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

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

[a] *University of Turku, Finnish Institute for Health and Welfare, VATT Institute for Economic Research*
[b] *University of Missouri*
[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 allocative effects of enhancing consumer choice and non-price competition in markets with heterogeneous producers. We use comprehensive administrative data and a difference-in-differences design based on the introduction of a regional patient choice reform for planned surgeries in Finland. We find that the enhanced choice led to a reallocation of patients towards large teaching hospitals and increased concentration in their markets. Waiting times decreased in hospitals exposed to the reform and more patients were treated, with little effect on clinical quality or surgical expenditure after the reform. Our results suggest that enhanced choice can improve public hospital performance and allocative efficiency.

Keywords: Choice Frictions, Reallocation, Heterogeneous Producers, Performance, Competition, Concentration, Patient Choice, Market Structure

JEL: I11, L11, I18, L32, L38

I. Introduction

Choice frictions can hamper the functioning of markets and removing them can result in substantial efficiency gains while potentially reallocating economic activity towards large producers. Choice frictions are particularly salient in the health care sector, where patient choice among producers is restricted by regulation or incomplete information about alternatives. Furthermore, governments are actively seeking effective policies to improve efficiency and performance in their health care systems, given the increasing demand of aging populations and long waiting times for health care services (OECD, 2020; National Audit Office, 2021; Gødøy et al., 2023).[1] Yet, there is limited empirical evidence on whether friction-reducing policies can mitigate these challenges, and what the implications for market structure are.

We provide quasi-experimental evidence on the effects of enhanced patient choice 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 that comprises approximately one-fifth of the Finnish population. Prior to this reform, patients were referred to the closest public hospital within their own health care district. After the reform, patients in the reform area could choose a public hospital in any of the health care districts in the reform area, leaving patients and hospitals outside the reform area unaffected. We take advantage of the nationwide hospital discharge data and a difference-in-differences (DiD) design based on the regional reform to study the effects of enhanced choice on patient allocation across heterogeneous-sized hospitals as well as on their health service delivery.

Patient choice reforms have been implemented at the national level in many countries such as the United Kingdom, Sweden, Denmark, and Norway to facilitate choice and stimulate non-price (waiting time or quality) competition among public hospitals at administratively set prices. However, there is little empirical evidence on the causal effects of patient choice reforms. The empirical challenge for the estimation of causal effects is that the reforms were implemented simultaneously nationwide and no suitable unaffected control group exists. Due to this challenge, the existing literature has studied whether hospital performance changed differently in less concentrated areas compared with more concentrated and potentially less competitive areas after the nationwide choice reforms (Gaynor, Moreno-Serra and Propper, 2013; Cooper et al., 2011; Moscelli et al., 2018; Brekke et al., 2021; Moscelli, Gravelle and Siciliani, 2021, 2023).[2] However, by enabling patient choice among all reform area hospitals, the reforms expanded their markets and exposed all of them to competition. Our research design based on the regional choice reform and a standard DiD methodology provides us with a unique opportunity to estimate the reform's effect in comparison to the unaffected control

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[1]Long waiting times can occur when demand exceeds supply. This might be due to inefficiencies in production and patient allocation processes as well as capacity constraints, for example (OECD, 2020). Long waiting times are common in many health care systems (Gødøy et al., 2023), especially in those with public insurance and restricted choice (Siciliani, Borowitz and Moran, 2013).

[2]This quasi-DiD approach is commonly used in evaluating the marginal effects of continuous treatments in settings where nationwide reforms or shocks apply at the same time to all individuals of interest (Duflo, 2001; Acemoglu, Autor and Lyle, 2004; Finkelstein, 2007).

group, rather than the marginal effect of concentration within the reform area.

We find that the regional choice reform had substantial effects on 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, which have competitive advantages over non-teaching hospitals in terms of resources and reputation.[3] Given that teaching hospitals attracted more patients, concentration, as measured by the Herfindahl-Hirschman Index, increased by up to 9 percent in their markets.

We then study the consequences of the reform for hospital performance in the health care system, which is characterized by prolonged waiting times, approximately 5–6 months for hip and knee replacements. We find that all hospital types treated more patients with shorter waiting times post-reform, consistent with an improvement in hospital performance in response to greater choice and competition. Moreover, hospitals shortened the length of stays for all orthopedic surgeries by 8 percent, with little impact on hospitals' clinical quality (such as emergency readmissions), patient mix, or surgical expenditures.[4] Based on the results, hospitals used resources more efficiently to increase health care production.

By showing evidence on how a policy to reduce choice frictions can improve allocative efficiency and the performance of public hospitals, we contribute to the large literature on the effects of competition, choice, and related reforms in health care, as reviewed by Gaynor, Ho and Town (2015) and Handel and Ho (2021). Our paper is related to a relatively small and recent literature on the effects of narrow health insurance networks that aim to reduce health care spending by steering patients away from high-cost providers through restricted choice and/or limited financial incentives (Gruber and McKnight, 2016; Atwood and Lo Sasso, 2016; Wallace, 2023). Yet, closest to our work is the literature on patient choice reforms that has estimated the marginal effects of concentration post-reform (Gaynor, Moreno-Serra and Propper, 2013; Cooper et al., 2011; Moscelli, Gravelle and Siciliani, 2021; Brekke et al., 2021; Moscelli, Gravelle and Siciliani, 2023). This literature has primarily focused on the effects on hospital performance, rather than the effects on choices or market concentration. An important exception is Gaynor, Propper and Seiler (2016), in which the authors estimated a structural model of demand to study changes in the quality elasticity of demand faced by hospitals post-reform and how this is linked to changes in mortality rates.

We differ from the patient choice literature in two ways. First, as mentioned above, our paper focuses on the effects of enhanced choice using a design-based approach based on standard DiD methodology. Second, we document comprehensive evidence on the effects along various dimensions related to hospital performance and patient allocation, with a specific focus on the roles of producer size and resources employed. Importantly, our DiD design with variation created by the regional patient choice reform also allows us to use market

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[3]Despite their better reputation and higher quality expectations (Newsweek and Statista, 2021), we find that teaching hospitals do not have higher clinical quality or risk-adjusted costs of care for surgical procedures, similar to Silber et al. (2020); Burke et al. (2019). Teaching hospitals, however, have the largest capacity as well as shorter waiting times compared with medium-sided hospitals.

[4]Moreover, there were no hospital entries or exits post-reform.

concentration as an outcome instead of a variable defining the intensity of competition induced by the reform as used in prior work estimating the marginal effects. We show how improvements in competition conditions due to greater choice can promote market concentration towards larger producers.

Our paper thus 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 one hand, it could result from reduced competition, which can lead to higher health care prices (Gowrisankaran, Nevo and Town, 2015) or longer waiting times (Gaynor, Laudicella and Propper, 2012) without improvements in quality. On the other hand, the dominance could signal a well-functioning market environment, where competition and choice enable producers with greater competitive advantages to gain more demand (De Loecker and Syverson, 2021; Van Reenen, 2018; Berry, Gaynor and Scott Morton, 2019; Bighelli et al., 2022). Our results are consistent with the latter conjecture and suggest the positive effects of the pro-competitive choice reform on both large hospital dominance and the functioning of public hospital markets.

Finally, we link the literature analyzing patient choice reforms with an extensive literature studying the allocation of economic activity across heterogeneous producers and its relationship with their performance in a variety of industries (e.g., Syverson, 2011; De Loecker and Syverson, 2021). Chandra et al. (2016) focus on health care and document that higher quality hospitals gain more patients and grow more over time, suggesting an important role for competitive reallocation forces. Unlike that paper, we present quasi-experimental evidence on the allocative effects of enhanced patient choice, with implications for public hospital performance and market concentration. We show that even though the resulting reallocation towards large, better-resourced teaching hospitals did not enhance clinical quality, it shortened waiting times and helped the health care system to meet patient needs with the resources it had available. Our results are thus informative about the effectiveness of choice reforms to improve producer performance in the presence of regulated prices and potentially overloaded waiting lists in public services generally.

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 baseline 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 cost-benefit calculations. Section VIII compares the results on the reform's effects to those obtained for the marginal effects of concentration using a quasi-DiD approach. The last section concludes.

II. Institutional Setting

II.A. The Finnish Health Care System

Finland has a decentralized, universal health care system that is financed primarily through taxation. All permanent residents are entitled to public health care services through universal, public health 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 by primary care physicians and nurses. Primary care physicians act as gatekeepers for planned (non-emergency) hospital-based specialized health care in the public sector.

Specialized health care such as surgeries is provided by public hospitals that are governed by health care districts known as hospital districts ($N = 20$ in 2010). Each municipality is a member of one of the hospital districts and is also responsible of the 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. Hospital-based specialized care is largely provided by the public sector, while the private sector accounts for only approximately 5 percent of hospital activity (Keskimäki et al., 2019).

The Finnish hospital sector consists of heterogeneous producers in terms of size, resources, location, and the services produced. There are large university-based teaching hospitals, medium-sized central hospitals, and small regional hospitals. Every hospital district has either a teaching hospital or central hospital typically located close to the center of the district. In addition, hospital districts may have one or more regional hospitals that only provide services for most common medical conditions. In contrast, teaching hospitals have a much greater range of services compared to non-teaching hospitals that is, central and regional hospitals. This includes services for common medical conditions as well as specialist services for more serious and rare diseases. Moreover, teaching hospitals partner with local university medical schools to provide medical education and conduct medical research, and generally tend to be at early adopters of new technologies (Skinner and Staiger, 2015). There are five such hospitals in Finland, but they have much higher patient volumes, better resources, and capacity compared to non-teaching hospitals ($N = 41$) (Karhunen, 2020). Thus, teaching hospitals have competitive advantages over non-teaching hospitals in terms of resources.

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 one million citizens. Prior to the reform, patients were typically referred to the closest hospital within their own hospital district (Government Proposal 90/2010).[5] The reform allowed planned surgical care patients in the reform area to choose any public hospital within and across hospital districts in the reform area, leaving patients and hospitals outside the reform area unaffected. The regional reform preceded a nationwide choice reform implemented in May 2011. Figure 1 shows the shaded reform area, hospital districts, and geographical distribution of hospitals in Finland in 2004–2010. Online Appendix Figure A1 further shows the locations of different hospital types: teaching, central, and regional.

The central policy goals of the reform were to enhance patient choice and timely access to care, improve

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

hospital performance such as quality of care and waiting times, and increase non-price competition between hospitals (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. In fact, hospital waiting times 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 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), but in contrast to these national reforms the Finnish reform was regional.

Patients access planned surgical care by a referral from their primary care physician, and patients' hospital choices are guided by these physicians. Physicians' financial incentives 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 assess whether it is necessary for the patient to undergo the procedure or not.

In the Finnish health care system, public hospitals are reimbursed for the services produced from their patients' municipalities of residence. Each hospital district sets the reimbursement rates of their own hospitals administratively, and many base them on nationally fixed diagnosis-related groups (DRGs) (Kautiainen, Häkkinen and Lauharanta, 2011). For example, 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.[6] DRG systems incentivize hospitals to control costs while increasing activity levels by providing them with a predetermined, flat reimbursement rate for treating 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).

