N	810	810	810	810
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	39.702***	24.110	-0.002	-0.008
	(12.324)	(16.304)	(0.008)	(0.010)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		104.107***		0.035*
		(32.720)		(0.019)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	462.267	462.267	0.766	0.766
N	896	896	896	896
Hospital and time FEs	✓	✓	✓	✓
Age & sex mix[c]	✓	✓	✓	✓
Surgery types[d]	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Includes hospital-quarter-level observations from Q1/2004 to Q4/2010. Standard errors clustered at the hospital district level ($N = 20$).
[a] Number of patients.
[b] Observed market concentration measured on a 0–1 scale. See online Appendix Section A1.5 for more information.
[c] Shares of females, 18–29, 30–39, 40–49, 50–59, and 70–74-year-old patients of hospital's total patient volume. Baseline = share of 60–69-year-old male patients.
[d] Shares of different procedure codes among hospital's patients.

Table 7 shows the effects of the reform on hospital-level means of performance outcomes in teaching and non-teaching hospitals. The estimates for emergency readmission rates were generally small and statistically insignificant (Columns 1 and 2). In line with the increased hospital volumes and supply, the reform reduced mean waiting times in hospitals (Columns 3 and 4). The point estimates are negative for both teaching and non-teaching hospitals, although they become smaller in magnitude when we exclude time periods affected by the implementation of the maximum waiting time target (online Appendix Table A21). Our point estimates further suggest that the reform reduced the mean length of stays for all orthopedic surgeries, although these

estimates are not statistically significant (Columns 5 and 6).[27] While some of these hospital-level estimates are imprecise, our findings as a whole suggest that all hospital types improved their performance in response to increased choice and competition.

Table 7: The Effects of the Reform on Hospital-level Means of Quality of Care, Waiting Times and Length of Stay

	Emergency readmission[a]		Waiting time[b]		Length of stay[c]	
	DiD	Hetero-geneity	DiD	Hetero-geneity	DiD	Hetero-geneity
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Hip replacement surgeries						
$\text{Treated}_h \times \text{Post}_t$	0.007	0.010	-83.110**	-68.900	-0.601	-0.947***
	(0.008)	(0.009)	(35.522)	(44.454)	(0.503)	(0.328)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-0.017		-48.217		1.094*
		(0.018)		(46.002)		(0.533)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	0.085	0.085	174.557	174.557	9.006	9.006
N	802	802	668	668	802	802
Panel B. Knee replacement surgeries						
$\text{Treated}_h \times \text{Post}_t$	0.009	0.010	-111.100**	-98.275	-0.724	-1.009*
	(0.019)	(0.025)	(42.234)	(56.985)	(0.523)	(0.534)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-0.007		-40.523		0.798
		(0.026)		(58.399)		(0.566)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	0.111	0.111	215.895	215.895	8.257	8.257
N	810	810	664	664	810	810
Panel C. All orthopedic surgeries						
$\text{Treated}_h \times \text{Post}_t$	-0.003	-0.004	-14.575	-8.785	-0.120	-0.087
	(0.004)	(0.004)	(11.235)	(18.590)	(0.157)	(0.183)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		0.008		-33.458*		-0.188
		(0.005)		(18.274)		(0.187)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	0.064	0.064	135.748	135.748	2.154	2.154
N	896	896	845	845	896	896
Hospital and time FEs	✓	✓	✓	✓	✓	✓
Age & sex mix[d]	✓	✓	✓	✓	✓	✓
Surgery types[e]	✓	✓	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Includes hospital-quarter-level observations from Q1/2004 to Q4/2010. Standard errors clustered at the hospital district level ($N = 20$).
[a] 30-day emergency readmission rate (0–1).
[b] Mean waiting time in days. Some hospitals did not report waiting times in some quarters, which results in a smaller N compared to the other columns (see online Appendix Section A1.4 for more details). See also online Appendix Table A21 for the waiting time estimates unaffected by the introduction of the maximum waiting time target.
[c] Mean length of stay in days.
[d] Shares of females, shares of 18–29, 30–39, 40–49, 50–59, and 70–74-year-old patients of hospital's total patient volume. Baseline = share of 60–69-year-old male patients.
[e] Shares of different procedure codes among hospital's patients.

VI.B. Case Mix and Resource Use

Because the reform changed hospitals' volumes, it could also have affected their patient composition and case mix. For example, if teaching hospitals operated on sicker patients post-reform, it could explain the null effects on their patients' emergency readmissions (quality of care). To assess these changes, we apply

[27] For hip and knee replacements, the mean length of stay decreased by 11–12 percent in non-teaching hospitals and somewhat less in teaching hospitals.

the estimation strategy from equation (3) to hospital-level averages of patient demographics (age, sex) and morbidity (pre-surgery emergency admissions. The results in online Appendix Table A22 show minimal change in patient composition across hospital types post-reform, except for hip replacements, where non-teaching hospitals treated sicker patients, and teaching hospitals treated healthier ones.

We also examine whether the reform affected hospitals' annual surgical expenditure and a coarse measure of productivity: expenditure per patient. Using a specification similar to equation (3), with hospital-year data (rather than more granular hospital-quarter-level) and the case mix index in $\mathbf{X}_{ht}$, we find a statistically insignificant and very small decrease in hospitals' surgical expenditure on average (online Appendix Table A23).[28] This finding suggests no increase in total resource use such as purchases of material and labor inputs in hospitals exposed to the reform on average (Table 6).[29] The only exception is teaching hospitals, whose surgical expenditure increased by more than 30 percent, likely due to the reallocation and disproportionate increase in their volumes. Expenditure per patient remained unchanged, indicating that hospitals did not use more resources to produce better patient outcomes. Partly due to limited data on hospital costs and resource use, we present additional analysis to further explore the cost and benefits of the choice reform.

VII. Back-of-the-Envelope Calculation

We perform a back-of-the-envelope calculation to evaluate the aggregate social benefits and costs of the introduction of choice and non-price competition. We outline the calculation and results for orthopedic surgery in this section and present further details in online Appendix Table A25. On the benefits side, we use the estimates of the health-related quality of life gained from orthopedic surgery (Jansson and Granath, 2011) and express their value in monetary terms (in 2010 euros) (Gyrd-Hansen, 2003). Based on these estimates, the estimated health gain per patient and year, denoted by g, would be $2,547$ euros.[30] Moreover, we assume that the number of years that each patient can benefit from these health gains is the discounted life expectancy, denoted by T, minus the waiting time: $w_0 = 0.33$ years (121 days) in the pre-reform period and $w_1 = 0.26$ years ($121 - 27 = 94$ days) in the post-reform period on average (Table 5).[31] The discounted life expectancy at the average age of orthopedic patients (52 years) would be $T = 19.8$ years if we use a time preference (discount factor) of 3 percent and the expected age of death at 80 years (WHO, 2014).

The benefits of the reform are positive because waiting time is shorter (a decrease of 27 days) and volume

[28]The case mix index is also part of the statistics on the costs and productivity of hospitals from the Finnish Institute for Health and Welfare.

[29]Using information in hospital districts' annual reports, we also confirmed that teaching hospitals did not operate at full capacity or increase capacity in terms of the number of beds post-reform.

[30]For comparison, g would be $4,386$ and $3,113$ euros for hip and knee replacements, respectively (online Appendix Table A25).

[31]Waiting time can also affect patient health g. For example, based on estimates by Nikolova, Harrison and Sutton (2016) and Gyrd-Hansen (2003), quality of life is reduced by approximately 0.009 percentage points ($14,149 \times 0.009/100 \approx 1.27$ euros) from an additional *day* of waiting for hip and knee replacements. Then, g would be reduced by $w_t/365.25 \times 1.27$ euros, depending on the waiting time in *years*, w_t (e.g., for hip replacements, $140.893 \times 1.27 \approx 179$ euros in the pre-reform period and slightly less, $89.701 \times 1.27 \approx 114$ euros, in the post-reform period).

is higher (an increase of 39.702 patients per hospital and quarter on average) after the reform (Tables 5 and 6). Specifically, the average pre-reform volume per hospital and quarter was 462 orthopedic patients and there were 9 hospitals in the reform area. The approximated total volume per year would then be $y_0 = 462 \times 9 \times 4 = 16,632$ patients in the pre-reform period and $y_1 = (462 + 39.702) \times 9 \times 4 \approx 18,061$ patients in the post-reform period using the estimates from Table 6. A higher total volume increases the number of patients receiving medical treatment (an increase of $y_1 - y_0 = 1,429$ patients or 9 percent annually), but also generates a positive externality because patients are waiting less, which increases the time period over which they can benefit from better health. The benefits of the reform are driven by the increase in volume, shorter waiting times, and the health gains of 2,547 euros for orthopedic surgery. The benefits are approximately 74 million euros per year in the reform area and are substantial, even under the conservative assumption that g is not improved by shorter waiting post-reform.[32]

On the cost side, we found little impact on hospitals' (average) surgical expenditure. Therefore, the higher total cost is only driven by the higher volume: $c \times (y_1 - y_0) > 0$, where c is the cost per patient. If we use the constant cost estimate of 6,645 euros for orthopedic surgery (Remes et al., 2007), the annual net social benefit of the reform is approximately 64.7 million euros. Moreover, the length of stay reduced by 8 percent (4.5 hours) for orthopedic surgery (Table 4), which could lead to cost savings: $c_1 < c_0$, where c_0 is the pre-reform cost and c_1 is the post-reform cost per patient. If we allow for this effect and assume $c_0 = 6,645$ and $c_1 = 6,374$[33], the annual net social benefit of the reform is even larger, approximately 70 million euros (4,000 euros per patient).

VIII. Comparison to Quasi-DiD Approach

Finally, we compare the DiD approach for estimating the reform's effects to the quasi-DiD approach employed in the previous patient choice reform literature for estimating the marginal effects of concentration post-reform (Cooper et al., 2011; Gaynor, Moreno-Serra and Propper, 2013; Moscelli et al., 2018; Roos et al., 2020; Brekke et al., 2021; Moscelli, Gravelle and Siciliani, 2021, 2023). We estimate the following quasi-DiD specification for patient i living in municipality m and operated by hospital h in quarter t, using data from the reform area only ($\text{Treated}_h = 1$):[34]

$$y_{imht} = \alpha_1 \widehat{HHI}_h + \alpha_2 \widehat{HHI}_h \times \text{Post}_t + \mathbf{X}'_{it}\nu + \lambda_t + \mu_m + \hat{r}'_{it}\theta + \epsilon_{imht}, \tag{4}$$

[32] $[g \times (T - w_1) \times y_1] - [g \times (T - w_0) \times y_0] = [2,547 \times (19.8 - 0.26) \times 18,061] - [2,547 \times (19.8 - 0.33) \times 16,632] \approx 74$ million euros.

[33] Based on the medical literature (Osnes-Ringen et al., 2011), we approximate that the decrease in costs implied by the 4.5-hour decrease in the length of stay could be almost 300 euros per patient.

[34] Analyzing only the reform area makes our approach comparable to the previous choice reform literature studying nationwide reforms and the literature evaluating the quasi-DiD approach with a continuous treatment (Callaway, Goodman-Bacon and Sant'Anna, 2024). Because we study a regional reform, it would also be possible to use data from both the reform and control areas. It would, however, make the model and its interpretation more complicated.

where $\widehat{HHI}_h$ is the pre-reform *predicted* market concentration faced by hospital h. To mitigate the endogeneity of market structure, we follow the standard practice (Kessler and McClellan, 2000; Gaynor, Moreno-Serra and Propper, 2013; Moscelli, Gravelle and Siciliani, 2021) of predicting $\widehat{HHI}_h$ on the basis of distance and other covariates, rather than using *actual* HHI in the specification. Because our focus is on hospital performance for planned surgical treatments, we follow Moscelli, Gravelle and Siciliani (2021) and control for the first-stage stage residuals ($\hat{r}_{it}$) from a hospital choice model to ensure that time-varying patient allocation to hospitals based on unobserved morbidity does not bias the estimates.[35] We bootstrap the clustered standard errors ($N = 74$ municipalities in the reform area) because $\widehat{HHI}_h$ is based on predicted choices. We base our inference on p-values and confidence intervals or their bounds because the bootstrap algorithm, a wild cluster bootstrap, does not produce standard errors. See online Appendix Section A2 for further details on the quasi-DiD and control function approaches.

The coefficient of interest, α_2, captures the marginal effect of concentration after the choice reform that is differential responses to the choice reform in more versus less concentrated markets of the reform area. The marginal effect is identified through differences in the treatment intensity, rather than assignment to a separate treatment or control group as used in the DiD approach.[36] The choice reform is the treatment, and its effect or intensity is expected to vary across hospitals exposed to different market structures.