Patients are publicly and universally insured, which reduces their financial consequences related to hospital choice. In the publicly administered health care system, patients' co-payments are generally 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 (Government Decree 464/2008). Hence, we do not expect hospital co-payments to impact patients' hospital choices to a great extent. However, 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) the National Health Insurance Scheme 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).

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[6]We are not aware of any major changes in the hospital reimbursement systems during the study period. However, one of the four districts in the reform area switched its pricing from its own grouping to nationally set DRG grouping in 2005. We have confirmed that our main results remain intact if we exclude this hospital district from the econometric analyses (Section V.C).

Figure 1: The 2007 Reform Area and Hospital Locations
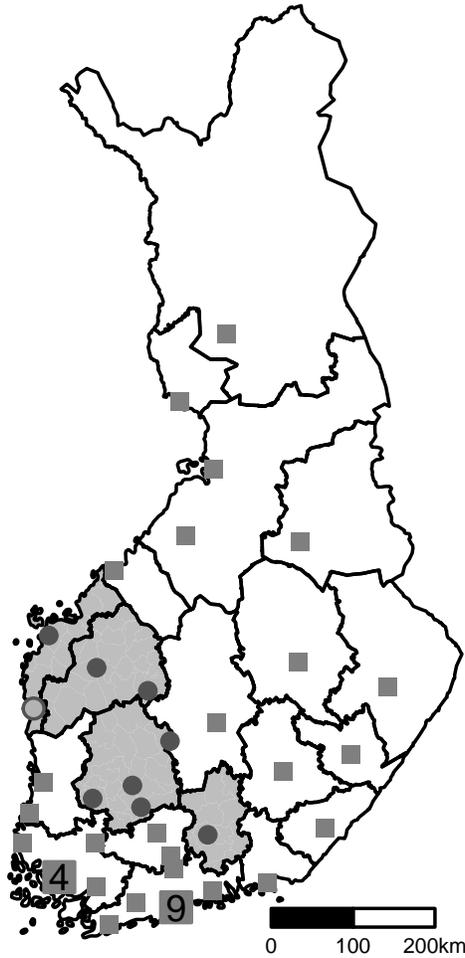
Notes: Borders indicate hospital districts in 2007 and the shaded area constitutes the 2007 reform area. The reform area includes four hospital districts, which comprise approximately one-fifth of the Finnish population or one million citizens. Finland is the size of Germany, but with one 15th of the population (approximately 5.4 million citizens). 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 municipal-owned hospitals), although some of them did not perform hip and/or knee replacement surgeries.

Although public hospitals are not profit maximizers in the same way as private for-profit hospitals are, they face significant pressures to perform well financially due to tight public sector budgets. Thus, attracting patients is important for hospitals because their funding and financial performance depends on it through municipality reimbursements. Given that administered co-payments are almost fixed, the way hospitals and their managers can increase demand is by making effort to improve performance in terms of quality or waiting time. A greater volume of patients can in turn incentivize hospitals to improve efficiency by containing costs to increase the profit margins (Longo et al., 2019). The patient choice reform brought about a substantial

shift in hospitals' ability to attract and compete for patients, with potential efficiency gain in health care production (see Gaynor, Moreno-Serra and Propper (2013) and Gaynor, Ho and Town (2015) for further discussions of the role of non-price competition and related reforms for public hospitals with administered prices).

Patients' ability to choose their hospital, and thereby the intensity of non-price competition, depends on the available information (Brown et al., 2023). There is publicly available information on hospital performance outcomes, although no specific patient review system similar to the one maintained by the English National Health Service (NHS) is provided in Finland. Hospital districts publish information on hospital-level waiting times by specialty on their own websites. Nationwide statistics on hospital district-level waiting times are also collected for common procedures such as hip and knee replacements (THL, 2012)—the surgeries we study. In terms of clinical quality information, the Finnish Institute for Health and Welfare 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). In addition to this public information, patients can receive information informally from their referring physicians and unofficial sources such as friends, family, and peers.

III. Data

We use a 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 hospital admission and discharge-related procedures and diagnoses. The first two samples include patients who had planned primary hip and knee replacement surgery. We analyze hip and knee replacement surgeries because they have been analyzed in prior work (Moscelli, Gravelle and Siciliani, 2021; Feng et al., 2015; Goude et al., 2022), were among the most common planned surgeries, they were available in all types of hospitals, and we expect scope for choice and producer competition as a result of the choice reform. The third sample includes all planned orthopedic (i.e., musculoskeletal) surgeries, which we analyze to get a more comprehensive picture of the effects of the choice reform. This sample also includes the planned primary hip and knee replacement surgeries that account for approximately 16 percent of the observations in the sample.

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 of hospital admission.[7] We match each observation with administrative data from Statistics Finland on the patient's date of death, demographics, and residence

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[7]We do not have detailed information on the residence location of patients over 74 years of age, and our data contain 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).

location at the end of each year. We discuss the construction of main variables and sample construction next and leave the more detailed description to online Appendix Section A1. In the remainder of this section, we first describe our variables and then proceed to the descriptive statistics.

III.A. Measures of Hospital Choice

We construct four outcome variables that relate to hospital choice and allocation for planned surgical patients. Our main hospital choice variable indicates if the patient was operated in a teaching hospital. Compared with non-teaching hospitals, teaching hospitals are large, have more resources, and are perceived to be higher quality 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. The third choice variable indicates if the patient was operated in their nearest hospital and our fourth choice variable indicates if the patient was operated 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 if the surgical patient had an emergency readmission within 30 days of discharge.[8] Emergency readmissions are a commonly used metric of hospital quality in health economics and clinical studies (Benbassat and Taragin, 2000; Varkevisser, van der Geest and Schut, 2012; Moscelli, Gravelle and Siciliani, 2021; Gupta, 2021). We also conduct additional analyses using more detailed measures of clinical quality for orthopedic surgeries such as mechanical complications and infections in the prosthesis, in addition to studying the quality of *emergency* care that was not targeted by the choice reform (Section V.C).

Waiting time. In addition to clinical quality, we examine other commonly studied aspects of hospital performance (Propper, Burgess and Gossage, 2008; Moscelli, Gravelle and Siciliani, 2021, 2023). We measure waiting time, which is the number of days from a patient being placed on the waiting list (after a specialist's final assessment of the need for surgery) to being admitted to hospital for surgery.[9] From an economics perspective, patients have to wait if demand is greater than supply. There is limited price rationing due to price regulation and health insurance. Instead, in publicly-funded or -administered systems, waiting times act as a non-price rationing device (Sá, Siciliani and Straume, 2019). Furthermore, waiting times for planned surgery can be long despite pre-specified policy targets (OECD, 2020; Siciliani, Moran and Borowitz, 2014).

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[8]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.

[9]Some hospitals or hospital districts, however, have reported their waiting times less consistently than others, although in most cases waiting times are observed (online Appendix Section A1). In Section V.C, we show that the results regarding waiting times remained similar when we excluded such hospital districts from our samples.

This can reflect inefficiencies in health care production processes, lack of competition and choice, as well as capacity constraints (Siciliani, Borowitz and Moran, 2013). Thus, waiting times can reflect the performance of public hospitals and health care systems as a whole.

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 our detailed discharge data do not include comprehensive information on costs or physical and human resources used and, thus 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. Measure of Hospital Market Structure

We measure market structure at the hospital level using the Herfindahl-Hirschman Index (HHI) based on observed hospital choices (Gaynor, Moreno-Serra and Propper, 2013). In the first step, we calculate an 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 degree of concentration in each hospital's municipality markets and allows large hospitals to operate in a larger markets compared 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 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 and Sunday), as staff may be more limited in the weekend. 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 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 hospital choice outcomes in the samples of hip and knee replacement surgeries. The hip or knee replacement patients were more likely to be treated in a teaching instead of non-teaching hospital in the reform than in the control area (55–56 versus 36–40 percent). They also traveled longer distances, approximately 34–37 kilometers in the areas affected by the reform, as opposed to approximately 28–29 kilometers in the control areas. Moreover, the hip or knee replacement patients were typically treated in the nearest hospital and this probability was lower in the reform than in the control area (81–84 versus 87 percent). These patients were also less likely to be treated outside their own hospital district in the reform than in the control area (6–7 versus 2 percent). The most notable difference in the sample of all orthopedic surgeries is that only 29 percent of reform area patients were operated in a teaching hospital, while the same was true to 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 over time (SD 0.09–0.16).[10]

Table 2 reports the descriptive statistics of our 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 approximately 5–10 percent longer in the reform area than in the control area (136–194 versus 129–184 days). Patient characteristics (age and sex) were, however, 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 treated less severe patients. In Section IV, we address the differences between the reform and control areas and the plausibility of the parallel trends assumption in our econometric approach.

Finally, we present the descriptive statistics by hospital type to shed light on heterogeneity in their outcomes. As expected, large teaching hospitals had much larger volumes than non-teaching hospitals, including medium-sized central hospitals and small regional hospitals (92–1,282 versus 30–416 and 16–217

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[10]Based on the distributions of the actual HHI, the concentration decreased in the reform area after the reform, while remaining relatively stable in the control area, especially in the sample of hip and knee replacements (online Appendix Figure A2).

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 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 greater value indicates more market concentration.

patients per quarter on average, respectively; online Appendix Table A1). Even though teaching hospitals are generally considered higher-quality and more expensive (Silber et al., 2020; Burke et al., 2019), their risk-adjusted re-admission rates (clinical quality) or surgical expenditures (hospital costs) per treated patient did not differ much from those of non-teaching hospitals (online Appendix Tables A2 and A3).[11] In contrast, for hip and knee replacements, teaching hospitals had shorter length of stays and waiting times compared with medium-sized central hospitals (e.g., 153 and 197 versus 177 and 211 days on average, respectively; online Appendix Table A2). Relatively short waiting times in teaching hospitals might have incentivized patients to exercise choice post-reform.[12]

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[11]This finding is consistent with the evidence for common medical and surgical conditions in other settings (Silber et al., 2020; Burke et al., 2019).

[12]Online Appendix Tables A4 and A5 further shows that teaching hospitals were very similar in terms of their mean performance and patient composition, respectively, between reform and control areas.

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 surgical patients in 2004–2010. The hip replacement sample includes 8, the knee replacement sample includes 7, and the orthopedic sample includes 648 types of planned orthopedic surgeries. Length of stay (days), waiting time (days), age (years) and pre-surgery emergency admission (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.