The sign of α_2 is ambiguous, however, depending on whether concentration is associated with either less or more competition (see, e.g., Syverson, 2019). Hospitals in less concentrated markets can be more exposed to the reform and non-price competition due to a higher density of competing hospitals and more options for patients to choose from in the post-reform period (Brekke, Siciliani and Straume, 2011; Gaynor, Moreno-Serra and Propper, 2013). If this were the case, then we would expect hospital performance to improve more in less concentrated markets post-reform: $\alpha_2 < 0$. On the other hand, if hospitals in more versus less concentrated markets were affected similarly by the reform, then $\alpha_2 = 0$, even if the reform itself had a large effect on the outcome. Finally, if the reform predominantly improved choice and competition for hospitals faced with relatively high levels of market concentration (in our setting, medium-sized central hospitals and large teaching hospitals, as shown by online Appendix Table A2), then we would expect $\alpha_2 > 0$.

We present the results for the marginal effects in online Appendix Table A24 and compare them to the earlier results on the effects of the choice reform based on the DiD approach (Table 4). A comparison of the results shows their similarity regarding surgical patients' readmission probability, as all the point estimates regarding this outcome are small and not statistically significant (Column 1 in Table 4 and online Appendix Table A24). For hip and knee replacements, waiting times decreased after the reform based on the baseline DiD estimates (Column 2 of Table 4) and the decrease was larger, although not statistically significant, in

[35] Changes in patient allocation to hospitals based on morbidity do not seem to drive our DiD and quasi-DiD results on hospital performance. This is shown by the results using a control function approach in the DiD approach (online Appendix Table A26) and the quasi-DiD results without the control function approach (online Appendix Table A27).

[36] This holds under certain identification assumptions, for example, on treatment effect homogeneity at different levels of treatment and a so-called strong parallel trends assumption (for details, see Callaway, Goodman-Bacon and Sant'Anna, 2024).

less concentrated areas (Column 2 of online Appendix Table A24). For all orthopedic surgeries, waiting times also decreased after the reform, but the decrease was smaller in less concentrated markets, as indicated by the negative quasi-DiD estimate.[37] Similarly, length of stay was longer in less concentrated markets post-reform. Overall, the quasi-DiD approach commonly used in the literature thus gives results on the marginal effects of concentration post-reform that deviate from the results of the DiD approach employed in this study that estimates the effect of the reform in the entire reform area.

IX. Conclusions

We studied the introduction of market-based allocation mechanism in public health care. We used a difference-in-differences (DiD) approach based on a unique quasi-experiment: a regional patient choice reform for planned surgeries in Finland which provided us a a novel setting for studying how the introduction of a market-based allocation mechanism affects public hospital choice and performance compared with a regulated allocation mechanism. Using nationwide administrative data, we found that patients responded to the reform by traveling longer distances and across hospital districts to receive orthopedic surgery at large teaching hospitals. The effects on patient behavior were considerable despite the relatively low densities of population and hospitals in Finland, and the limited financial incentives related to hospital choice due to universal public insurance.

After the reform, hospitals were also able to operate on more orthopedic patients with shorter waiting times. Hospital volumes increased disproportionately in large teaching hospitals post-reform, increasing concentration in their markets. Thus enhanced choice can promote concentration by reallocating patients towards large hospitals.

Our results show that adoption of non-market-based allocation mechanisms can enhance hospital performance while increasing large hospitals' market dominance. Our back-of-the-envelope calculation further suggests that the net social benefit of the regional reform could be approximately 70 million euros a year (4,000 euros per patient) for orthopedic surgery. The reform had direct benefits for patients, as the total hospital volume increased by 1,429 patients (9 percent) annually and waiting times (i.e., non-monetary costs) became much shorter. In addition to increased competition, the decrease in waiting times can reflect improved patient allocation to hospitals. As a result of improved choice, patient demand is reallocated towards large hospitals with better resources or capacity, potentially easing the pressure in crowded hospitals with long waiting lists and large excess demand relative to their capacity. Lastly, the reform had only little impact on hospitals' clinical quality or patient mix, despite the large allocative effects and increased supply.

Our results provide suggestive evidence that public policies to increase patient choice and non-price competition among producers can improve efficiency in the presence of limited resources and long waiting

[37] The statistically significant quasi-DiD point estimate of -217 implies that a one standard deviation (0.11) increase in the predicted HHI (more concentration) is associated with a $217 \times 0.11 \approx 24$ days (15 percent) decrease in waiting time post-reform.

times, which are present in many health care systems globally (OECD, 2020). The results are directly relevant to health care systems relying on public production (including those of the United Kingdom, Sweden, and Norway, for example), but also to other systems with administratively set reimbursements to producers (such as the Medicare system in the United States). Our results also have relevance in other settings, such as education, where market-based allocation has been adopted via introduction of choice and non-price competition.

More broadly, our results based on a patient choice reform are informative about the role of market-based mechanisms in health care. The results closely tie greater competition to higher concentration, as implied by the enhanced patient choice.The more competitive a market is, the more concentrated is the market towards large, better-resourced producers, therefore potentially improving market allocation and performance. Our results do not, however, imply that smaller hospitals should be closed, as their volumes did not decrease after the reform (waiting lists just became shorter) and there are likely social gains from a larger number of hospitals due to better scope for choice and competition. While our results suggest that the reform improved allocation and performance in terms of waiting times and there has been no hospital entry or exit after the choice reform, further research is needed to disentangle the demand and supply side responses to the enhanced patient choice, as well as to study the implications of choice reforms for redistribution and inequality of health care delivery.

References

Acemoglu, Daron, David H. Autor, and David Lyle. 2004. "Women, War, and Wages: The Effect of Female Labor Supply on the Wage Structure at Midcentury." *Journal of Political Economy*, 112(3): 497–551.

Angrist, Joshua D., and Jörn-Steffen Pischke. 2009. *Mostly Harmless Econometrics: An Empiricist's Companion.* Princeton: Princeton University Press.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen. 2017. "Concentrating on the Fall of the Labor Share." *American Economic Review*, 107(5): 180–85.

Bayliss, Lee E., David Culliford, A. Paul Monk, Sion Glyn-Jones, Daniel Prieto-Alhambra, Andrew Judge, Cyrus Cooper, Andrew J. Carr, Nigel K. Arden, David J. Beard, and Andrew J. Price. 2017. "The Effect of Patient Age at Intervention on Risk of Implant Revision After Total Replacement of the Hip or Knee: a Population-Based Cohort study." *The Lancet*, 389(10077): 1424–1430.

Benbassat, Jochanan, and Mark Taragin. 2000. "Hospital Readmissions as a Measure of Quality of Health Care: Advantages and Limitations." *Archives of Internal Medicine*, 160(8): 1074–1081.

Berry, Steven, Martin Gaynor, and Fiona Scott Morton. 2019. "Do Increasing Markups Matter? Lessons from Empirical Industrial Organization." *Journal of Economic Perspectives*, 33(3): 44–68.

Bighelli, Tommaso, Filippo di Mauro, Marc J Melitz, and Matthias Mertens. 2022. "European Firm Concentration and Aggregate Productivity." *Journal of the European Economic Association*, 21(2): 455–483.

Braghieri, Luca, Ro'ee Levy, and Alexey Makarin. 2022. "Social Media and Mental Health." *American Economic Review*, 112(11): 3660–93.

Brekke, Kurt R., Chiara Canta, Luigi Siciliani, and Odd Rune Straume. 2021. "Hospital Competition in a National Health Service: Evidence from a Patient Choice Reform." *Journal of Health Economics*, 79: 102509.

Brekke, Kurt R., Luigi Siciliani, and Odd Rune Straume. 2011. "Hospital Competition and Quality with Regulated Prices." *Scandinavian Journal of Economics*, 113(2): 444–469.

Brown, Zach Y., Christopher Hansman, Jordan Keener, and Andre F. Veiga. 2023. "Information and Disparities in Health Care Quality: Evidence from GP Choice in England." National Bureau of Economic Research Working Paper 31033.

Burke, Laura G., Dhruv Khullar, Jie Zheng, Austin B. Frakt, E. John Orav, and Ashish K. Jha. 2019. "Comparison of Costs of Care for Medicare Patients Hospitalized in Teaching and Nonteaching Hospitals." *JAMA Network Open*, 2(6): e195229–e195229.

Callaway, Brantly, Andrew Goodman-Bacon, and Pedro H. C Sant'Anna. 2024. "Difference-in-differences with a Continuous Treatment." National Bureau of Economic Research Working Paper 32117.

Campos, Christopher, and Caitlin Kearns. 2023. "The Impact of Public School Choice: Evidence from Los Angeles's Zones of Choice." *The Quarterly Journal of Economics*, 139(2): 1051–1093.

Chandra, Amitabh, Amy Finkelstein, Adam Sacarny, and Chad Syverson. 2016. "Health Care Exceptionalism? Performance and Allocation in the US Health Care Sector." *American Economic Review*, 106(8): 2110–44.

Cooper, Jack, Stuart V. Craig, Martin Gaynor, and John Van Reenen. 2019. "The Price Ain't Right? Hospital Prices and Health Spending on the Privately Insured*." *The Quarterly Journal of Economics*, 134(1): 51–107.

Cooper, Zack, Stephen Gibbons, and Matthew Skellern. 2018. "Does Competition from Private Surgical Centres Improve Public Hospitals' Performance? Evidence from the English National Health Service." *Journal of Public Economics*, 166: 63–80.

Cooper, Zack, Stephen Gibbons, Simon Jones, and Alistair McGuire. 2011. "Does Hospital Competition Save Lives? Evidence From The English NHS Patient Choice Reforms." *Economic Journal*, 121(554): F228–F260.

De Loecker, Jan, and Chad Syverson. 2021. "An Industrial Organization Perspective on Productivity." In *Handbook of Industrial Organization, Vol. 4.* , ed. Kate Ho, Ali Hortaçsu and Alessandro Lizzeri, Chapter 3, 141–223. Amsterdam: Elsevier.

Duflo, Esther. 2001. "Schooling and Labor Market Consequences of School Construction in Indonesia: Evidence from an Unusual Policy Experiment." *American Economic Review*, 91(4): 795–813.

Ellis, Randall P. 1998. "Creaming, Skimping and Dumping: Provider Competition on the Intensive and Extensive Margins." *Journal of Health Economics*, 17(5): 537–555.

Finkelstein, Amy. 2007. "The Aggregate Effects of Health Insurance: Evidence from the Introduction of Medicare." *The Quarterly Journal of Economics*, 122(1): 1–37.

Finnish Broadcasting Company. 2007. "A million Finns will soon have more freedom to choose their hospital." *https://yle.fi/a/3-5791182 (in Finnish).*

Finnish Government Decree 464/2008. 2008. "Valtioneuvoston asetus sosiaali- ja terveydenhuollon asiakasmaksuista annetun asetuksen muuttamisesta." *https://www.finlex.fi/fi/laki/alkup/2008/20080464*.

Finnish Government Proposal 90/2010. 2010. "Hallituksen esitys Eduskunnalle terveydenhuoltolaiksi sekä laeiksi kansanterveyslain ja erikoissairaanhoitolain muuttamiseksi sekä sosiaali- ja terveydenhuollon asiakasmaksuista annetun lain muuttamiseksi." *https://www.eduskunta.fi/FI/vaski/HallituksenEsitys/Documents/he_90+2010.pdf*.

Finnish Intitute for Health and Welfare (THL). 2012. "Trends in Access to Specialised Health Care in 2007–2012." THL Statistical Report 28/2012.

Fleischman, Andrew N., Majd Tarabichi, Zachary Magner, Javad Parvizi, and Richard H. Rothman. 2019. "Mechanical Complications Following Total Hip Arthroplasty Based on Surgical Approach: A Large, Single-Institution Cohort Study." *The Journal of Arthroplasty*, 34(6): 1255–1260.

Gaynor, Martin. 2016. "New Health Care Symposium: Consolidation And Competition In US Health Care." *Health Affairs blog. http://healthaffairs.org/blog/2016/03/01/new-health-care-symposium-consolidation-and-competition-in-us-health-care [accessed 16th May 2024].*

Gaynor, Martin, Carol Propper, and Stephan Seiler. 2016. "Free to Choose? Reform, Choice, and Consideration Sets in the English National Health Service." *American Economic Review*, 106(11): 3521–57.

Gaynor, Martin, Kate Ho, and Robert J. Town. 2015. "The Industrial Organization of Health-Care Markets." *Journal of Economic Literature*, 53(2): 235–84.

Gaynor, Martin, Mauro Laudicella, and Carol Propper. 2012. "Can Governments Do It Better? Merger Mania and Hospital Outcomes in the English NHS." *Journal of Health Economics*, 31(3): 528–543.

Gaynor, Martin, Rodrigo Moreno-Serra, and Carol Propper. 2013. "Death by Market Power: Reform, Competition, and Patient Outcomes in the National Health Service." *American Economic Journal: Economic Policy*, 5(4): 134–66.