IV. Baseline Econometric Approach for Estimating Choice Reform Effects

The patient choice reform should affect hospital choices, allocation, and performance by increasing substitution and non-price competition across hospitals (Gaynor, Moreno-Serra and Propper, 2013; Gaynor, Propper and Seiler, 2016; Moscelli, Gravelle and Siciliani, 2021). Thus, we estimate the average effects of the reform on related patient outcomes in the entire reform area, using administrative patient-level data and a difference-in-differences (DiD) approach.[13] 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:

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

where y_{imht} is the outcome for patient i living in municipality m and treated by hospital h in period (quarter) t. $\mathbb{1}[\text{Treated}_h]$ is a binary indicator for the treatment group equal to one if hospital h was located in the reform area, and equal to zero if located in the control area.[14] $\mathbb{1}[\text{Post}_t]$ is a binary post-reform indicator equal to one after the introduction of the reform in the fourth quarter of 2007 (Q4/2007). We include quarter fixed effects λ_t to control for time-varying national-level shocks that may affect the outcome (they also absorb $\mathbb{1}[\text{Post}_t]$) in addition to the patient's municipality of residence fixed effects, μ_m, to control for any time-invariant differences between municipalities (and also between the reform and control areas), for example in their average population size and morbidity. $\mathbf{X}_{it}$ includes patient-specific control variables: type of surgery, sex, and 10-year age bins.

To avoid the *bad* control problem (Angrist and Pischke, 2009) we use a minimal set of patient characteristics (age and sex) as control variables in our baseline analysis. To address the concern that our results are driven by changes in the patient mix, we show that the reform had little impact on hospitals' patient characteristics such as age and sex (Section VI). Our results are also robust to controlling for hospital fixed effects, which capture time-invariant hospital-level unobserved factors such as average patient mix, and to controlling for the patient's pre-existing health status (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. We view the municipality-level clustering as a conservative choice because many Finnish municipalities are geographically large and unobservables related to hospital choice outcomes, in particular, are likely to be even more strongly correlated within smaller regions such as postal codes.

The key coefficient of interest β_2 identifies under certain assumptions the average treatment effect of the

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[13]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.

[14]The results remain intact if we define the treatment group indicator based on the patient home location, instead of the hospital location. This is because we have excluded from the data a small share (1–2%) of patients who obtained care across reform and control area borders. Thus, reform (control) area patients obtained care only from reform (control) area hospitals in our data.

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, however, unlikely; choice opportunities should have remained unchanged in the control area post-reform (Section II.B), and obtaining care across reform and control area borders was very unlikely (1–2% of observations and we have excluded them from our data).

Another key identifying assumption is that 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:

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

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 adoption" to zero, $\delta_{2,-1} = 0$.

V. Baseline Results

V.A. Effects on Hospital Choice and Allocation

We investigate how the reform affected patients' hospital choices and 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 study whether the reform led to the reallocation of patients towards large teaching hospitals. As expected, we find that patients were much more willing to undergo a surgery in a teaching, rather than in non-teaching hospital after the reform (column 1 of Table 3). More specifically, the probability of choosing a teaching hospital increased by 5–6 percentage points (10–14 percent in comparison to pre-reform mean) for hip and knee replacements. Patients might be more willing to choose teaching hospitals post-reform in part due to their better reputation and resources, as well as relatively short waiting times for hip and knee replacements (Section III.E). 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 short waiting times.[15]

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.[16]

We also investigate whether the reform that expanded patient choice of hospitals within and across hospital districts induced patient to travel longer distances. The reform may have induced patients to choose more distant hospital thereby increasing the traveled distances. On the other hand, the reform allowed some patients to choose nearer hospitals than before the reform, which may have decreased the travel distances.[17] We find that the surgical patients responded to the reform by choosing more distant hospitals (column 2 of Table 3, online Appendix Figure A4). Depending on the sample, the travel distance increased by approximately by 2–5 kilometers or 6–16 percent compared to the pre-reform mean distance. The DiD point estimate is statistically significant at 5 percent level for all orthopedic surgeries, and at 10 percent level for hip replacements, while not statistically significant for knee replacements.

We also tested whether the probability to be treated 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 A5), indicating a 4 percentage point (5 percent) increase in this probability. In turn, we find evidence that the reform substantially increased the probability of a patient being treated outside their own hospital district (column 4 of Table 3 and online Appendix Figure A6). The magnitude of the DiD point estimates (Table 3) ranges from 1 to 3 percentage points (24–83 percent at the sample mean). The statistically and economically significant estimates for hip replacements and all orthopedic surgeries mean that a larger share of the patients chose a hospital beyond their own hospital district after the reform. Taking the results together, the reform induced patients to travel longer distances and across hospital district borders to obtain care from large teaching hospitals. In Section VI, we show what this implied, for example, for patient volumes in teaching versus non-teaching hospitals.

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[15]When the health risks of surgery are small and waiting times are short, patients might be less willing to choose 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 is increased when we exclude hip and knee replacements from the sample of all orthopedic surgeries (online Appendix Table A6).

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

[17]According to our data, the mean distance decreased for patients living in some hospital district border areas.

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

◆ Point estimate ----- 90% CI

DiD estimate: 0.063*** (0.018)

Panel A. Hip replacements

◆ Point estimate ----- 90% CI

DiD estimate: 0.045*** (0.016)

Panel B. Knee replacements

◆ Point estimate ----- 90% CI

DiD estimate: 0.015* (0.008)

Panel C. All orthopedic surgeries

Notes: Includes the DiD estimates in percentage points corresponding to column 1 in Table 3.

Table 3: 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 patient's home municipality ($N = 326$).
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

V.B. Effects on Hospital Performance

Table 4 displays the results on the effects of the choice reform on hospital performance, as measured by the probability of 30-day readmission, waiting time, and length of stay. Column 1 shows that the reform did not affect the 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 A7 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 very 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 A3), this is mostly explained by a law change introducing a national 6-month treatment time guarantee close to 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 treatment guarantee disproportionately affected long waiting times for knee replacements in the reform area.

Table 4: Effects of the Reform on Surgical Care Quality, 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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$).
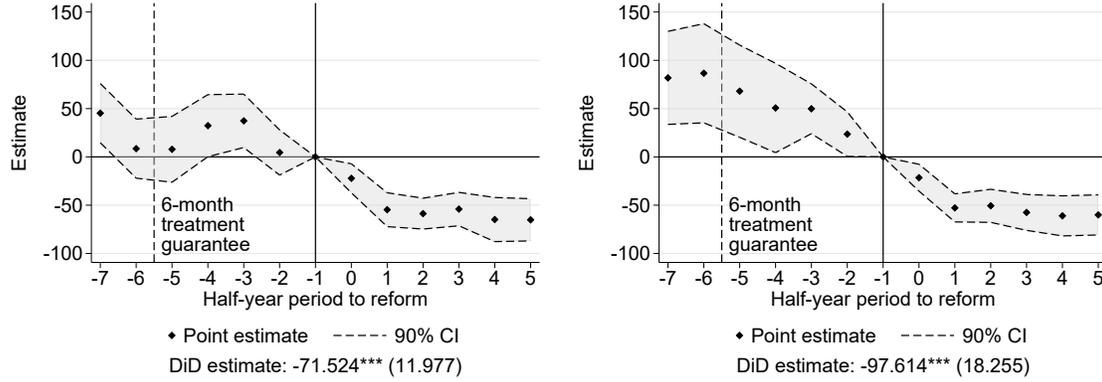[a] Emergency readmission (to any hospital) within 30 days after discharge.
[b] Number of days. Part of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

To isolate the effect of the patient choice reform from that of the treatment guarantee, 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 treatment time guarantee 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. Thus, the two policies—treatment guarantee and choice reforms—act as complementary policy tools to tackle 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 volumes.

Hospitals can reduce the length of stay in order to improve efficiency and to free resources to treat more patients. We find that the estimates of the effects of the reform on length of stay are not statistically significant for hip and knee replacement patients (Column 3 of Table 4, Figure 4). On the other hand, for all orthopedic surgeries, including many minor procedures, the length of stay decreased by 8 percent from the pre-reform mean. The reform may have incentivized hospitals to reduce the length of stay for patients needing relatively less invasive orthopedic surgery, whose health is less likely to deteriorate due to shorter stays compared with those needing major surgery such as a hip or knee replacement. To the extent that clinical quality did not change, as indicated by our earlier results on readmissions, shorter stays imply

Figure 3: Effect of the Reform on Waiting Times of Planned Surgery Patients
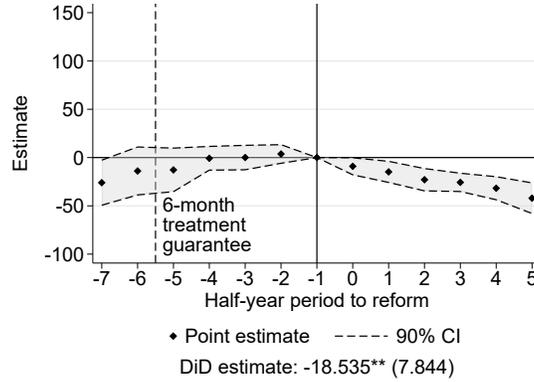
Point estimate   ----- 90% CI
DiD estimate: -71.524*** (11.977)

Panel A. Hip replacements

Point estimate   ----- 90% CI
DiD estimate: -97.614*** (18.255)

Panel B. Knee replacements

Point estimate   ----- 90% CI
DiD estimate: -18.535** (7.844)

Panel C. All orthopedic surgeries

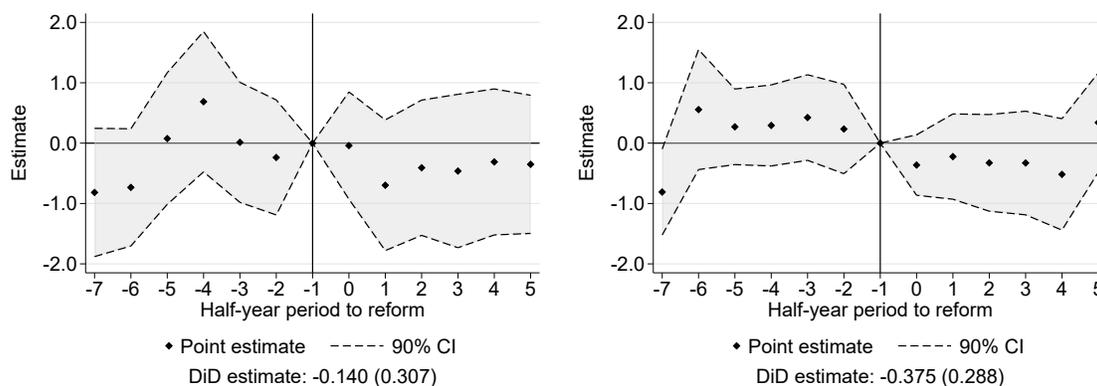*Notes:* Includes the DiD estimates in the number of days corresponding to column 2 in Table 4.

Table 5: Effect of the Choice Reform on Waiting Time Estimates After the 6-month Medical Treatment Guarantee

	Hip replacements		Knee replacements		All orthopedic surgeries	
	Whole time period	After treatment guarantee	Whole time period	After treatment guarantee	Whole time period	After treatment guarantee
	(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 is waiting time in days. Estimated using equation (1). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$). Columns (1), (3), and (5) re-display baseline estimates from Table 4 column (2). Columns (2), (4), and (6) display estimates using data from Q4/2006–Q4/2010 only.
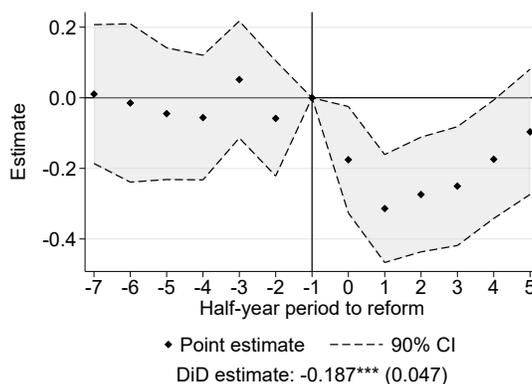
improved efficiency post-reform.

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

DiD estimate: -0.140 (0.307)

Panel A. Hip replacements

DiD estimate: -0.375 (0.288)

Panel B. Knee replacements

DiD estimate: -0.187*** (0.047)

Panel C. All orthopedic surgeries

Notes: Includes the DiD estimates in the number of days corresponding to column 3 in Table 4.

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

We conduct a number of robustness tests (online Appendix Section A4). We begin by testing whether our results are sensitive to the inclusion of additional controls to 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 remain very similar (Tables A7 and A8).

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.[18] The baseline results are robust to the exclusion

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[18]The exclusion may generate some bias because it removes most of the patients from the nearby area in the pre-closure

of all patients living in municipalities near the closed-down hospital (Tables A9 and A10). 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 A11–A14). Third, one reform area hospital district implemented DRG pricing in the beginning of 2005. The results are robust for excluding the district from the estimations, although some estimates lose statistical significance (Tables A15–A16). Fourth, 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 with 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 from 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).

To address a potential concern of emergency readmissions not being sensitive enough to capture changes in all clinical quality attributes, we also estimated the effects of the reform on more detailed measures for planned hip and knee replacements: indicators for revision surgery, mechanical complication in the prosthesis, and infection or inflammation in the prosthesis (Bayliss et al., 2017; Fleischman et al., 2019; Urquhart et al., 2010; Mäkelä et al., 2011). The results in online Appendix Table A20 show that the point estimates are not statistically significant on these quality outcomes, except for the revision probability of knee replacement surgeries, which increased by 0.7 percentage points or 23 percent compared to to the mean.

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 estimated the effects of the reform on emergency care clinical quality and length of stay for acute myocardial infarction (AMI), stroke, and hip fracture patients. 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 treated in the closest hospital) (Kessler and McClellan, 2000; Moscelli et al., 2018). Complementing our baseline results, the DiD estimates in online Appendix Table A21 show no other statistically significant effects than a decrease in stroke patients' emergency readmissions

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period, but not in the post-closure period.

(4 percentage points or 22 percent).

VI. Hospital-Level Analyses and Heterogeneity

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

The results in Section V.A showed that the reform had substantial effects on hospital choices as patients were more likely to choose teaching, instead of non-teaching, hospitals in the post-reform period. In this section, we study whether these effects translated into changes in hospitals' patient volumes, market concentration, and mean performance and whether these changes were different in teaching versus non-teaching hospitals. We estimate the following specification using hospital-quarter-level data:

$$
\begin{aligned}
y_{ht} = &\beta_1 \mathbb{1}[\text{Treated}_h] \times \mathbb{1}[\text{Post}_t] + \beta_2 \mathbb{1}[\text{Post}_t] \times \mathbb{1}[\text{Teaching}_h] \\
&+ \beta_3 \mathbb{1}[\text{Treated}_h] \times \mathbb{1}[\text{Post}_t] \times \mathbb{1}[\text{Teaching}_h] + \mathbf{X}'_{ht}\gamma + \lambda_t + \eta_h + \varepsilon_{ht},
\end{aligned}
\tag{3}
$$

where y_{ht} is the outcome for hospital h and period (quarter) t, and $\mathbb{1}[\text{Teaching}_h]$ is the teaching hospital indicator. η_h are hospital fixed effects, which absorb time-invariant hospital-level factors such as $\mathbb{1}[\text{Treated}_h]$, $\mathbb{1}[\text{Teaching}_h]$, their interaction, hospital location, and average patient mix. The indicator $\mathbb{1}[\text{Post}_t]$ for the introduction of the reform in the fourth quarter of 2007 (Q4/2007) is 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 compared to non-teaching hospitals. For the specification estimating the average hospital-level effects (without heterogeneity), we set $\beta_2, \beta_3 = 0$.[19] We cluster the standard errors at the hospital district level.

Table 6 shows the effects of the patient choice reform on hospital volumes and market concentrations, as measured by the 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 volumes increased by 9–35 percent on average after the reform (column 1). The increase is 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 (the sum of the coefficients on $\text{Treated}_h \times \text{Post}_t$ and $\text{Treated}_h \times \text{Post}_t \times \text{Teaching}_h$), which 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 with the mean volume of teaching hospitals (92–105 patients per quarter, see online Appendix Table A1).

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

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[19]More specifically, we estimate the following specification: $y_{ht} = \beta_1 \mathbb{1}[\text{Treated}_h] \times \mathbb{1}[\text{Post}_t] + \mathbf{X}'_{ht}\gamma + \lambda_t + \eta_h + \varepsilon_{ht}$.

types of hospitals (column 4): depending on the sample, the measure of market concentration increased by 4–8 percent for teaching hospitals and decreased by 1–4 percent for non-teaching hospitals, although the latter effect was not statistically significant. Thus, reflecting the disproportionate increase in teaching hospitals' volumes, concentration in their markets increased.

Table 6: 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 surgeries.
[b] Observed market concentration measured on a 0–1 scale. See A1.9 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] Incidence 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. We find that the estimates for emergency readmissions were generally small and not statistically significant (columns 1 and 2). Moreover, in line with the increase in hospital volumes (Table 6), we find evidence that the reform reduced mean waiting times in both teaching and non-teaching hospitals (columns 3 and 4). All point estimates for the mean waiting time remain negative, although become smaller in magnitude when we exclude time periods affected by the implementation of waiting time guarantee (online Appendix Table A22). Even though some of these estimates are imprecisely estimated, our findings suggests that hospital performance improved in response to increased choice and competition. For hip and knee replacements, the mean length of stay decreased by 11–12 percent in non-teaching hospitals, whereas for

all orthopedic surgeries, the statistically insignificant point estimates suggest a larger reduction in teaching than non-teaching hospitals (column 6).

Table 7: Effects of the Reform on Hospital-level Means of Care Quality, 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.
[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 A1.6 for more details and online Appendix Table A22 for the estimates without treatment guarantee).
[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] Incidence of different procedure codes among a hospital's patients.

VI.B. Case Mix and Resource Use

Because the reform changed hospitals' volumes and patient allocation into different types of hospitals, it could also have affected hospitals' patient composition and case mix. For example, if teaching hospitals treated sicker patients post-reform, it could explain the null effects on emergency readmissions (quality of care) for teaching hospitals' surgical patients. To explore changes in patient composition and allocation into different types of hospitals based on morbidity, we use the same estimation strategy as in equation (3) while using hospital-wise means of pre-determined patient characteristics as outcomes. The results in online

Appendix Table A23 do not reveal any impact on the mean age, sex composition, or morbidity (number of pre-surgery emergency admissions) of a hospital's patients on average or by hospital type.[20] The only exception is the sample of hip replacements, where non-teaching hospitals treated sicker patients post-reform, whereas teaching hospitals attracted healthier patients.

Earlier, we found that the reform led to shorter lengths of stays for orthopedic patients, which may have enabled hospitals to reduce costs and to free up capacity and human resources to treat more patients. Next, we study the effects on hospitals' annual surgical expenditures and a coarse measure of productivity: surgical expenditure per treated patient. We estimate a specification similar to the one in equation (3), except that we use hospital-year-level (rather than more granular hospital-quarter-level) data and only include the case mix index in $\mathbf{X}_{ht}$.[21] We find statistically insignificant and very small negative point estimate on hospitals' surgical expenditure on average (online Appendix Table A24). This finding suggests that total resource use such as purchases of material and labor inputs did not increase on average after the reform despite the increase in orthopedic surgery volumes (Table 6). The only exception is teaching hospitals, whose surgical expenditure increased by more than 30 percent. Moreover, we do not find any economically or statistically significant effect on expenditure per treated patient in teaching and non-teaching hospitals. This finding suggests that hospitals did not use more resources to produce better patient outcomes. 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 number of beds post-reform. Nonetheless, because we only have coarse data on hospital costs and resource use, we provide a complementary analysis of the potential effects on costs as well as the benefits in the next section.

VII. Back-of-the-Envelope Calculation

We perform simple back-of-the-envelope calculations to summarize the benefits and costs of the reform in monetary terms. In this section, we briefly describe the calculation and its inputs for orthopedic surgeries and show more detailed calculations and results in online Appendix Table A26. We use y to represent the total hospital volume per year and h to denote the surgical health gain per patient and year. If we use estimates of the health-related quality of life gained from orthopedic surgery by Jansson and Granath (2011) and express their value in monetary terms (in 2010 euros) following Gyrd-Hansen (2003), we would get an estimate of the health gain of 2,547 euros per patient and year.

We use T to denote the number of years that an individual patient would live after health improvement (discounted life expectancy at treatment date). The average age of orthopedic patients is 52 years so the discounted life expectancy would be $T = 19.8$ years with the discount rate of 3 percent and the life expectancy

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[20]We also confirmed that within each sample of planned surgeries, there is no clear change in hospitals' surgery types or mix, which would have indicated teaching hospitals performing more demanding hip or knee replacement surgeries post-reform.

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

of 80 years in 2010 in Finland (WHO, 2014). w denotes the waiting time *in years* and c is the hospital cost per patient. The total health benefit is given by: $h \times (T - w) \times y$, that is, the health gain times the volume. We assume that longer waiting times reduce patients' ability to benefit while waiting. The total costs are simply $c \times y$.

Consider a pre- and post-reform period, which we call 0 (pre-reform) and 1 (post-reform). If h is not affected by waiting, the yearly benefits of the reform can be expressed as: $[h \times (T - w_1) \times y_1] - [h \times (T - w_0) \times y_0]$.[22] These benefits are positive because volume is higher and waiting time is shorter post-reform based on our results in Tables 6 and 5. Specifically, the average pre-reform volume per hospital and quarter was 462 patients for orthopedic surgery and there are 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 in Table 6. Moreover, the average waiting time for orthopedic surgery is $w_0 = 0.33$ years (121 days) in the pre-reform period and $w_1 = 0.26$ years ($121 - 27 = 94$ days) in the post-reform period based on the estimates in Table 5. In this case, there are two effects. A higher total volume increases the number of patients who receive the treatment (an increase of $y_1 - y_0 = 1{,}429$ patients), but also generates a positive externality as everyone is waiting less which increases total health. Given the volume increase, shorter waiting times, and the approximated health gains ($2{,}547$ euros) of orthopedic surgery, the benefits of the reform could be substantial, approximately $74{,}2$ million euros per year in the reform area.