Godøy, Anna, Venke F. Haaland, Ingrid Huitfeldt, and Mark Votruba. 2024. "Hospital Queues, Patient Health, and Labor Supply." *American Economic Journal: Economic Policy*, 16(2): 150–81.

Gowrisankaran, Gautam, Aviv Nevo, and Robert Town. 2015. "Mergers When Prices Are Negotiated: Evidence from the Hospital Industry." *American Economic Review*, 105(1): 172–203.

Gupta, Atul. 2021. "Impacts of Performance Pay for Hospitals: The Readmissions Reduction Program." *American Economic Review*, 111(4): 1241–83.

Gyrd-Hansen, Dorte. 2003. "Willingness to pay for a QALY." *Health Economics*, 12(12): 1049–1060.

Handel, Ben, and Kate Ho. 2021. "The Industrial Organization of Health Care Markets." In *Handbook of Industrial Organization, Vol. 5.* , ed. Kate Ho, Ali Hortaçsu and Alessandro Lizzeri, Chapter 16, 521–614. Amsterdam: Elsevier.

Hetemaa, Tiina, Katja Ilmarinen, Satu Kapiainen, Ilmo Keskimäki, Meri Koivusalo, Merja Korajoki, Ismo Linnosmaa, Eeva Liukko, Pasi Moisio, Susanna Mukkila, Kimmo Parhiala, Mikko Peltola, Eeva Reissell, Liina-Kaisa Tynkkynen, and Maria Vaalavuo. 2018. "Social and Health Care Client Fees: Allocation, Effects and Fairness." Prime Minister's Office Publication Series 30/2018.

Jansson, Karl-Åke, and Fredrik Granath. 2011. "Health-related quality of life (EQ-5D) before and after orthopedic surgery." *Acta orthopaedica*, 82: 82–9.

Karhunen, Elina. 2020. "Study on the Number and Regional Distribution of Hospital Beds in Finland – Background Study for Assessing the Need for Construction Investments." Reports and Memorandums of the Ministry of Social Affairs and Health 2020:36.

Kautiainen, Kirsi, Unto Häkkinen, and Jorma Lauharanta. 2011. "Finland: DRGs in a Decentralized Health Care System." In *Diagnosis-Related Groups in Europe – Moving towards transparency, efficiency and quality in hospitals.* , ed. Reinhard Busse, Alexander Geissler and Wilm Quentin, Chapter 18, 321–338. New York, USA: McGraw-Hill Open University Press.

Keskimäki, Ilmo, Liina-Kaisa Tynkkynen, Eeva Reissell, Meri Koivusalo, Vesa Syrjä, Lauri Vuorenkoski, Rechel Bernd, and Marina Karanikolos. 2019. *Finland: Health System Review. Health Systems in Transition, vol. 21 (2)*, World Health Organization. Regional Office for Europe.

Kessler, Daniel P., and Mark B. McClellan. 2000. "Is Hospital Competition Socially Wasteful?" *The Quarterly Journal of Economics*, 115(2): 577–615.

Kortelainen, Mika, Liisa T Laine, Konsta Lavaste, Tanja Saxell, and Luigi Siciliani. 2023. "Improving Performance Through Allocation and Competition : Evidence from a Patient Choice Reform."

Longo, Francesco, Luigi Siciliani, Giuseppe Moscelli, and Hugh Gravelle. 2019. "Does Hospital Competition Improve Efficiency? The Effect of the Patient Choice Reform in England." *Health Economics*, 28(5): 618–640.

Moscelli, Giuseppe, Hugh Gravelle, and Luigi Siciliani. 2021. "Hospital Competition and Quality for Non-Emergency Patients in the English NHS." *The RAND Journal of Economics*, 52(2): 382–414.

Moscelli, Giuseppe, Hugh Gravelle, and Luigi Siciliani. 2023. "The Effect of Hospital Choice and Competition on Inequalities in Waiting Times." *Journal of Economic Behavior & Organization*, 205: 169–201.

Moscelli, Giuseppe, Hugh Gravelle, Luigi Siciliani, and Rita Santos. 2018. "Heterogeneous Effects of Patient Choice and Hospital Competition on Mortality." *Social Science & Medicine*, 216: 50–58.

Mäkelä, Keijo T, Mikko Peltola, Reijo Sund, Antti Malmivaara, Unto Häkkinen, and Ville Remes. 2011. "Regional and Hospital Variance in Performance of Total Hip and Knee Replacements: A National Population-Based Study." *Annals of Medicine*, 43(Suppl. 1): S31–S38.

Newsweek and Statista. 2021. "World's Best Hospitals 2021." *https://www.newsweek.com/best-hospitals-2021 [accessed 12th September 2023].*

Nikolova, Silviya, Mark Harrison, and Matt Sutton. 2016. "The Impact of Waiting Time on Health Gains from Surgery: Evidence from a National Patient-reported Outcome Dataset." *Health Economics*, 25(8): 955–968.

OECD. 2020. *Waiting Times for Health Services: Next in Line. OECD Health Policy Studies*, Paris: OECD Publishing.

Osnes-Ringen, H., M. K. Kvamme, I. S. Kristiansen, M. Thingstad, J. E. Henriksen, T. K. Kvien, and H. Dagfinrud. 2011. "Cost-Effectiveness Analyses of Elective Orthopaedic Surgical Procedures in Patients with Inflammatory Arthropathies." *Scandinavian Journal of Rheumatology*, 40(2): 108–115.

Paltta, Päivi. 2008. "Eligibility for Reimbursements of Health-Related Travel Costs in Finland and Selected Other Countries." The Social Insurance Institution Studies in Social Security and Health 99.

Pirkanmaa Hospital District. 2007. "Miljoona suomalaista voi valita leikkaushoitopaikkansa." *https://web.archive.org/web/20070826180414/http:/www.pshp.fi/default.aspx?contentid=1604&nodeid=9469&contentlan=1 [archived August 26th 2007, accessed 17th June 2024].*

Propper, Carol, Simon Burgess, and Denise Gossage. 2008. "Competition and Quality: Evidence from the NHS Internal Market 1991–9." *The Economic Journal*, 118(525): 138–170.

Ray, Debraj, and Arthur Robson. 2018. "Certified Random: A New Order for Coauthorship." *American Economic Review*, 108(2): 489–520.

Remes, Ville, Mikko Peltola, Unto Häkkinen, Heikki Kröger, Juhana Leppilahti, Miika Linna, Antti Malmivaara, Keijo Mäkelä, Olavi Nelimarkka, Ilmo Parvinen, Seppo Seitsalo, and Jarmo Vuorinen. 2007. "PERFECT - Arthroplasty: Costs and Effectiveness of Hip and Knee Arthroplasty (in Finnish)." Stakes Working Paper 29/2007.

Robinson, James C., Harold S. Luft, Stephen J. McPhee, and Sandra S. Hunt. 1988. "Hospital Competition and Surgical Length of Stay." *JAMA*, 259(5): 696–700.

Roos, Anne-Fleur, Owen O'Donnell, Frederik T. Schut, Eddy Van Doorslaer, Raf Van Gestel, and Marco Varkevisser. 2020. "Does Price Deregulation in a Competitive Hospital Market Damage Quality?" *Journal of Health Economics*, 72: 102328.

Roth, Jonathan. 2022. "Pretest with Caution: Event-Study Estimates after Testing for Parallel Trends." *American Economic Review: Insights*, 4(3): 305–22.

Silber, Jeffrey H., Paul R. Rosenbaum, Bijan A. Niknam, Richard N. Ross, Joseph G. Reiter, Alexander S. Hill, Lauren L. Hochman, Sydney E. Brown, Alexander F. Arriaga, Rachel R. Kelz, and Lee A. Fleisher. 2020. "Comparing Outcomes and Costs of Surgical Patients Treated at Major Teaching and Nonteaching Hospitals: A National Matched Analysis." *Annals of Surgery*, 271(3): 412–421.

Skinner, Jonathan, and Douglas Staiger. 2015. "Technology Diffusion and Productivity Growth in Health Care." *The Review of Economics and Statistics*, 97(5): 951–964.

Statistics Finland. 2010. "The first phase of the recession lowered real income of high and low-income households." *https://stat.fi/til/tjt/2008/tjt_2008_2010-05-20_tie_001_en.html [accessed 29th May 2024].*

Syverson, Chad. 2011. "What Determines Productivity?" *Journal of Economic Literature*, 49(2): 326–65.

Syverson, Chad. 2019. "Macroeconomics and Market Power: Context, Implications, and Open Questions." *Journal of Economic Perspectives*, 33(3): 23–43.

THL. 2021. "PERFECT – PERFormance, Effectiveness and Cost of Treatment episodes." *https://thl.fi/en/web/thlfi-en/research-and-development/research-and-projects/perfect-performance-effectiveness-and-cost-of-treatment-episodes [accessed June 23rd 2022].*

Torkki, Paulus. 2012. "Best Practice Processes - What Are the Reasons for Differences in Productivity Between Surgery Units." PhD diss. Aalto University School of Science.

Urquhart, Donna M., Fahad S. Hanna, Sharon L. Brennan, Anita E. Wluka, Karin Leder, Peter A. Cameron, Stephen E. Graves, and Flavia M. Cicuttini. 2010. "Incidence and Risk Factors for Deep Surgical Site Infection After Primary Total Hip Arthroplasty: A Systematic Review." *The Journal of Arthroplasty*, 25(8): 1216–1222.

Van Reenen, John. 2018. "Increasing Difference Between Firms: Market Power and the Macro Economy." *Changing Market Structures and Implications for Monetary Policy, Kansas City Federal Reserve: Jackson Hole Symposium*, 19–65.

Varkevisser, Marco, Stéphanie A. van der Geest, and Frederik T. Schut. 2012. "Do Patients Choose Hospitals With High Quality Ratings? Empirical Evidence from the Market for Angioplasty in the Netherlands." *Journal of Health Economics*, 31(2): 371–378.

World Health Organization (WHO). 2024. "Health Data Overview for the Republic of Finland – Life Expectancy." *https://data.who.int/countries/246 [accessed 21st May 2024].*

ONLINE APPENDIX

Improving Performance Through Allocation and Competition: Evidence from a Patient Choice Reform

Mika Kortelainen[a] ⓡ Liisa T. Laine[b] ⓡ Konsta Lavaste[c]
ⓡ Tanja Saxell[d] ⓡ Luigi Siciliani[e]

[a] University of Turku, Finnish Institute for Health and Welfare

[b] University of Missouri, IZA

[c] Finnish Institute for Health and Welfare, University of Jyväskylä

[d] Aalto University, VATT Institute for Economic Research, Helsinki GSE

[e] University of York

A1. Data

We use de-identified, non-coded data on public hospital discharges and admissions in Finland in 2004–2010. The discharge data, officially known as the Care Register for Health Care, are from the Finnish Institute for Health and Welfare.

A1.1. Hospital Treatment Spell Construction

The discharge data are at the level of hospital treatment episodes and do not contain identifiers for hospital treatment spells.[38] Hence we use information on hospital admission and discharge dates to identify the spells. We made the following assumptions when assigning observations to the spells: hospital treatment episodes a and b of patient i belong to the same hospital treatment spell if

- admission date in episode $a \leq$ admission date in episode $b \leq$ discharge date in episode a, or
- admission date in episode $a =$ admission date in episode b.

Treatment episodes in nursing homes and other long-term care facilities are excluded from the data before constructing the hospital treatment spells. We analyze treatment spells that began between January 1st 2004 and December 31st 2010 (our observation period).

A1.2. Sample Construction

For our baseline estimations, we construct three estimation samples of surgeries from the discharge data: planned (primary) hip replacement surgeries, planned (primary) knee replacement surgeries, and all planned orthopedic surgeries. We identified the surgeries based on the main procedure code and the type of hospital admission: non-emergency/planned.[39] In total, the hip replacement sample includes 8, the knee replacement sample includes 7, and the full orthopedic sample includes 648 detailed surgery types.

For our analyses on the quality spillover effect on emergency care, we also constructed three emergency care samples based on the main diagnosis code (ICD-10): AMI, stroke, and hip fracture admissions. The main inclusion criteria for different samples are shown in the table below. We also identified all planned surgeries for the purpose of calculating the predicted HHI that we use in our quasi-DiD approach.

A1.3. Combining Discharge Data with Additional Data Sources

After constructing the samples from the discharge data, the samples are combined with with additional de-identified, non-coded administrative data. First, patients' dates of death are from Statistics Finland's Causes of Death Registry. Second, the grid locations of patients' residences at the end of each year are from

[38] Hospital treatment spell is a collection of treatment episodes (often just one episode) denoting the entirety of a patient's hospital stay from admission to the initial hospital to discharge from the final hospital. For example, a surgery and the following post-operative care are often two separate episodes but comprise one spell. Note that a patient might be transferred to another hospital for post-operative care, hence one hospital treatment spell can include care in several hospitals.