On the cost side, we found little impact on hospitals' surgical expenditure. Nonetheless, it is still possible that a higher total volume leads to higher hospital costs for orthopedic surgeries: $c * (y_1 - y_0) > 0$. However, we also found an 8 percent (4.5-hour) reduction in the length of stay for orthopedic surgeries (Table 4), which could lead to cost savings. Approximating the cost of orthopedic surgery ($6{,}645$ euros per patient) based on the medical literature (Remes et al., 2007)[23] and taking into account the potential cost savings from shorter stays, we find evidence that the increase in total orthopedic costs is much smaller than the benefits, approximately 4.6 million euros per year. Taking the results together, our calculation suggests that the benefits outweigh the costs by approximately 70 million euros per year or $4{,}000$ euros per patient and year.

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[22]For hip and knee replacement, h would be $4{,}386$ and $3{,}113$ euros, respectively (online Appendix Table A26). We get slightly different estimates if we instead assume that h is affected by waiting. Specifically, based on the estimates by Nikolova, Harrison and Sutton (2016) and Gyrd-Hansen (2003), the quality of life would be 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, h would be reduced by $w_t/365.25 \times 1.27$ euros, $t = 0, 1$, depending on the waiting time w_t (e.g., for hip replacements, $140.893 \times 1.27 \approx 179$ euros in the pre-reform period and $89.701 \times 1.27 \approx 114$ euros in the post-reform period).

[23]For comparison, the average cost per patient is $8{,}377$ euros for hip replacement and $8{,}503$ euros for knee replacement in Finland (expressed in 2010 euros) (Remes et al., 2007).

VIII. Comparison to Quasi-DiD Approach

Finally, we use a complementary quasi-DiD approach to estimate differential changes in hospital performance in more versus less concentrated markets after the reform allowed all patients to choose their hospital (within the reform area) to compare our main DiD approach and results to prior research studying nationwide patient choice reforms (Cooper et al., 2011; Gaynor, Moreno-Serra and Propper, 2013; Moscelli et al., 2018; Moscelli, Gravelle and Siciliani, 2021; Roos et al., 2020; Brekke et al., 2021; Moscelli, Gravelle and Siciliani, 2023).[24] In general, a quasi-DiD approach with a continuous treatment provides different information about the treatment effects than a binary DiD approach, but requires relatively strong identification assumptions, for example, on treatment effect homogeneity at different levels of treatment (Fricke, 2017; de Chaisemartin and D'Haultfœuille, 2018; Callaway, Goodman-Bacon and Sant'Anna, 2021). Specifically, we estimate the following specification, using patient-level data from the reform area only ($\mathbb{1}[\text{Treated}_h] = 1$):

$$y_{imht} = \alpha_1 \widehat{HHI}_h + \alpha_2 \widehat{HHI}_h \times \mathbb{1}[\text{Post}_t] + \mathbf{X}'_{it}\nu + \lambda_t + \mu_m + \hat{r}'_{it}\theta + \epsilon_{imht}, \tag{4}$$

where $\widehat{HHI}_h$ is the continuous treatment assigned to hospital h, that is, the pre-reform mean of hospital-level predicted HHI.[25] We use the predicted, rather than actual, HHI in the pre-reform period to mitigate the endogeneity of the market structure, following the standard practice (Kessler and McClellan, 2000; Gaynor, Moreno-Serra and Propper, 2013; Moscelli, Gravelle and Siciliani, 2021). Following the literature, we predict the HHI based on distance and other covariates except for our measures of hospital performance for all patients that were subject to the choice reform. Moreover, to ensure that time-varying patient allocation to hospitals based on unobserved morbidity does not bias the estimates, we follow Moscelli, Gravelle and Siciliani (2021) and control for the first-stage stage residuals ($\hat{r}_{it}$) from a hospital choice model.[26] 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 approach.

The coefficient of interest, α_2, captures the differential response to the choice reform between hospitals in more versus less concentrated markets, measured by $\widehat{HHI}_h$. The change in the marginal effect of concentration after the choice reform is identified through differences in the treatment intensity, rather than assignment to a separate treatment or control group. The choice reform is the treatment, and its effect or

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[24]It would also be possible in our setting to use data from both reform and control areas. It would, however, make the model and its interpretation more complicated. Analyzing only the reform area (treatment group) also makes the approach comparable to the previous choice reform literature and the literature evaluating the continuous treatment approach (Callaway, Goodman-Bacon and Sant'Anna, 2021).

[25]Note that the HHI is hospital-specific, municipal fixed effects μ_m are patient-specific, and the hospital treats patients from multiple municipalities. Hence, the time-invariant HHI is not perfectly collinear with the patient municipality fixed effects.

[26]Changes in patient allocation into 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 strategy in the DiD approach (online Appendix Table A27) and the quasi-DiD results without the control function approach (online Appendix Table A28).

intensity is assumed 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 exposed to the reform and non-price competition more due to a higher density of competing hospitals and more options for patients to choose from in the post-reform period (Gaynor, Moreno-Serra and Propper, 2013; Brekke, Siciliani and Straume, 2011). If this were the case, then we would expect hospital performance to improve more in less concentrated markets post-reform with $\alpha_2 < 0$. On the other hand, by removing constraints on choice across different hospitals and hospital districts, the reform expanded the markets and exposed all reform area hospitals and markets to competition. 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), then we would expect $\alpha_2 > 0$.[27]

We present the results for the marginal effects in online Appendix Table A25 and compare them to the earlier results on the effects of the choice reform based on the DiD approach (Table 4). The 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 A25). 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 less concentrated areas (column 2 of online Appendix Table A25). For all orthopedic surgeries, waiting times also decreased after the reform, but the decrease was smaller in less concentrated areas as indicated by the negative quasi-DiD estimate.[28] Therefore, the results on waiting times differ between the two empirical approaches. Similarly, length of stay was longer in less concentrated areas post-reform. Overall, our results suggest that the quasi-DiD approach commonly used in the literature gives different results on the marginal effects of concentration post-reform than the DiD approach employed in this study that estimates the effect of the reform in the entire area.

IX. Conclusions

We studied the allocative effects of enhancing patient choice and non-price competition among public hospitals. We used a difference-in-differences (DiD) approach based on a unique quasi-experiment in Finland: a regional patient choice reform for planned surgeries. Using nationwide administrative data, we found that surgical patients responded to the reform by traveling longer distances and across hospital districts to receive

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[27]Specifically, central hospitals had a mean HHI of 0.85–0.94, followed by teaching hospitals (0.85–0.89), and regional hospitals (0.64–0.80), see online Appendix Table A1.

[28]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.

care from large teaching hospitals. The effects on patient behavior were considerable despite relatively low densities of population and hospitals in Finland, and very small financial incentives related to hospital choice due to universal public insurance.

After the reform, hospitals were also able to treat more surgical patients with shorter waiting times. Hospital volumes increased disproportionately in large teaching hospitals post-reform, increasing concentration in their geographical markets. Thus, an improvement in choice and competition conditions can promote concentration by re-allocating patients towards large hospitals.

Our results show that market-oriented choice reforms can enhance hospital performance with little impact on hospitals' surgical expenditure. Our back-of-the-envelope estimates suggest that the net benefit of the regional reform is approximately 70 million euros per year or 4,000 euros per patient and year. The reform had direct benefits for patients, as hospital volumes increased 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 clinical quality or hospitals' patient mix, despite the large allocative effects and increased supply.

Our results provide suggestive evidence on the roles of enhancing consumer choice and friction-reducing public policy in improving allocative efficiency in the presence of limited resources and long waiting times, which are present in many health care systems (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 public housing, nursing homes, and daycare centers, where long waiting times are a potential concern.

More broadly, our results based on a choice reform are informative about the role of market-based mechanisms in health care. The results closely tie greater concentration to more competition, as implied by the increased amount of choice post-reform. The more competitive a market is, the more concentrated is the market towards large, better-resourced producers, therefore potentially improving the performance of the market. 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, as well as to study the social welfare implications of enhancing consumer choice.

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ONLINE APPENDIX

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

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

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

[b] University of Missouri

[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

Our main data source is the Finnish hospital discharge data, officially known as the Care Register for Health Care, from the Finnish Institute for Health and Welfare. The original data include the universe of inpatient care discharges and admissions, day surgeries, and specialized outpatient care in Finland since 1994, but we consider years 2004–2010 in our analyses.

A1.1. Treatment Spell Construction

The discharge data are at the level of hospital treatment episodes and do not contain identifiers for treatment spells.[29] Hence, we use information on hospital admission and discharge dates to identify the spells. We made the following assumptions when assigning observations into the spells: treatment episodes a and b of patient i belong to the same 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 treatment spells.

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 care type code. 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 inclusion criteria for different samples are shown in the table below. Only episodes which began a treatment spell were included in the estimation samples, meaning that we excluded episodes for which the admission date was not equal to the spell beginning date. We also identified all planned surgeries for the purpose of calculating the predicted HHI that we use in our quasi-DiD approach.

We made the following restrictions to all our baseline samples. First, only treatment spells which began between January 1st 2004 and December 31st 2010 (our observation period) were included. Second, each surgery to hospital h in quarter t was excluded if the sample-wise number of surgeries in hospital h in quarter t was less than 5. Third, the reform concerned only public hospitals which were owned by reform area hospital districts, hence we excluded private hospitals ($N = 37$) and small municipal-owned public hospitals ($N = 21$) which performed planned orthopedic surgeries. We also exclude one military hospital

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[29]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 compose one spell. Note that patient might be transferred to another hospital for post-operative care and, hence, one treatment spell can include care in several hospitals.

Inclusion Criteria of Different Estimation Samples

Sample	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] See classification of surgical procedures (in Finnish) in: `https://www.terveysportti.fi/terveysportti/toimenpideluokitus.koti`.
[b] See ICD-10 codes in: `https://icd.who.int/browse10/2010/en#/`.
[c] Identification of surgical procedures taken from: `https://urn.fi/URN:NBN:fi-fe201205085475`.

which performed orthopedic surgeries. Note that episodes in these hospitals were, however, included when we calculated spell-level length of stay and identified emergency readmission which took place within 30 days of departure. Fourth, we excluded patients from the Åland islands and admissions to Åland central hospital (0.3–0.6% of observations depending on the sample). Fifth, we excluded patients without a Finnish identification number or home municipality, as well as patients from foreign countries (0.1–0.5%). Sixth, we excluded patients under 18 or over 74 years of age (14–31%). Seventh, we excluded patients who lived within (outside) the reform area, but underwent surgery in a control (reform) area hospital (1–2%). Eight, we excluded patients who underwent surgery in a small hospital which closed down in the pre-reform period (0.3–0.4%). Ninth, we excluded patients who traveled more than 400 kilometers (0.1–0.2%) or whose length of stay lasted more than 180 days (<0.1%) as outliers.

In the samples of emergency AMI, stroke, and hip fracture patients, we employed the same sample restrictions. In comparison to surgical samples, the most important difference is that the age restriction (18–74) drops 48–71 percent of all emergency AMI, stroke, and hip fracture patients. We also employ additional restrictions for emergency samples. We excluded admissions to hospital h in quarter t when h did not perform at least 5 planned surgeries in quarter t. We also excluded emergency patients who were admitted to hospital h, but transferred immediately to hospital k. It is likely that these were more severe cases that required advanced treatment only available in certain hospitals.

A1.3. Additional Data Sources

After constructing the samples from the discharge data, we combined them with information on patients and hospitals from additional administrative data sources. First, patients' dates of death are from Statistics Finland's Causes of Death Registry. Second, locations of patients' residences at the end of each year are also

from Statistics Finland. The locations are recorded at December 31st each year and are thus not available for those who died or emigrated from Finland mid-year. We assume that their location at the time of their admission was as in the end of the previous year. For the remaining patients whose residence locations are missing ($\approx 0.5\%$), 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 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.

A1.4. Measures of Hospital Choice

	Outcome	Source	Description
(1)	Distance	Discharge data, patient location (grid) data, & hospital location[a]	A straight line distance between patient i's residence and hospital h's location in kilometers. Some neighboring hospitals are recorded under a joint identifier, and in these cases we use the location of the largest hospital under the joint identifier.
(2)	Nearest hospital	Discharge data, patient location (grid) data, & hospital location[a]	An indicator equal to one if the patient was treated in the hospital nearest to their residence location. Created based on (1).
(3)	Different hospital district	Discharge data, patient location (grid) data, & hospital location[a]	An indicator equal to one if patient i's hospital district was not the same as hospital h's hospital district.
(4)	Teaching hospital	Discharge data	An indicator equal to one if the patient was treated in a teaching (university-based) hospital.

[a] See (7) in A1.7.

A1.5. Measures of Hospital Volume and Market Structure

	Outcome	Source	Description
(1)	Hospital volume	Discharge data	Sample-wise number of patients in hospital h and quarter t.
(2)	Actual HHI	Discharge data	Concentration of hospital h's market in quarter t. Ranges from 0 (minimal concentration) to 1 (monopoly). For more information, see A1.9.

A1.6. Hospital Performance: Clinical Quality, Waiting Time, and Length of Stay

	Outcome	Source	Description
Panel A. Main clinical quality measure			
(1)	Emergency readmission within 30 days	Discharge data	An indicator equal to one if the patient had an emergency admission to *any* hospital for *any* reason within 30 days of being discharged from the last hospital in the treatment spell.
Panel B. Additional planned clinical care quality measures			
(2)	Revision surgery within 2 years[a]	Discharge data	An indicator equal to one if the patient had planned admission with main procedure code NFC* or NGC* to *any* hospital within 730 days of the initial surgery.
(3)	Mechanical complication of prosthesis within 2 years[a]	Discharge data	An indicator equal to one if the patient had admission with ICD-10 diagnosis code T84.0 to *any* hospital within 730 days of the initial surgery.
(4)	Infection or inflammation in prosthesis within 2 years[a]	Discharge data	An indicator equal to one if the patient had admission with ICD-10 diagnosis code T84.5 to *any* hospital within 730 days of the initial surgery.
Panel C. Additional emergency care quality measure			
(5)	Death within 30 days	Causes of death registry	An indicator equal to one if the patient died within 30 days after the initial treatment episode began (includes deaths in and out of the hospital).
Panel D. Length of stay			
(6)	Length of stay	Discharge data	Number of days between the admission and the departure in the treatment spell. Includes days in multiple hospitals in case there were hospital transfers. May include days in hospitals that were not part of the reform (especially the municipal-owned health centre hospitals).
Panel E. Waiting time			
(7)	Waiting time	Discharge data	Number of days between the specialist's referral and surgery.

Notes: See classification of surgical procedures (in Finnish) in: `https://www.terveysportti.fi/terveysportti/toimenpideluokitus.koti`. See ICD-10 codes in: `https://icd.who.int/browse10/2010/en#/`.
[a] The discharge data does not allow us to identify whether the revision surgery, mechanical complication, infection or inflammation concerned the same prosthesis as in the initial surgery. It is possible that we identify that, for example, the patient underwent revision surgery within 2 years, even if the initial surgery concerned the left knee and the infection concerned the right knee. We assume that the magnitude of the bias resulting from these false positives is of minor magnitude.

Waiting time is readily available in the discharge data, but its reporting has been inconsistent across hospitals. In the hip replacement sample, 21% of waiting time values are missing, while the same is true for 22% of observations in the knee replacement sample and for more than 30% of the sample of all orthopedic surgeries.[30] We implement comprehensive robustness checks in Section VIII, and confirm that the missing values do not bias the estimates of the effects on waiting times.

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[30]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.

A1.7. Other Variables

	Variable	Source	Description
Panel A. Covariates			
(1)	Patient age	Discharge data	Patient age at the the time of admission.
(2)	Patient sex	Discharge data	An indicator equal to one if the patient is female.
(3)	N of emergency admissions within 1 year	Discharge Data	Number of emergency admissions that the patient had to *any* hospital within 365 days before the surgery or emergency admission under consideration. May include multiple admissions from one treatment spell.
(4)	Weekend admission	Discharge data	An indicator equal to one if the admission date was Saturday or Sunday.
Panel B. Other variables			
(5)	Patient residence location	Location (grid) data	Finland was divided into 1x1 kilometer squares. The residence location is the easting and northing coordinates (ETRS-TM95FIN) of the square in which the patient's residence was located.
(6)	Patient's municipality of residence	Location (grid) data	The municipality in which the patient was resident at the end of the year.
(7)	Hospital location	Provider registry (TOPI) & municipality center locations (Google Maps)	Easting and northing coordinates of the municipality in which hospital was located (ETRS-TM95FIN). Constructed based on hospital's municipality in TOPI and municipality center locations.
(8)	Hospital districts of patients and hospitals	(6), provider registry (TOPI), & hospital district data from Association of Finnish Municipalities	The hospital district to which the patient's municipality of residence or the hospital's municipality belonged. We use publicly available information on the hospital district of each municipality (patient's or hospital's) from the Association of Finnish Municipalities.
(9)	Reform area	Discharge data & (8)	An indicator equal to one if the hospital in which the patient was treated belonged to Vaasa, Etelä-Pohjanmaa, Pirkanmaa, or Päijät-Häme hospital districts.

A1.8. Hospital expenditure

The discharge data does not include hospital expenditures, hence we use the Hospital Benchmarking Data from the Finnish Institute for Health and Welfare.[31] The data provide hospitals' operating expenditures by specialty, allowing us to measure hospitals' surgery-related expenditures, and a case mix index for controlling patients' severity.

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[31]See https://thl.fi/en/web/thlfi-en/statistics-and-data/statistics-by-topic/health-care-services/hospital-benchmarking

	Outcome	Source	Description
Panel A. Expenditure outcomes			
(1)	Total expenditure	Hospital benchmarking data	Hospital h's annual surgery-related operating expenditures (millions of $€^*$) in year t.
(2)	Expenditure per treated patient (treatment episode)	Hospital benchmarking data	Hospital h's annual surgery-related operating expenditures ($€^*$) divided by hospital's DRG-weighted number of treated surgical patients (treatment episodes) in year t.
Panel B. Covariates			
(3)	Case mix index	Hospital benchmarking data	Number of DRG-weighted treated surgical patients of hospital h in year t is divided by absolute number of treated surgical patients (treatment episodes) of hospital h in year t and then transformed into an index by setting the whole country equal to 1.

* Deflated using Statistics Finland's price index of public health care services (see `https://stat.fi/en/statistics/jmhi`). Base year = 2000.

A1.9. 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:

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

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 Approach: Further Details

A2.1. Predicted HHI

We follow Kessler and McClellan (2000) and construct a predicted version of the HHI and use it as the continuous treatment variable in the quasi-DiD specifications (4). We calculate the predicted HHI in four steps. First, we estimate the predicted patient flows of *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 each observable patient and hospital characteristic (except hospital quality) affects the probability of patient i choosing hospital h in quarter t. Specifically, we estimate the following conditional logit model separately for each quarter during Q1/2004–Q4/2010:

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

where $\mathbf{X}_{iht}$ 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. km_{iht} is the distance between patient i's residence and hospital h in kilometers.[32] 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 patient flows of each hospital as a sum of probabilities over all patients.[33] Third, we calculate the predicted municipality-level HHI as the sum of the squares of the predicted market shares (based on predicted patient flows):

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

$\widehat{n}_{hmt}$ is the predicted number of patients from municipality m who were treated by hospital h in quarter t. $\widehat{N}_{mt}$ is the predicted number of patients from municipality m (treated 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

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[32]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 it yields flows that results in similar HHI values.

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

weights:

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

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

Our model predicts approximately 85% 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%). 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).

Finally, we fix the predicted HHI to its pre-reform mean, as follows:[34]

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

We refer to $\widehat{HHI}_{h}^{HOSP}$ used in our analyses as the *predicted* HHI.

A2.2. Control Function Strategy

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 strategy. In the first stage, we estimate the following conditional logit model separately for each quarter in Q1/2004–Q4/2010:

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

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 (i.e., the largest) and regional (i.e., the smallest) hospitals.[35] 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).[36]

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[34]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.

[35]Baseline = central hospitals. Unlike Moscelli, Gravelle and Siciliani (2021), we do not restrict patients' choice sets, but instead let them choose among all hospitals ($N = 29$–32 hospital IDs depending on the sample).

[36]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 targets also the unrestricted *post-reform* choices in the reform area.

Patient i chooses hospital h with the probability of

$$P_{iht} = \exp(V_{iht}) \left[\sum_{h' \in S_i} \exp(V_{ih't}) \right]^{-1}, \tag{B.7}$$
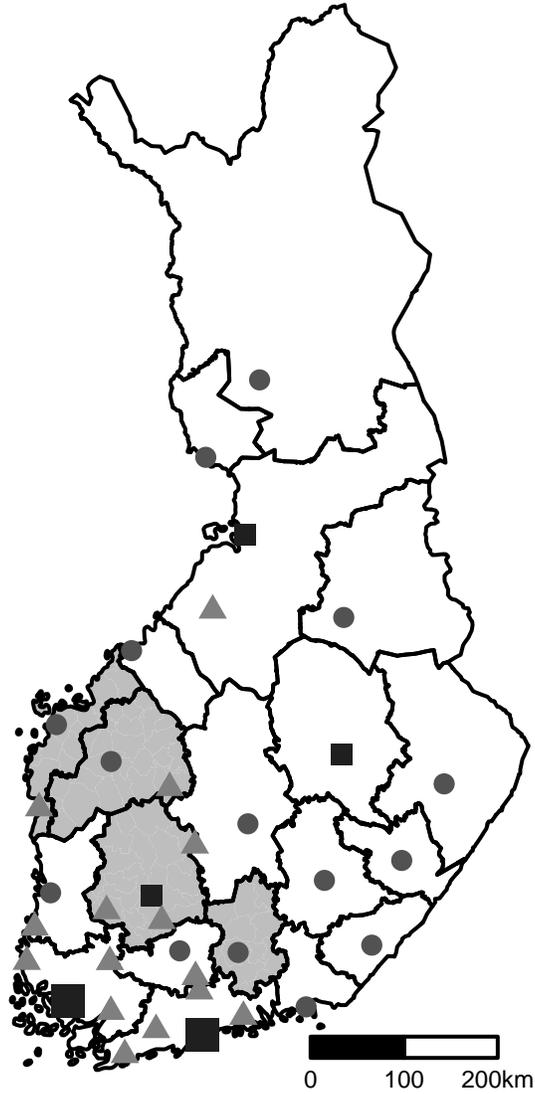
After calculating the choice probabilities, we can derive the set of residuals (one for each hospital h):

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

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

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 surgeries (excluding municipal-owned hospitals), although some of them did not perform hip and/or knee replacement surgeries.