[39] Primary surgery means the initial rather than revision surgery. Our sample of all orthopedic surgeries includes both primary and revision surgeries because they are separately identifiable only for some surgeries such as hip and knee replacements.

Main Inclusion Criteria of Different Estimation Samples

Sample/description	Procedure codes[a]	Diagnosis codes (ICD-10)[b]
Planned surgeries:		
Primary hip replacement surgeries	NFB*	
Primary knee replacement surgeries	NGB*	
Orthopedic surgeries	N* excluding the ones in which third character is a number[c]	
All surgeries	A*–Q* excluding the ones in which third character is a number[c]	
Emergency admissions:		
AMI admissions		I21.0, I21.1, I21.2, I21.3, I21.4, I21.9, I22.0, I22.1, I22.8, I22.9
Stroke admissions		I60*, I61*, I62*, I63* I16.4, I16.6, G46*, I67.2, I69.8, R47.0
Hip fracture admissions		S72.0, S72.1, S72.2

[a] According to the Finnish version of the Nordic Classification of Surgical Procedures (NCSP), see (in Finnish): `https://urn.fi/URN:ISBN:978-952-245-858-2`. The code may continue with any set of characters after the symbol *, indicating a more disaggregated classification.
[b] According to ICD-10 codes, see: `https://icd.who.int/browse10/2010/en#/`.
[c] Identification of surgical procedures follows the official statistics by the Finnish Institute for Health and Welfare: `https://urn.fi/URN:NBN:fi-fe201205085475`.

Grid Database by Statistics Finland. The locations are recorded on December 31st each year and are thus not available for those who died or emigrated from Finland mid-year. We assume that patient's grid location at the time of their admission was the same as at the end of the previous year. For the remaining patients whose residence locations are missing (≈ 0.5 percent), we use the coordinates of the center of their home municipality. Throughout the paper, we use the 2010 municipality classification. Third, hospitals' locations are determined by the centers of the municipalities where they are located (we do not have more detailed information on hospital locations). We link the discharge data to the provider registry (TOPI) from the Finnish Institute for Health and Welfare to obtain information on hospitals' municipalities. We also link municipalities with the coordinates of their centers. Fourth, we linked patients' and hospitals' municipalities to hospital districts by data from the Association of Finnish Municipalities. We use the hospital district classification of 2010.

A1.4. Measures of Hospital Performance

We provide details on the measures of hospital performance (for more details on the construction of other variables, see the working paper version of this paper: Kortelainen et al. (2023)). We calculate the 30-day follow-up period of emergency readmission from discharge from the last, rather than the initial, hospital in the treatment spell to account for transfers to another hospital after surgery (Torkki, 2012). The practice is similar to transferring patients to post-acute care facilities in the U.S. In our data, 4–19 percent of patients (depending on the sample) were transferred to another hospital for post-acute care. Similarly, the length of stay includes days in multiple hospitals in case there were hospital transfers.

Waiting time is readily available in the discharge data, but some hospitals or hospital districts have

reported it less consistently than others. In the hip replacement sample, 21 percent of waiting time values are missing, while the same is true for 22 percent of observations in the knee replacement sample and for more than 30 percent of the sample of all orthopedic surgeries.[40] We implement comprehensive robustness checks in Section VIII, and confirm that the missing values do not bias the estimates of the

A1.5. Actual HHI

We constructed the hospital-level Herfindahl-Hirschman Index (HHI) in two steps. First, we calculated a municipality-level HHI value for each municipality m in each quarter t as a sum of squared market shares:

$$HHI_{mt}^{MUN} = \sum_{h=1}^{H} \left(\frac{n_{hmt}}{N_{mt}} \right)^2, \tag{A.1}$$

where n_{hmt} is the number of patients from municipality m who underwent surgery in hospital h in quarter t. N_{mt} is the total number of surgical patients from municipality m.

Second, we calculated the hospital-level HHI as a weighted average of the values of municipality-level HHI, using each municipality's share of the hospital's total patient volume as weights:

$$HHI_{ht}^{HOSP} = \sum_{m=1}^{M} \left(\frac{n_{mht}}{N_{ht}} \times HHI_{mt}^{MUN} \right), \tag{A.2}$$

where n_{mht} is the number of patients from municipality m who underwent surgery in hospital h in quarter t. N_{ht} is the total number of patients (from any municipality) who underwent surgery in hospital h. We refer to HHI_{ht}^{HOSP} as the *actual* HHI. We calculated it separately for samples of hip replacement surgeries, knee replacement surgeries, and all orthopedic surgeries.

A2. Quasi-DiD and Control Function Approaches: Further Details

A2.1. Predicted HHI

Following Kessler and McClellan (2000) and the patient choice reform literature (Gaynor, Moreno-Serra and Propper, 2013), we construct a predicted version of the HHI and use it as the continuous treatment variable in the quasi-DiD specification (4). We calculate the predicted HHI in four steps. First, we estimate the predicted hospital volumes using data on *all* planned surgery patients. We restrict the sample to patients aged 18–74 and allow them to choose any hospital in Finland. We estimate how travel distance and other observable patient and hospital characteristics affect the probability of patient i choosing hospital h in quarter t. Specifically, we estimate the following conditional logit model separately for each quarter during

[40] Compared to hip and knee replacements, it is more likely that hospitals do not record waiting times for minor procedures included in the broad class of all orthopedic surgeries.

Q1/2004–Q4/2010:

$$\begin{aligned} U_{iht} &= V_{iht} + \varepsilon_{iht} \\ &= \alpha_{0t} + \alpha_{1t}\mathbf{X}_{iht} + \alpha_{2t}\text{km}_{iht} + \alpha_{3t}\text{km}_{iht}^2 \\ &+ \alpha_{4t}(\mathbf{X}_{iht} \times \text{km}_{iht}) + \alpha_{5t}(\mathbf{X}_{iht} \times \text{km}_{iht}^2) + \varepsilon_{iht}, \end{aligned} \tag{B.1}$$

where km_{iht} is the distance between patient i's residence and hospital h in kilometers and $\mathbf{X}_{iht}$ are the hospital characteristics: an indicator for hospital h being located in the same hospital district as patient i, an indicator for teaching hospital, and an indicator for regional hospital.[41] Patient i chooses hospital h with the probability of:

$$P_{iht} = \exp(V_{iht})\Big[\sum_{h' \in S_i} \exp(V_{ih't})\Big]^{-1}, \tag{B.2}$$

Second, we calculate the predicted volume of each hospital's patients from a given municipality m as a sum of probabilities over all these patients.[42] Third, we calculate the predicted municipality-level HHI as the sum of the squares of the predicted market shares (based on the predicted volumes):

$$\widehat{HHI}_{mt}^{MUN} = \sum_{h=1}^{H} \left(\frac{\widehat{n}_{hmt}}{\widehat{N}_{mt}} \right)^2 \tag{B.3}$$

$\widehat{n}_{hmt}$ is the predicted volume from municipality m, that is the number of patients from that municipality who were operated on by hospital h in quarter t. $\widehat{N}_{mt}$ is the predicted number of patients from municipality m (operated on by any hospital).

Fourth, the predicted hospital-level HHI is calculated as a weighted average of the values of the predicted municipality-level HHI, using each municipality's share of the hospital's predicted total patient volume as weights:

$$\widehat{HHI}_{ht}^{HOSP} = \sum_{m=1}^{M} \left(\frac{\widehat{n}_{mht}}{\widehat{N}_{ht}} \times \widehat{HHI}_{mt}^{MUN} \right) \tag{B.4}$$

$\widehat{n}_{mht}$ is the predicted number of patients from municipality m who were operated by hospital h in quarter t. $\widehat{N}_{ht}$ is the total predicted number of patients (from any municipality) operated by hospital h.

Our model predicts approximately 85 percent of patients' choices correctly in Q1/2004–Q4/2010. The share is higher than what Gaynor, Moreno-Serra and Propper (2013) predict in a United Kingdom setting (approximately 75 percent). The correlation between the actual and predicted HHI is 0.86. The correlation is higher than what Moscelli et al. (2018) predict in the United Kingdom setting (0.65–0.80).

[41] The specification for predicting hospital choices is similar to Moscelli et al. (2018) and Moscelli, Gravelle and Siciliani (2021). An alternative specification used by Gaynor, Moreno-Serra and Propper (2013) includes differential distances and interactions between hospital and patient characteristics, and we confirmed that it yields hospital volumes that result in similar HHI values to the specification we use.

[42] An alternative way is to determine the option with the highest probability and regard it as the predicted choice. The predicted volume would be counted as sums of these choices.

Finally, we fix the predicted HHI to its pre-reform mean, as follows:[43]

$$\widehat{HHI}_h^{HOSP} = \frac{\sum_{t=2004Q1}^{2007Q3} \widehat{HHI}_{ht}^{HOSP}}{15} \tag{B.5}$$

We refer to $\widehat{HHI}_h^{HOSP}$ used in our quasi-DiD analyses as the *predicted* HHI.

A2.2. Control Function Approach

The continuous treatment variable in the quasi-DiD approach (predicted HHI) is affected by patients' choices, which may correlate with unobserved quality. We follow Moscelli, Gravelle and Siciliani (2021) to control for time-varying patient selection to hospitals using a control function approach. In the first stage, we estimate the following conditional logit model separately for each quarter in Q1/2004–Q4/2010:

$$\begin{aligned} U_{iht} &= V_{iht} + \xi_{iht} \\ &= \lambda_{1t}\text{km}_{ih} + \lambda_{2t}\text{km}_{ih}^2 + \lambda_{3t}\text{km}_{ih}^3 + \lambda_{4t}\text{nearest}_{ih} \\ &+ \lambda_{5t}\text{sameHD}_{ih} + \lambda_{6t}\text{teaching}_h + \lambda_{7t}\text{regional}_h + \xi_{iht}, \end{aligned} \tag{B.6}$$

where km_{ih} is the distance between the patient and the hospital, nearest_{ih} is an indicator for h being the geographically nearest hospital for patient i, sameHD_{ih} is an indicator for patient i and hospital h being located in the same hospital district, and teaching_h and regional_h are indicators for teaching and regional hospitals.[44] The chosen covariates reflect geographical access (km_{ih}, nearest_{ih}) and factors potentially relevant to hospital choice post-reform (sameHD_{ih}, teaching_h, regional_h).[45] Patient i chooses hospital h with a probability of

$$P_{iht} = \exp(V_{iht})\Big[\sum_{h' \in S_i} \exp(V_{ih't})\Big]^{-1}, \tag{B.7}$$

After calculating the choice probabilities, we can derive the set of residuals (one for each hospital h):

$$\hat{r}'_{it} = [\hat{r}_{i1t}, \hat{r}_{i2t}, \ldots, \hat{r}_{iHt}] = C_{iht} - \widehat{P}_{iht} \tag{B.8}$$

All these residuals ($H = 29$–32 depending on the sample) are then added to the second-stage specification (4).

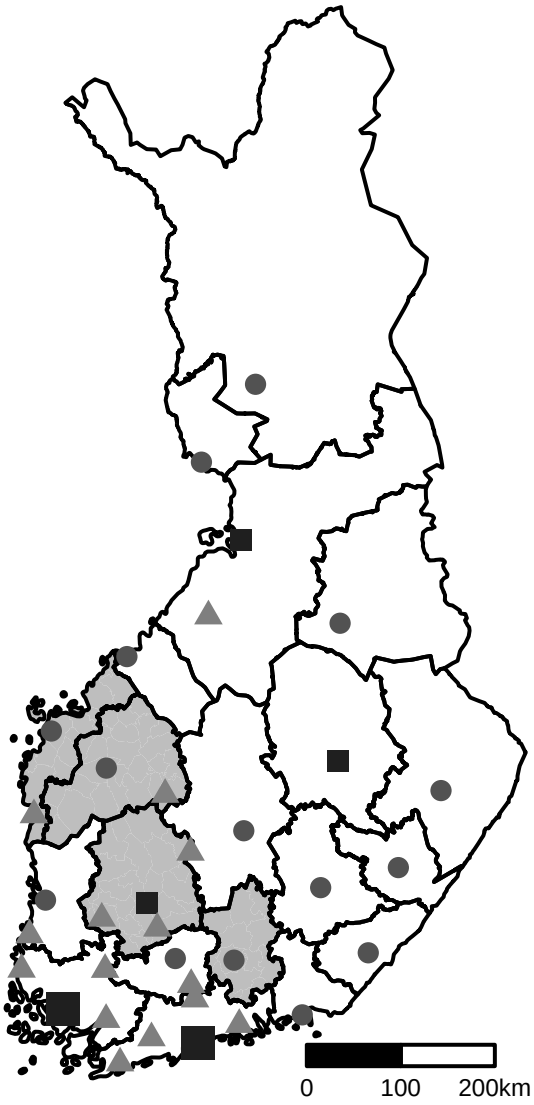
[43] Note that the conditional logit model (equation (B.1)) and its parameters are estimated separately for each period. In practice, we only use estimates from the pre-reform period in constructing the predicted HHI.

[44] Baseline = central hospitals. We let patients choose among all hospitals in Finland ($N = 29$–32 hospital IDs depending on the sample, where some neighboring hospitals are recorded under a joint identifier). This is essentially the same as in Moscelli, Gravelle and Siciliani (2021), who restrict patients' choice sets to the closest 50 hospitals in the country.

[45] The covariates differ from the choice model in section A2.1, because the predicted HHI concerns only the restricted *pre-reform* choices, for which these factors were much less relevant, while the control function also targets the unrestricted *post-reform* choices in the reform area.

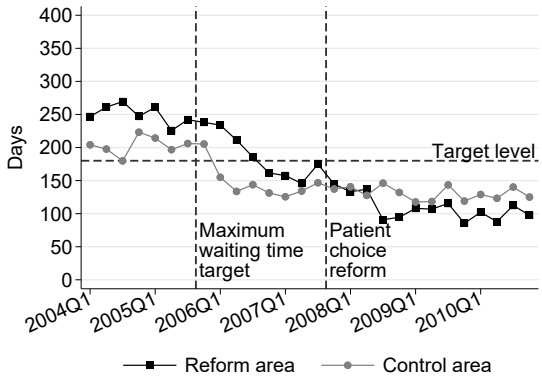
A3. Figures

Figure A1: Teaching, Central, and Regional Hospital Locations

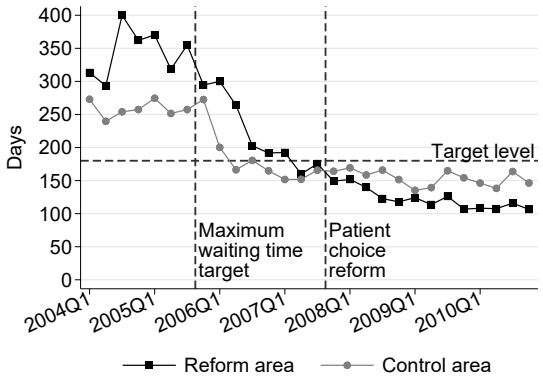


Notes: Borders indicate hospital districts in 2007 and the shaded area constitutes the 2007 reform area. Squares are teaching hospitals, dots central hospitals, and triangles regional hospitals. The large squares mark the capital region (9 hospitals) and the Turku region (4 hospitals), both of which had one teaching hospital and several regional hospitals. In total, there were $N = 9$ hospitals in the reform area and $N = 37$ hospitals in the control area. The figure includes all public hospitals which performed planned orthopedic surgeries (excluding municipal-owned hospitals), although some of them did not perform hip and/or knee replacement surgeries.

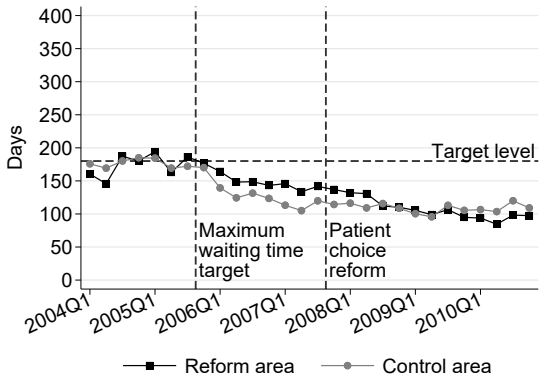
Figure A2: Mean Waiting Time



Panel A. Hip replacements



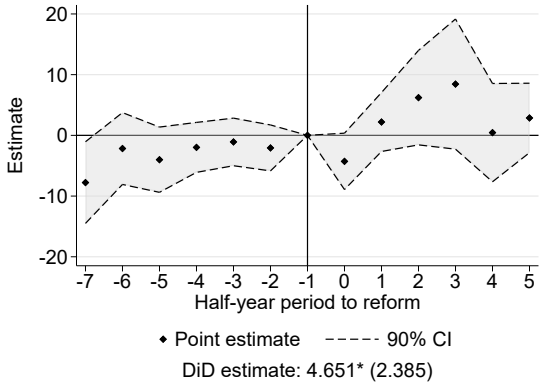
Panel B. Knee replacements



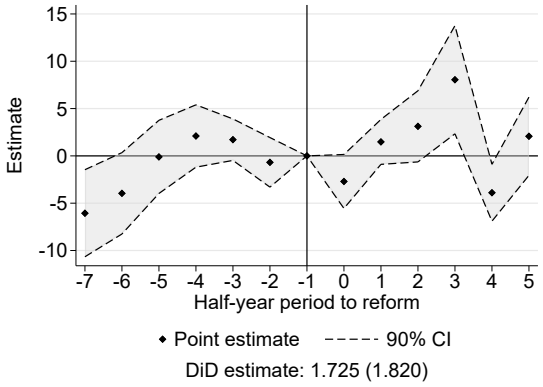
Panel C. All orthopedic surgeries

Notes: The figure plots the evolution of mean waiting time over time in the reform and control areas. The dashed vertical line indicates the introduction of a maximum waiting time target that guarantees medical treatment within 6 months and the dashed horizontal line indicates the 6-month target level.

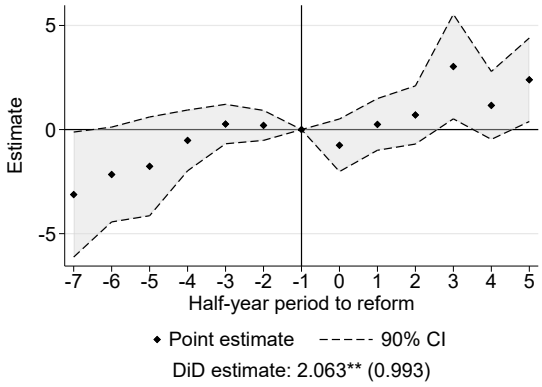
Figure A3: The Effect of the Reform on Travel Distance of Surgical Patients



Panel A. Hip replacements



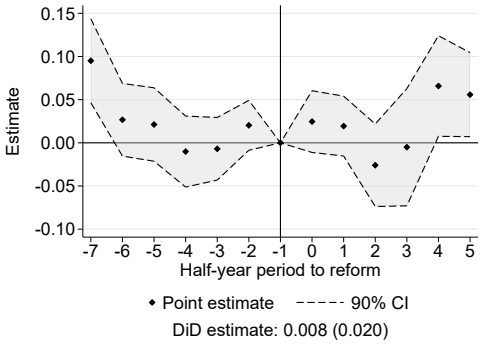
Panel B. Knee replacements



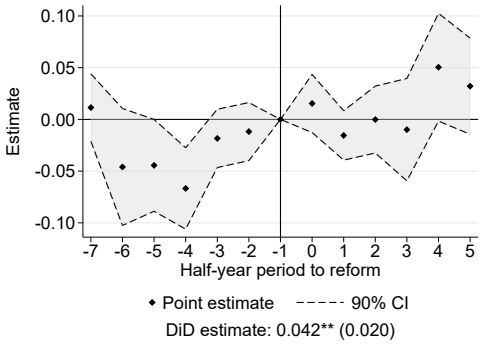
Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in kilometers) shown in Column 2 of Table 3.

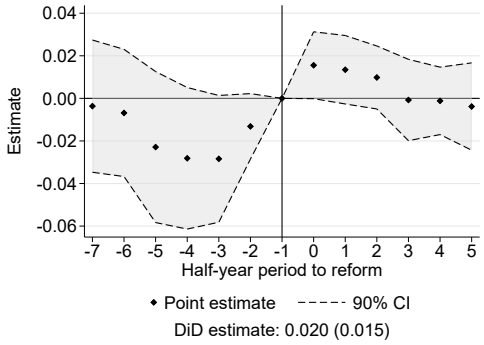
Figure A4: The Effect of the Reform on Probability of Surgical Patients Being Operated On In Their Nearest Hospital



Panel A. Hip replacements



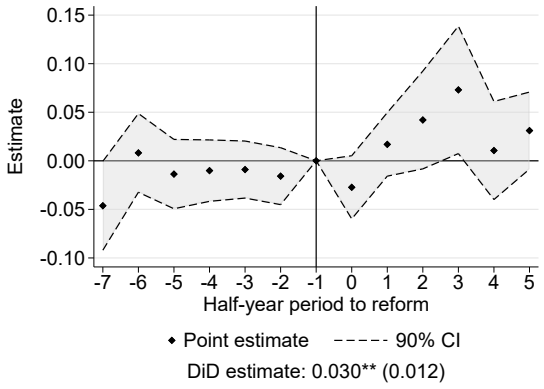
Panel B. Knee replacements



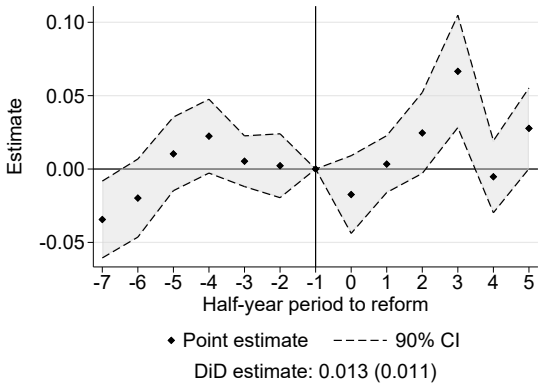
Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in percentage points) shown in Column 3 of Table 3.

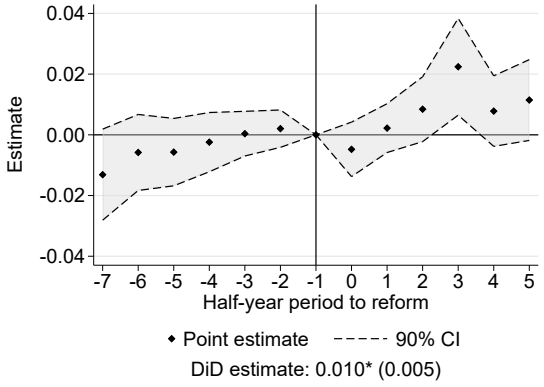
Figure A5: The Effect of the Reform on Probability of Surgical Patients Being Operated On Outside Their Own Hospital District



Panel A. Hip replacements



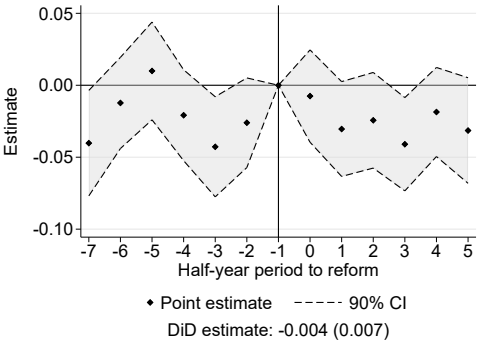
Panel B. Knee replacements



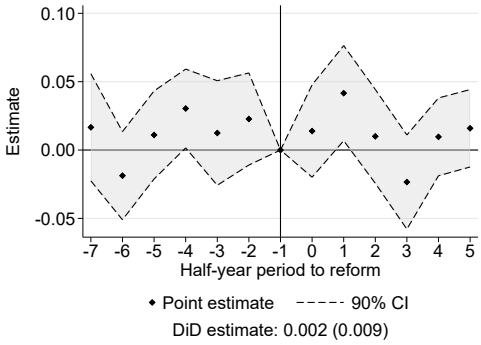
Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in percentage points) shown in Column 4 of Table 3.

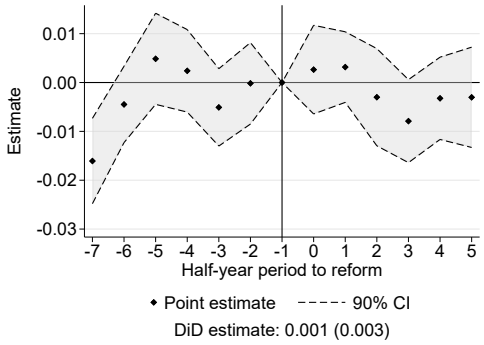
Figure A6: The Effect of the Reform on Emergency Readmissions of Surgical Patients



Panel A. Hip replacements



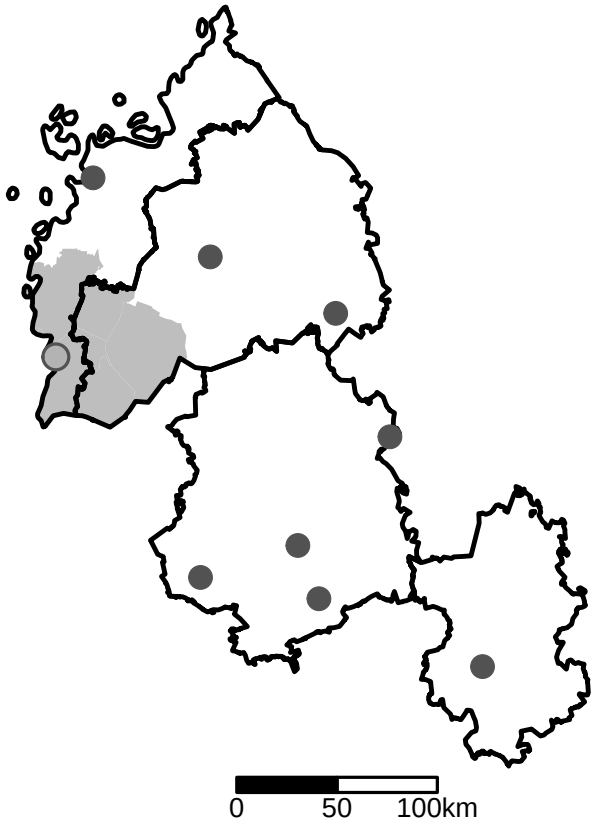
Panel B. Knee replacements



Panel C. All orthopedic surgeries

Notes: Estimated using equation (2). Includes the DiD estimates (in percentage points) shown in Column 1 of Table 4.