Figure A2: Kernel Density Estimates for the Distribution of the Actual HHI Before and After the Reform

Panel A. Hip replacements in the reform area

Panel B. Hip replacements in the control area

Panel C. Knee replacements in the reform area

Panel D. Knee replacements in the control area

Panel E. Orthopedic surgeries in the reform area

Panel F. Orthopedic surgeries in the control area
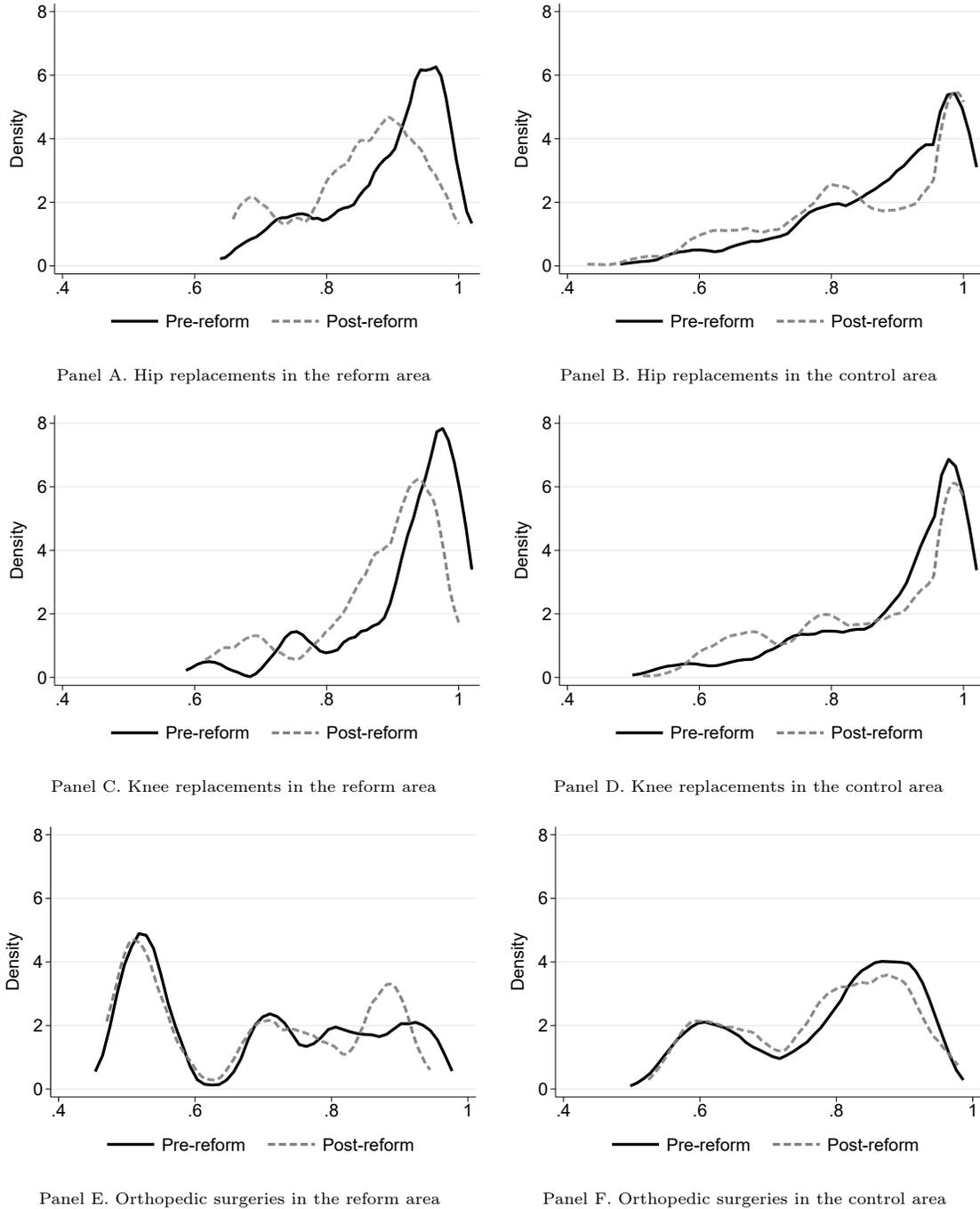
Notes: The figure plots Epanechnikov kernel density estimates for the distribution of the actual hospital-quarter-level HHI that are calculated based on observed patient flows in reform (Panels A, C, and E) and control areas (Panels B, D, and F). N of hospital IDs = 4–7 (reform area) and 25 (control area). Pre-reform corresponds to Q1/2004–Q3/2007 and post-reform to Q4/2007–Q4/2010.

Figure A3: Mean Waiting Time
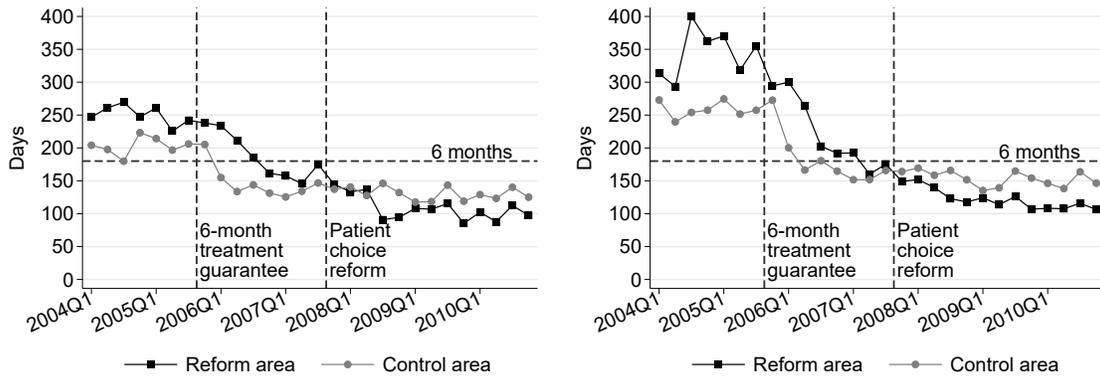
Panel A. Hip replacements

Panel B. Knee replacements

Panel C. All orthopedic surgeries

13
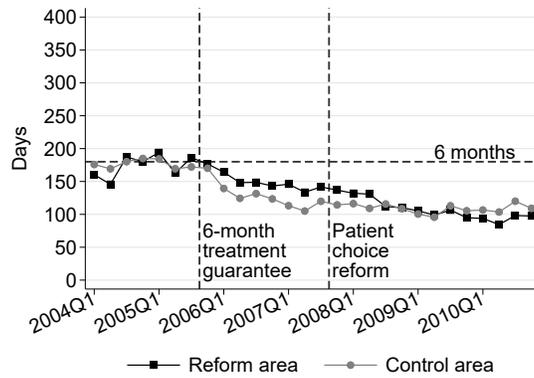
Figure A4: Effect of the Reform on Travel Distance of Surgical Patients
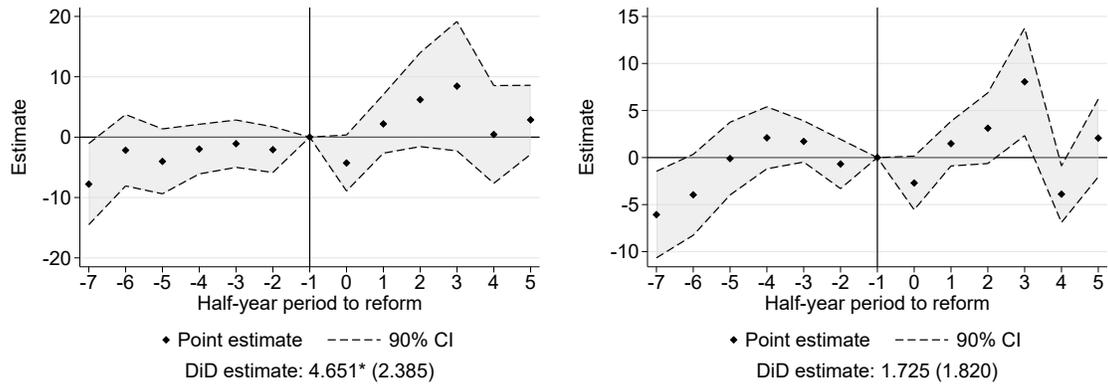
DiD estimate: 4.651* (2.385)

Panel A. Hip replacements

DiD estimate: 1.725 (1.820)

Panel B. Knee replacements

DiD estimate: 2.063** (0.993)

Panel C. All orthopedic surgeries

Notes: Includes the DiD estimates in kilometers corresponding to column 2 in Table 3.

Figure A5: Effect of the Reform on Probability of Surgical Patients Being Treated In Their Nearest Hospital
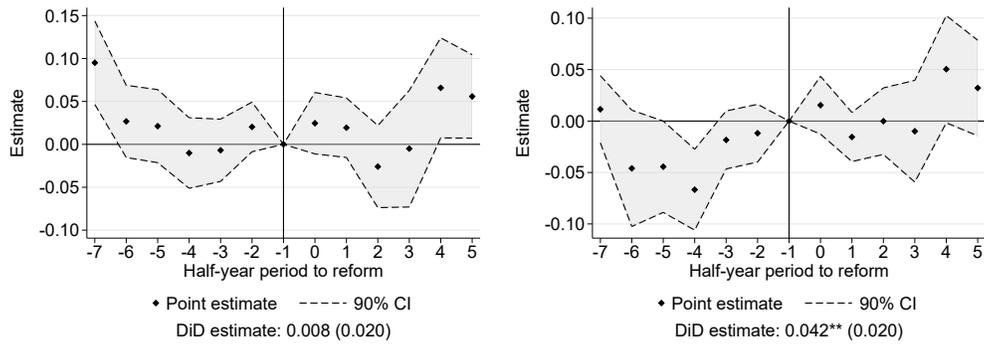
Panel A. Hip replacements
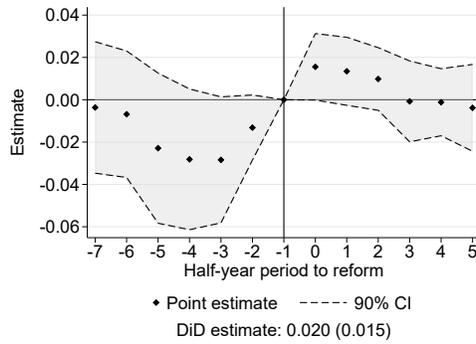
Panel B. Knee replacements

Panel C. All orthopedic surgeries

Notes: Includes the DiD estimates in percentage points corresponding to column 3 in Table 3.