Figure A7: Areas Excluded As a Robustness Check for Being Affected by the Closure of a Reform Area Hospital



Notes: The figure plots the map of the reform area in 2007 with hospital district borders. Dots mark reform area hospitals. The dot with an empty middle marks the hospital which closed down in the pre-reform period. Patients living in the shaded area around the closed hospital were excluded from the robustness check estimation.

A4. Tables

Table A1: Top-20 Orthopedic Surgeries in 2004–2010

Rank	Group[a]	Description	Share[b]
1	NGD*	Operations on meniscus of knee	11%
2	NGB*	Primary knee replacement surgeries	9%
3	NGF*	Operations on synovia and joint surfaces of knee	8%
4	NFB*	Primary hip replacement surgeries	7%
5	NBG*	Excision, reconstruction and fusion of joints of shoulder	7%
6	NHG*	Excision, reconstruction and fusion of joints of ankle and foot	4%
7	NDM*	Operations on fascia, ganglia, synovial sheaths and bursae of wrist and hand	4%
8	NHK*	Operations on bone of ankle and foot	4%
9	NGA*	Exploratory procedures on knee and lower leg	3%
10	NHU*	Removal of implants and external fixation devices from ankle and foot	3%
11	NBL*	Operations on muscles and tendons of shoulder and upper arm	3%
12	NDU*	Removal of implants and external fixation devices from wrist and hand	2%
13	NAG*	Excision, reconstruction and fusion of joints of spine	2%
14	NBE*	Operations on capsules and ligaments of joints of shoulder	2%
15	NGE*	Operations on capsules and ligaments of knee joint	2%
16	NDG*	Excision, reconstruction and fusion of joint of wrist and hand	2%
17	NHL*	Operations on muscles and tendons of ankle and foot	1%
18	NBT*	Miscellaneous operations on shoulder or upper arm	1%
19	NBA*	Exploratory procedures on shoulder and upper arm	1%
20	NDL*	Operations on muscles and tendons of wrist and hand	1%
		Other orthopedic surgeries	20%

[a] According to the Finnish version of the Nordic Classification of Surgical Procedures (NCSP). The grouping is based on the procedure code's first three characters (the code may continue with any set of characters after the symbol *, indicating a more disaggregated classification).

[b] The number of observations for each group is divided by the number of observations for all orthopedic surgeries in 2004–2010 ($N = 418,109$).

Table A2: Descriptive Statistics: Hospital Volume and Actual HHI by Hospital Type

	Hospital volume[a]				Actual HHI[b]			
	All	Teaching	Central	Regional	All	Teaching	Central	Regional
Panel A. Hip replacement surgeries								
Mean	36.94	92.29	30.46	16.28	0.87	0.89	0.92	0.77
SD	(35.14)	(46.73)	(16.66)	(8.92)	(0.12)	(0.09)	(0.09)	(0.12)
N	802	140	418	244	802	140	418	244
Panel B. Knee replacement surgeries								
Mean	44.74	104.73	37.73	22.15	0.89	0.89	0.94	0.80
SD	(39.69)	(52.88)	(20.89)	(12.86)	(0.12)	(0.11)	(0.08)	(0.12)
N	800	140	418	242	800	140	418	242
Panel C. All musculoskeletal surgeries								
Mean	506.52	1282.28	415.56	217.25	0.79	0.85	0.85	0.64
SD	(501.98)	(743.66)	(184.80)	(103.37)	(0.12)	(0.09)	(0.06)	(0.07)
N	802	140	418	244	802	140	418	244

Notes: Values calculated from hospital-quarter level data spanning from Q1/2004 to Q4/2010.
[a] Number of patients.
[b] Hospital-quarter level actual HHI (0–1).

Table A3: Descriptive Statistics: Quality, Waiting Time, and Length of Stay, by Hospital Type

	Risk-adjusted readmission rate[a]				Mean waiting time[b]				Mean length of stay[c]			
	All	Teaching	Central	Regional	All	Teaching	Central	Regional	All	Teaching	Central	Regional
Panel A. Hip replacement surgeries												
Mean	0.08	0.08	0.08	0.08	155.76	153.01	177.30	126.33	7.97	6.63	8.26	8.24
SD	(0.01)	(0.01)	(0.01)	(0.01)	(73.91)	(58.85)	(78.19)	(65.27)	(2.81)	(2.03)	(2.87)	(2.86)
N	802	140	418	244	668	135	315	218	802	140	418	244
Panel B. Knee replacement surgeries												
Mean	0.11	0.11	0.11	0.11	186.78	196.95	210.56	145.12	7.35	6.63	7.62	7.30
SD	(0.02)	(0.01)	(0.02)	(0.02)	(95.07)	(89.35)	(103.28)	(68.81)	(2.02)	(1.80)	(2.06)	(1.98)
N	800	140	418	242	658	135	312	211	800	140	418	242
Panel C. All musculoskeletal surgeries												
Mean	0.06	0.07	0.06	0.06	128.11	138.47	140.21	101.67	2.22	2.83	2.15	2.00
SD	(0.01)	(0.01)	(0.01)	(0.01)	(57.10)	(46.98)	(63.90)	(38.90)	(0.76)	(0.97)	(0.60)	(0.67)
N	802	140	418	244	775	140	398	237	802	140	418	244

Notes: Values calculated from hospital-quarter-level data spanning from Q1/2004 to Q4/2010.
[a] Risk-adjusted 30-day readmission rate (0–1). Risk-adjusted by predicting patients' probability of readmission within 30 days with age, sex, number of emergency admissions within one year prior to the surgery, weekend indicator, time fixed effects, and surgery type fixed effects.
[b] Mean waiting time in days (no risk-adjustment). Some hospitals did not report any waiting times in some quarters, which is depicted as a smaller N.
[c] Mean length of stay in days (no risk-adjustment).

Table A4: Descriptive Statistics: Hospital Expenditure for All Surgeries by Hospital Type

	No weights				DRG weights[a]			
	All	Teaching	Central	Regional	All	Teaching	Central	Regional
Panel A. Total expenditure (millions of €)[b]								
Mean	30.13	100.42	24.22	6.77				
SD	(41.54)	(67.96)	(8.64)	(3.09)				
N	224	35	112	77				
Panel B. Expenditure per patient (€)[c]								
Mean	617.86	921.71	619.59	477.22	420.49	460.62	425.86	394.43
SD	(170.32)	(111.10)	(87.72)	(76.17)	(47.15)	(38.18)	(44.31)	(39.14)
N	224	35	112	77	224	35	112	77

Notes: Values calculated from hospital-year-level data spanning from 2004 to 2010.
[a] Number of patients (treatment episodes) multiplied by DRG weights, which describe the relative average expenditure for operating on patients in a particular DRG category.
[b] Hospital's annual care-related expenditure in the surgical ward. (€, deflated using prices in 2000)
[c] Hospital's annual care-related expenditure in the surgical ward. (€, deflated using prices in 2000) divided by number of patients (treatment episodes) in the surgical ward.

Table A5: Descriptive Statistics: Quality, Waiting Time, and Length of Stay in Teaching Hospitals, by Area (Reform and Control)

	Risk-adjusted readmission rate[a]		Mean waiting time[b]		Mean length of stay[c]	
	Reform area	Control area	Reform area	Control area	Reform area	Control area
Panel A. Hip replacement surgeries						
Mean	0.08	0.08	158.69	151.53	5.90	6.82
SD	(0.01)	(0.01)	(75.15)	(54.12)	(0.87)	(2.19)
N	28	112	28	107	28	112
Panel B. Knee replacement surgeries						
Mean	0.11	0.11	208.06	194.04	5.85	6.82
SD	(0.01)	(0.01)	(122.04)	(79.11)	(0.73)	(1.93)
N	28	112	28	107	28	112
Panel C. All orthopedic surgeries						
Mean	0.08	0.07	141.36	137.74	4.41	2.43
SD	(0.00)	(0.01)	(55.58)	(44.83)	(0.54)	(0.56)
N	28	112	28	112	28	112

Notes: Values calculated from hospital-quarter level data spanning from Q1/2004 to Q4/2010.
[a] Risk-adjusted 30-day readmission rate (0–1). Risk-adjusted by predicting patients' probability of readmission within 30 days with age, sex, number of emergency admissions within one year prior to the surgery, weekend indicator, time fixed effects, and surgery type fixed effects.
[b] Mean waiting time in days (no risk-adjustment). Some hospitals did not report any waiting times in some quarters, which is depicted as a smaller N.
[c] Mean length of stay in days (no risk-adjustment).

Table A6: Descriptive Statistics: Mean Age, Share of Females, and Mean Number of Previous Emergency Admissions in Teaching Hospitals, by Area (Reform and Control)

	Mean age[a]		Share of females[b]		Mean N of pre-surgery emergency admissions[c]	
	Reform area	Control area	Reform area	Control area	Reform area	Control area
Panel A. Hip replacement surgeries						
Mean	61.65	60.79	0.52	0.53	0.30	0.43
SD	(0.93)	(1.80)	(0.05)	(0.07)	(0.10)	(0.18)
N	28	112	28	112	28	112
Panel B. Knee replacement surgeries						
Mean	64.12	63.31	0.66	0.67	0.31	0.39
SD	(0.65)	(1.32)	(0.03)	(0.06)	(0.06)	(0.15)
N	28	112	28	112	28	112
Panel C. All orthopedic surgeries						
Mean	55.17	50.72	0.53	0.53	0.62	0.63
SD	(1.17)	(1.22)	(0.03)	(0.02)	(0.08)	(0.12)
N	28	112	28	112	28	112

Notes: Values calculated from hospital-quarter level data spanning from Q1/2004 to Q4/2010.
[a] Mean age at the time of admission (18–74).
[b] Share of females out of all patients.
[c] Mean number of emergency readmissions the hospital's patients had within 1 year before their surgery.

Table A7: Robustness Check: All Orthopedic Surgeries Except Hip and Knee Replacements (Choice Outcomes)

	Teaching hospital[a]	Distance (km)[b]	Nearest hospital[c]	Different hospital district[d]
	(1)	(2)	(3)	(4)
$\text{Treated}_h \times \text{Post}_t$	-0.002	0.187	0.027*	-0.002
	(0.006)	(0.285)	(0.015)	(0.004)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.431	27.820	0.840	0.042
N	352,537	352,537	352,537	352,537
Surgery type / Diagnosis code FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$).
[a] Equals one if the patient was operated on in a teaching (university) hospital.
[b] Distance from the patient's residence to the hospital in kilometers.
[c] Equals one if the patient was operated on in the nearest hospital.
[d] Equals one if the patient was operated on outside their hospital district of residence.

Table A8: The Effects of the Reform Additional Quality Measures

	Revision[a] (1)	Infection[b] (2)	Complication[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.007	-0.001	0.004
	(0.005)	(0.004)	(0.006)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.034	0.012	0.056
N	29,625	29,625	29,625
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.007*	0.001	-0.008
	(0.004)	(0.003)	(0.005)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.031	0.019	0.043
N	35,884	35,884	35,884
Surgery type FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$).
[a] Equals one if the patient had a revision surgery within 2 years of the initial surgery.
[b] Equals one if the patient had an infection or inflammation in the prosthesis within 2 years of the initial surgery.
[c] Equals one if the patient had a mechanical complication in the prosthesis within 2 years of the initial surgery.

Table A9: Robustness Check: Additional Controls (Choice Outcomes)

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.064***	4.599*	0.008	0.030**
	(0.017)	(2.376)	(0.020)	(0.012)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.460	29.847	0.864	0.036
N	29,625	29,625	29,625	29,625
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.046***	1.630	0.042**	0.013
	(0.016)	(1.779)	(0.020)	(0.011)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.436	28.953	0.870	0.033
N	35,884	35,884	35,884	35,884
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.015*	2.064**	0.020	0.010*
	(0.008)	(0.994)	(0.015)	(0.005)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.434	28.046	0.838	0.041
N	418,090	418,090	418,090	418,090
Surgery type / Diagnosis code FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓
Hospital FEs				
N of emergency admissions	✓	✓	✓	✓
Weekend	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$).
[a] Equals one if the patient was operated on in a teaching (university) hospital.
[b] Distance from the patient's residence to the hospital in kilometers.
[c] Equals one if the patient was operated on in the nearest hospital.
[d] Equals one if the patient was operated on outside their hospital district of residence.

Table A10: Robustness Check: Additional Controls (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.005	-67.851***	-0.206
	(0.008)	(12.473)	(0.296)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.080	183.757	8.044
N	29,625	23,481	29,625
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.003	-96.444***	-0.410
	(0.009)	(18.574)	(0.284)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.103	229.671	7.528
N	35,884	28,269	35,884
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.001	-18.118**	-0.198***
	(0.002)	(7.875)	(0.047)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.062	150.935	2.340
N	418,090	294,198	418,090
Surgery type / Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓
Hospital FEs	✓	✓	✓
N of emergency admissions	✓	✓	✓
Weekend	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$).
[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).
[c] Number of days between admission and discharge.

Table A11: Robustness Check: Excluding Patients Near the Reform Area Hospital That Closed Down in the Pre-Reform Period (Choice Outcomes)

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.061***	4.545*	-0.002	0.030**
	(0.018)	(2.461)	(0.019)	(0.013)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.464	29.276	0.870	0.035
N	29,293	29,293	29,293	29,293
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.046***	1.841	0.029	0.015
	(0.016)	(1.843)	(0.018)	(0.011)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.439	28.525	0.874	0.032
N	35,544	35,544	35,544	35,544
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.014*	2.081**	0.000	0.011**
	(0.008)	(1.002)	(0.008)	(0.005)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.436	27.762	0.842	0.041
N	415,348	415,348	415,348	415,348
Surgery type / Diagnosis code FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 319$). All patients from the municipalities of Kristiinankaupunki, Isojoki, Karijoki, Kaskinen, Närpiö, Kauhajoki, and Teuva excluded. See Figure A7 in Appendix A3 for a map.

[a] Equals one if the patient was operated on in a teaching (university) hospital.

[b] Distance from patient's residence to the hospital in kilometers.

[c] Equals one if the patient was operated on in the nearest hospital.

[d] Equals one if the patient was operated on outside their hospital district of residence.

Table A12: Robustness Check: Excluding Patients Near the Reform Area Hospital That Closed Down in the Pre-Reform Period (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.003	-72.214***	-0.138
	(0.008)	(12.309)	(0.318)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.080	183.154	8.018
N	29,293	23,199	29,293
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.002	-97.832***	-0.379
	(0.009)	(18.688)	(0.297)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.103	229.208	7.510
N	35,544	27,985	35,544
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.000	-19.173**	-0.173***
	(0.003)	(7.984)	(0.047)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.062	150.843	2.330
N	415,348	292,413	415,348
Surgery type / Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 319$). All patients from the municipalities of Kristiinankaupunki, Isojoki, Karijoki, Kaskinen, Närpiö, Kauhajoki, and Teuva excluded. See Figure A7 in Appendix A3 for a map.

[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.

[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).

[c] Number of days between admission and discharge.

Table A13: Robustness Check: Excluding Three Western Hospital Districts With Possibilities to Obtain Referral Outside Own Hospital District (Choice Outcomes)

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.057***	2.978**	-0.012	0.034***
	(0.015)	(1.499)	(0.019)	(0.010)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.489	27.495	0.880	0.024
N	27,175	27,175	27,175	27,175
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.052***	2.507*	0.014	0.029***
	(0.015)	(1.486)	(0.017)	(0.010)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.458	27.206	0.880	0.024
N	33,179	33,179	33,179	33,179
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.011	1.903*	-0.001	0.015**
	(0.010)	(0.997)	(0.009)	(0.006)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.458	27.163	0.843	0.038
N	391,237	391,237	391,237	391,237
Surgery type / Diagnosis code FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 291$). Excludes patients who lived in the three Western hospital districts that some degree of patient choice.

[a] Equals one if the patient was operated on in a teaching (university) hospital.

[b] Distance from patient's residence to the hospital in kilometers.

[c] Equals one if the patient was operated on in the nearest hospital.

[d] Equals one if the patient was operated on outside their hospital district of residence.

Table A14: Robustness Check: Excluding Three Western Hospital Districts Where Possible to Obtain Referral Outside Own Hospital District (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.001	-74.513***	0.347
	(0.009)	(14.778)	(0.299)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.081	180.051	7.881
N	27,175	21,379	27,175
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.010	-110.759***	-0.024
	(0.011)	(20.999)	(0.315)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.103	228.605	7.398
N	33,179	26,041	33,179
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.002	-25.012***	-0.108*
	(0.003)	(9.595)	(0.057)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.063	150.245	2.291
N	391,237	276,910	391,237
Surgery type / Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 291$). Excludes patients who lived in the three Western hospital districts that allowed some degree of patient choice.

[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.

[b] Number of days between the specialist's final treatment decision and the surgery. Part of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).

[c] Number of days between admission and discharge.

Table A15: Robustness Check: Excluding Four Northern Hospital Districts Where Possible to Obtain Referral Outside Own Hospital District (Choice Outcomes)

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.066***	4.545*	0.011	0.030**
	(0.018)	(2.438)	(0.021)	(0.012)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.490	28.524	0.859	0.036
N	27,547	27,547	27,547	27,547
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.048***	1.723	0.043**	0.013
	(0.017)	(1.904)	(0.021)	(0.011)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.464	27.883	0.864	0.033
N	33,404	33,404	33,404	33,404
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.015*	2.101**	0.021	0.010*
	(0.008)	(1.064)	(0.015)	(0.006)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.462	26.280	0.833	0.037
N	386,224	386,224	386,224	386,224
Surgery type / Diagnosis code FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 288$). Excludes patients who lived in the four Western hospital districts that some degree of patient choice.

[a] Equals one if the patient was operated on in a teaching (university) hospital.

[b] Distance from patient's residence to the hospital in kilometers.

[c] Equals one if the patient was operated on in the nearest hospital.

[d] Equals one if the patient was operated outside their hospital district of residence.

Table A16: Robustness Check: Excluding Four Northern Hospital Districts Where Possible to Obtain Referral Outside Own Hospital District (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.008	-69.584***	-0.191
	(0.008)	(12.046)	(0.306)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.077	183.916	7.887
N	27,547	22,301	27,547
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.001	-93.675***	-0.434
	(0.010)	(18.405)	(0.289)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.102	231.280	7.398
N	33,404	26,730	33,404
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.000	-15.109*	-0.207***
	(0.003)	(7.799)	(0.048)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.061	152.674	2.321
N	386,224	273,869	386,224
Surgery type / Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 288$). Excludes patients who lived in the three Western hospital districts that some degree of patient choice.
[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).
[c] Number of days between admission and discharge.

Table A17: Robustness Check: Excluding Hospitals That Used a Joint Hospital ID (Choice Outcomes)

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.069***	7.524***	-0.043**	0.056***
	(0.017)	(2.732)	(0.017)	(0.016)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.355	33.089	0.876	0.043
N	19,814	19,814	19,814	19,814
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.048***	4.035***	-0.008	0.033***
	(0.011)	(1.378)	(0.012)	(0.009)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.341	31.085	0.888	0.038
N	24,330	24,330	24,330	24,330
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.021**	1.797***	0.002	0.014***
	(0.008)	(0.637)	(0.009)	(0.004)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.274	30.083	0.859	0.047
N	264,905	264,905	264,905	264,905
Surgery type / Diagnosis code FEs	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 318$).
[a] Equals one if the patient was operated on in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if the patient was operated on in the nearest hospital.
[d] Equals one if the patient was operated outside their hospital district of residence.

Table A18: Robustness Check: Excluding Hospitals That Used a Joint Hospital ID (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.010	-84.872***	0.130
	(0.007)	(12.937)	(0.345)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.083	185.398	7.960
N	19,814	14,941	19,814
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.010	-122.254***	-0.312
	(0.010)	(18.574)	(0.355)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.109	233.832	7.585
N	24,330	18,334	24,330
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.001	-32.061***	-0.136**
	(0.003)	(8.841)	(0.058)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.063	148.667	2.295
N	264,905	183,821	264,905
Surgery type / Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 318$).
[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).
[c] Number of days between admission and discharge.

Table A19: Robustness Check: Tests Regarding Waiting Times

	Baseline	Districts for which <30% missing[a]	Surgeries for which <30% missing[b]	Excluding hospital which did not report waiting times in 2008–2009[c]	2006 vs 2010[d]
	(1)	(2)	(3)	(4)	(5)
Panel A. Hip replacement surgeries					
$\text{Treated}_h \times \text{Post}_t$	-71.524***	-70.601***		-78.705***	-94.832***
	(11.977)	(12.280)		(12.849)	(17.237)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	183.757	188.893		183.231	158.503
N	23,481	19,892		22,475	7,848
Panel B. Knee replacement surgeries					
$\text{Treated}_h \times \text{Post}_t$	-97.614***	-97.301***		-113.376***	-114.880***
	(18.255)	(19.015)		(18.466)	(20.460)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	229.671	234.900		230.647	196.198
N	28,269	23,809		27,045	9,716
Panel c. All orthopedic surgeries					
$\text{Treated}_h \times \text{Post}_t$	-18.535**	-23.358***	-27.868***	-23.524***	-42.332***
	(7.844)	(8.754)	(9.573)	(8.414)	(9.461)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	150.935	150.075	158.491	151.307	134.116
N	294,198	245,032	237,948	285,303	92,702
Surgery type / Diagnosis code FEs	✓	✓	✓	✓	✓
Municipal FEs	✓	✓	✓	✓	✓
Age & sex	✓	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality (N = 324–326 depending on the column). Outcome in all columns is waiting time in days.

[a] Including only hospitals in districts in which less than 30 percent of the waiting time values were missing in 2004–2010.

[b] Including only those surgeries for which less than 30 percent of the waiting time values were missing in 2004–2010.

[c] Excluding one reform area hospital which did not report most of its waiting times in Q1/2008–Q4/2009.

[d] Including only the years 2006 and 2010, when the share of missing waiting time values was generally low across all regions and hospitals. This analysis mitigates the potential bias which may arise when hospitals' shares of missing waiting time values fluctuate over time.

Table A20: The Effects of the Reform on Emergency Care Quality and Length of Stay

	Death within 30 days[a] (1)	Readmission[b] (2)	Length of stay[c] (3)
Panel A. AMI			
$\text{Treated}_h \times \text{Post}_t$	0.010	-0.007	-0.200
	(0.008)	(0.010)	(0.591)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.072	0.179	8.724
N	32,107	32,107	32,107
Panel B. Stroke			
$\text{Treated}_h \times \text{Post}_t$	0.004	-0.044***	-0.615
	(0.007)	(0.012)	(0.783)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.082	0.199	16.231
N	48,495	48,495	48,495
Panel C. Hip fracture			
$\text{Treated}_h \times \text{Post}_t$	-0.007	-0.025	-1.697
	(0.007)	(0.019)	(1.480)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.030	0.195	21.805
N	10,747	10,747	10,747
Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$ depending on the sample).
[a] Equals one if the patient died (before or after discharge) within 30 days of admission.
[b] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[c] Number of days between admission and discharge.

Table A21: The Effect of the Reform on Hospital-level Waiting Times After Adjusting to the Introduction of Maximum Waiting Time Target

	Whole time period		After target	
	DiD (1)	Heterogeneity (2)	DiD (3)	Heterogeneity (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	-83.110**	-68.900	-35.524*	-22.548
	(35.522)	(44.454)	(17.338)	(14.790)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-48.217		-49.730*
		(46.002)		(24.405)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	174.557	174.557	141.217	141.217
N	668	668	401	401
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	-111.100**	-98.275	-48.931**	-43.824*
	(42.234)	(56.985)	(17.263)	(23.820)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-40.523		-20.868
		(58.399)		(31.406)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	215.895	215.895	163.569	163.569
N	664	664	397	397
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	-14.575	-8.785	-19.068*	-15.152
	(11.235)	(18.590)	(10.588)	(16.273)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-33.458*		-21.266
		(18.274)		(17.630)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	135.748	135.748	114.912	114.912
N	845	845	509	509
Hospital and time FEs	✓	✓	✓	✓
Age & sex mix[a]	✓	✓	✓	✓
Surgery types[b]	✓	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Outcome in all columns is mean waiting time in hospital h in quarter t. Columns 1–2 include hospital-quarter-level observations from Q1/2004 to Q4/2010 and Columns 3–4 observations from Q4/2006 to Q4/2010. Standard errors clustered at the hospital district level ($N = 20$).

[a] Shares of females, 18–29, 30–39, 40–49, 50–59, and 70–74-year-old patients of all of the hospital's patients. Baseline = share of 60–69-year-old male patients.

[b] Shares of different procedure codes among the hospital's patients.

Table A22: The Effect of the Reform on Patient Characteristics at the Hospital Level

	Mean age[a]		Female (%)[b]		Emergency admissions[c]	
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A. Hip replacement surgeries						
$\text{Treated}_h \times \text{Post}_t$	0.834	0.828	-0.009	-0.017	0.119**	0.111*
	(0.730)	(0.949)	(0.017)	(0.016)	(0.056)	(0.056)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-0.181		0.021		-0.016
		(1.071)		(0.021)		(0.059)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	63.134	63.134	0.522	0.522	0.480	0.480
N	802	802	802	802	802	802
Panel B. Knee replacement surgeries						
$\text{Treated}_h \times \text{Post}_t$	-0.084	-0.036	-0.034*	-0.044*	0.027	0.014
	(0.185)	(0.241)	(0.019)	(0.022)	(0.058)	(0.063)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		-0.188		0.045**		0.035
		(0.421)		(0.021)		(0.051)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	64.494	64.494	0.659	0.659	0.465	0.465
N	810	810	810	810	810	810
Panel C. All orthopedic surgeries						
$\text{Treated}_h \times \text{Post}_t$	-0.438	-0.511	0.013**	0.010	0.038	0.030
	(0.310)	(0.354)	(0.006)	(0.007)	(0.060)	(0.060)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		0.439		0.017**		0.066
		(0.367)		(0.007)		(0.064)
$\text{mean}(y_{ht}\|\text{Post}_t = 0)$	51.907	51.907	0.520	0.520	0.595	0.595
N	896	896	896	896	896	896
Surgery/diagnosis FEs	✓	✓	✓	✓	✓	✓
Hospital FEs	✓	✓	✓	✓	✓	✓

Notes: Estimated using hospital-quarter-level data in Q1/2004–Q4/2010. t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors clustered at the hospital district level ($N = 20$).

[a] Mean age of patients at the time of admission (18–74).

[b] Share of females of all patients.

[c] Mean number of emergency admissions hospital's patients had within 1 year before their surgery.

Table A23: The Effects on Hospitals' Surgical Expenditure

	Total expenditure (millions of €)[a]		Expenditure per patient (€)[b]	
	DiD	Heterogeneity	DiD	Heterogeneity
	(1)	(2)	(3)	(4)
$\text{Treated}_h \times \text{Post}_t$	-0.521	-1.129	2.213	1.050
	(1.078)	(0.879)	(12.207)	(12.692)
$\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$		10.220**		-0.143
		(3.915)		(17.140)
mean(y_{ht}|$\text{Post}_t = 0$)	28.740	28.740	417.671	417.671
N	224	224	224	224
Hospital and time FEs	✓	✓	✓	✓
Case mix index	✓	✓	✓	✓

Notes: Estimated using hospital-year-level data in 2004–2010. t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Standard errors clustered at the hospital district level ($N = 20$).
[a] Hospital's annual care-related expenditure in the surgical ward (millions of €, deflated using prices in 2000).
[b] Hospital's annual care-related expenditure in the surgical ward (€, deflated using prices in 2000) divided by DRG-weighted number of surgical patients.

Table A24: The Marginal Effects of Concentration on Quality of Care, Waiting Time, and Length of Stay

	Readmission[a]	Waiting time[b]	Length of stay[c]
	(1)	(2)	(3)
Panel A. Hip replacement surgeries			
$\text{PredictedHHI}_h \times \text{Post}_t$	0.152	170.199	-19.150***
	[-0.042, 0.329]	[-322.737, 639.127]	[-25.362, -12.596]
mean(y_{imht}|$\text{Post}_t = 0$)	0.071	212.851	7.756
N	6,974	6,393	6,974
Panel B. Knee replacement surgeries			
$\text{PredictedHHI}_h \times \text{Post}_t$	0.038	411.592	-19.526***
	[-0.299, 0.412]	[-156.686, 981.157]	[-24.287, -14.198]
mean(y_{imht}|$\text{Post}_t = 0$)	0.103	265.332	7.485
N	8,276	7,541	8,276
Panel C. All orthopedic surgeries			
$\text{PredictedHHI}_h \times \text{Post}_t$	0.015	-216.998**	-2.219***
	[-0.040, 0.076]	[-341.779, -88.250]	[-2.901, -1.511]
mean(y_{imht}|$\text{Post}_t = 0$)	0.056	160.512	2.763
N	72,483	56,307	72,483
Surgery type FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓
Control function residuals	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (4). Standard errors clustered at the level of the patient's home municipality ($N = 74$). HHI measured on a 0–1 scale, where higher value indicates more market concentration. See online Appendix A2.2 for further details on the control function approach.
[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).
[c] Number of days between admission and discharge.

Table A25: Back-of-the-Envelope Calculation

		Hip replacement surgeries		Knee replacement surgeries		All orthopedic surgeries	
Variable	Description	Source	Value	Source	Value	Source	Value
Panel A. Benefits of the reform							
g	Health gain from surgery (2010 euros)[a]	Jansson and Granath (2011); Gyrd-Hansen (2003)	4,386.17	Jansson and Granath (2011); Gyrd-Hansen (2003)	3,112.76	Jansson and Granath (2011); Gyrd-Hansen (2003)	2,546.81
	Average age (years)	Table 2	62	Table 2	64	Table 2	52
T	Discounted life expectancy at ave. age[b]		14.75		13.56		19.76
$w_0 \times 365.25$	Waiting time (days), pre-reform	Table 5	140.89	Table 5	165.66	Table 5	120.63
$w_1 \times 365.25$	Waiting time (days), post-reform	Table 5	89.70	Table 5	106.73	Table 5	93.26
	Average volume per hospital/qrt	Table 6	35	Table 6	41	Table 6	462
y_0	Total volume per year, pre-reform[c]	Table 6	1,260	Table 6	1,476	Table 6	16,632
y_1	Total volume per year, post-reform[d]	Table 6	1,414	Table 6	1,990	Table 6	18,061
$g \times (T - w_0) \times y_0$	Total health benefit per year, pre-reform		79,385,171.94		60,216,705.50		823,015,201.20
$g \times (T - w_1) \times y_1$	Total health benefit per year, post-reform		89,943,791.48		82,184,736.11		897,187,972.00
	Total benefit change (post − pre)		10,558,619.54		21,968,030.61		74,172,770.85
Panel B. Costs of the reform (2010 euros)							
c_0	Average cost, pre-reform	Remes et al. (2007)	8,376.50	Remes et al. (2007)	8,503.00	Osnes-Ringen et al. (2011)	6,645.23[e]
	Costs related to LOS per patient[f]						
c_0^{LOS}	- Pre-reform					Osnes-Ringen et al. (2011), Table 4	3,389.07
c_1^{LOS}	- Post-reform					Osnes-Ringen et al. (2011), Table 4	3,118.23
c_1	Average cost, post-reform[g]		8,376.50		8,503.00		6,374.39
$c_1 \times y_1 - c_0 \times y_0$			1,288,238.69		4,370,303.92		4,606,126.26
Panel C. Net effects of the reform							
	Total benefits − total costs		9,270,380.85		17,597,726.69		69,566,644.59

Notes: [a] To measure h, we first use the estimates of the quality of life (EQ-5D index) gains from hip and knee replacements and orthopedic surgeries (index score improvements of 0.31, 0.22, and 0.18, respectively; Jansson and Granath (2011)). Then we measure their monetary value based on the willingness-to-pay estimates by Gyrd-Hansen (2003), which we express in 2010 euros.

[b] The discounted life expectancy is calculated at the average age using a discount factor of 3 percent and expected death at 80 years of age.

[c] y_0 = the average number of patients per hospital and quarter in the pre-reform period × the number of reform area hospitals (N=9) × the number of quarters (N=4).

[d] y_1 = the average number of patients per hospital and quarter in the post-reform period × the number of reform area hospitals (N=9) × the number of quarters (N=4). The post-reform average number of patients is calculated by adding the coefficient estimate of $\text{Treated}_h \times \text{Post}_t$ for the volume (Column 1 of Table 6) to the average pre-reform volume.

[e] c_0 is approximated by taking a weighted average of the costs for different orthopedic surgeries in Osnes-Ringen et al. (2011), using their observation shares as weights and expressed in 2010 euros.

[f] Following Osnes-Ringen et al. (2011), we assume that the costs related to length of stay, c_0^{LOS}, account for 51 percent of the costs in the pre-reform period. In the post-reform period, we take into account shorter length of stays in that period (a decrease of 0.187 days, Table 4). Then the post-reform costs related to LOS could be $c_1^{LOS} = c_0^{LOS}/mean\ LOS * (mean\ LOS - 0.187)$, where $mean\ LOS$ is the mean length of stay in the pre-reform period (2.34 days).

[f] $c_1 = c_0 + (c_1^{LOS} - c_0^{LOS})$.

Table A26: Robustness Check: Effect of the Reform when Controlling for First-Stage Residuals from a Hospital Choice Model (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.003	-100.662***	-1.692***
	(0.005)	(11.834)	(0.264)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.080	183.757	8.044
N	29,625	23,481	29,625
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.016**	-140.146***	-1.584***
	(0.007)	(15.667)	(0.275)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.103	229.671	7.528
N	35,884	28,269	35,884
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	0.000	-56.324***	-0.596***
	(0.002)	(6.769)	(0.041)
$\text{mean}(y_{imht}\|\text{Post}_t = 0)$	0.062	150.935	2.340
N	418,090	294,198	418,090
Surgery type FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓
Control function residuals	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (1). Standard errors clustered at the level of the patient's home municipality ($N = 326$). See online Appendix A2.2 for further details on the control function approach.

[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.

[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).

[c] Number of days between admission and discharge.

Table A27: The Marginal Effects of Concentration Without Controlling for First-Stage Residuals from a Hospital Choice Model

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
PredictedHHI$_h$ × Post$_t$	0.111	291.854	-19.215***
	[-0.070, 0.267]	[-276.330, 783.864]	[-25.489, -12.526]
mean(y_{imht}|Post$_t$ = 0)	0.071	212.851	7.756
N	6,974	6,393	6,974
Panel B. Knee replacement surgeries			
PredictedHHI$_h$ × Post$_t$	0.085	598.836	-21.464***
	[-0.227, 0.410]	[-35.440, 1208.133]	[-26.506, -15.690]
mean(y_{imht}|Post$_t$ = 0)	0.103	265.332	7.485
N	8,276	7,541	8,276
Panel C. All orthopedic surgeries			
PredictedHHI$_h$ × Post$_t$	-0.016	-147.248*	-2.481***
	[-0.060, 0.032]	[-260.873, -28.611]	[-3.244, -1.723]
mean(y_{imht}|Post$_t$ = 0)	0.056	160.512	2.763
N	72,483	56,307	72,483
Surgery type FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓
Control function residuals			

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (4). Standard errors clustered at the level of the patient's home municipality ($N = 74$). HHI measured on a 0–1 scale, where higher value indicates more market concentration. See online Appendix A2.2 for further details on the control function approach.
[a] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days between the specialist's final treatment decision and the surgery. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.4 for more details).
[c] Number of days between admission and discharge.

Table A28: The Marginal Effect of Concentration on Emergency Care Quality and Length of Stay

	Death within 30 days[a] (1)	Readmission[b] (2)	Length of stay[c] (3)
Panel A. AMI			
PredictedHHI$_h$ × Post$_t$	0.197**	0.256	7.915
	[0.031, 0.387]	[-0.069, 0.576]	[-6.689, 24.473]
mean(y_{imht}|Post$_t$ = 0)	0.074	0.154	9.499
N	5,347	5,347	5,347
Panel B. Stroke			
PredictedHHI$_h$ × Post$_t$	-0.137	1.024***	-25.749
	[-0.462, 0.143]	[0.795, 1.319]	[-67.701, 5.545]
mean(y_{imht}|Post$_t$ = 0)	0.070	0.201	15.625
N	9,312	9,312	9,312
Panel C. Hip fracture			
PredictedHHI$_h$ × Post$_t$	0.024	0.316	-28.012
	[-0.218, 0.213]	[-0.566, 1.026]	[-64.740, 9.183]
mean(y_{imht}|Post$_t$ = 0)	0.034	0.211	21.166
N	1,833	1,833	1,833
Diagnosis code FEs	✓	✓	✓
Municipal FEs	✓	✓	✓
Age & sex	✓	✓	✓

Notes: t-test level of significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. Estimated using equation (4). Standard errors clustered at the level of the patient's home municipality ($N = 74$).
[a] Equals one if the patient died (before or after discharge) within 30 days of admission.
[b] Equals one if the patient had an emergency readmission (to any hospital) within 30 days after discharge.
[c] Number of days between admission and discharge.