Figure A6: Effect of the Reform on Probability of Surgical Patients Being Treated Outside Their Own Hospital District
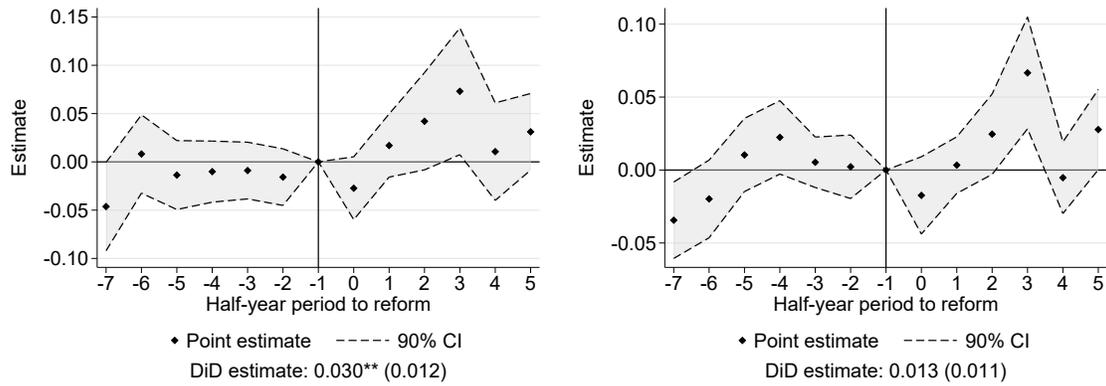
Panel A. Hip replacements
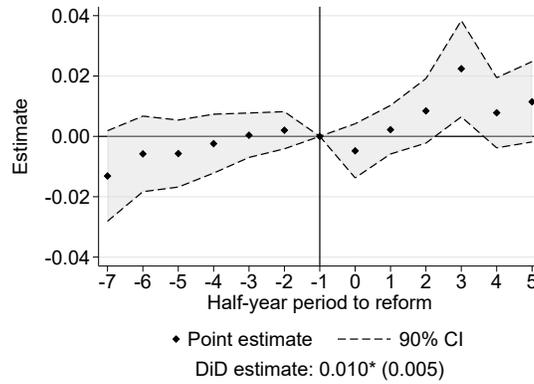
Panel B. Knee replacements

Panel C. All orthopedic surgeries

Notes: Includes the DiD estimates in percentage points corresponding to column 4 in Table 3.

Figure A7: Effect of the Reform on Emergency Readmissions of Surgical Patients
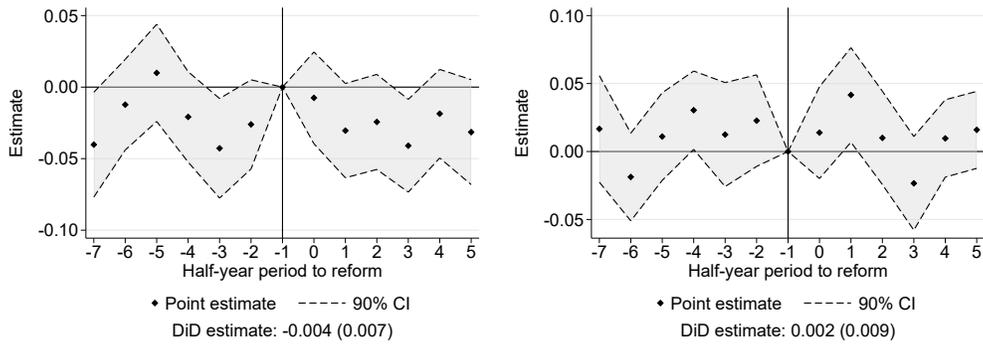
Panel A. Hip replacements
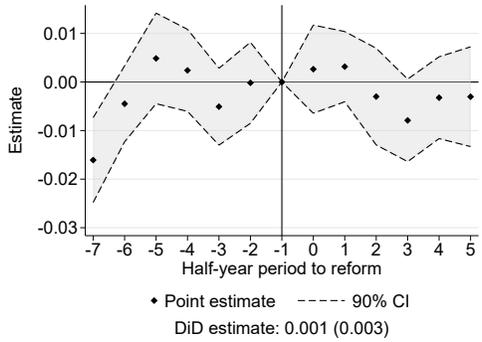
Panel B. Knee replacements

Panel C. All orthopedic surgeries

Notes: Includes the DiD estimates in percentage points corresponding to column 1 in Table 4.

Figure A8: Areas Excluded As a Robustness Test for Being Affected by a Closure of a Reform Area Hospital
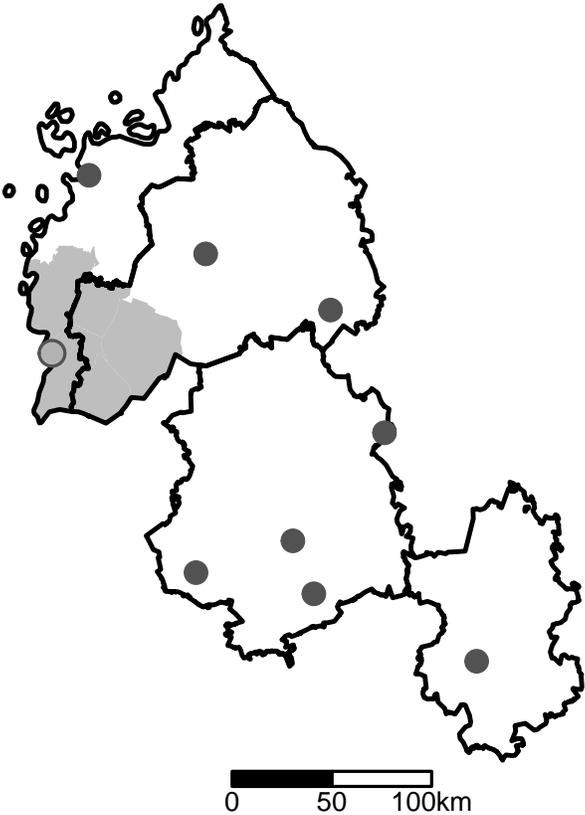
Notes: The figure shows the map of the reform area in 2007 with hospital district borders. Dots mark reform area hospitals. The dot with an empty middle marks the hospital which closed down in the pre-reform period. Patients living in the shaded area around the closed hospital were excluded from the robustness test estimation.

A4. Tables

Table A1: 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] Mean of hospital-quarter level volumes (N of patients).
[b] Mean of hospital-quarter level actual HHI (0–1).

Table A2: 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] Hospital-quarter-level mean of patient's probability of emergency readmission to any hospital within 30 days of the surgery. 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 effect.
[b] Hospital-quarter-level mean of 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] Hospital-quarter-level mean of length of stay in days (no risk-adjustment).

Table A3: 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 treated (€)[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 treatment episodes (treated patients) multiplied by DRG weights, which describe the relative average expenditure for treating 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 treatment episodes (treated patients) in the surgical ward.

Table A4: 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] Hospital-quarter-level mean of patient's probability of emergency readmission to any hospital within 30 days of the surgery. 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 effect.
[b] Hospital-quarter-level mean of 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] Hospital-quarter-level mean of length of stay in days (no risk-adjustment).

Table A5: 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 admissions hospital's patients had within 1 year before their surgery.

Table A6: Robustness Test: 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)
$Treated_h \times Post_t$	-0.002	0.187	0.027*	-0.002
	(0.006)	(0.285)	(0.015)	(0.004)
$mean(y_{imht}|Post_t = 0)$	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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$).
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital in a different hospital district than where they live.

Table A7: Robustness Test: 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				
Treated$_h$ × Post$_t$	0.064***	4.599*	0.008	0.030**
	(0.017)	(2.376)	(0.020)	(0.012)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.046***	1.630	0.042**	0.013
	(0.016)	(1.779)	(0.020)	(0.011)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.015*	2.064**	0.020	0.010*
	(0.008)	(0.994)	(0.015)	(0.005)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$).
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

Table A8: Robustness Test: 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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$).
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A9: Robustness Test: 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				
Treated$_h$ × Post$_t$	0.061***	4.545*	-0.002	0.030**
	(0.018)	(2.461)	(0.019)	(0.013)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.046***	1.841	0.029	0.015
	(0.016)	(1.843)	(0.018)	(0.011)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.014*	2.081**	0.000	0.011**
	(0.008)	(1.002)	(0.008)	(0.005)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 319$). All patients from Kristiinankaupunki, Isojoki, Karijoki, Kaskinen, Närpiö, Kauhajoki, and Teuva excluded. See Figure A8 in Appendix A3 for a map.
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

Table A10: Robustness Test: 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			
Treated$_h$ × Post$_t$	-0.003	-72.214***	-0.138
	(0.008)	(12.309)	(0.318)
mean(y_{imht}|Post$_t$ = 0)	0.080	183.154	8.018
N	29,293	23,199	29,293
Panel B. Knee replacement surgeries			
Treated$_h$ × Post$_t$	0.002	-97.832***	-0.379
	(0.009)	(18.688)	(0.297)
mean(y_{imht}|Post$_t$ = 0)	0.103	229.208	7.510
N	35,544	27,985	35,544
Panel C. All orthopedic surgeries			
Treated$_h$ × Post$_t$	0.000	-19.173**	-0.173***
	(0.003)	(7.984)	(0.047)
mean(y_{imht}|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. Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 319$). All patients from Kristiinankaupunki, Isojoki, Karijoki, Kaskinen, Närpiö, Kauhajoki, and Teuva excluded. See Figure A8 in Appendix A3 for a map.
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A11: Robustness Test: 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				
Treated$_h$ × Post$_t$	0.057***	2.978**	-0.012	0.034***
	(0.015)	(1.499)	(0.019)	(0.010)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.052***	2.507*	0.014	0.029***
	(0.015)	(1.486)	(0.017)	(0.010)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.011	1.903*	-0.001	0.015**
	(0.010)	(0.997)	(0.009)	(0.006)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 291$). Excludes patients who lived in the three western hospital districts that allowed patient choice to some degree.
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

Table A12: Robustness Test: Excluding Three Western Hospital Districts With Possibilities 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			
Treated$_h$ × Post$_t$	-0.001	-74.513***	0.347
	(0.009)	(14.778)	(0.299)
mean(y_{imht}|Post$_t$ = 0)	0.081	180.051	7.881
N	27,175	21,379	27,175
Panel B. Knee replacement surgeries			
Treated$_h$ × Post$_t$	0.010	-110.759***	-0.024
	(0.011)	(20.999)	(0.315)
mean(y_{imht}|Post$_t$ = 0)	0.103	228.605	7.398
N	33,179	26,041	33,179
Panel C. All orthopedic surgeries			
Treated$_h$ × Post$_t$	0.002	-25.012***	-0.108*
	(0.003)	(9.595)	(0.057)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 291$). Excludes patients who lived in the three western hospital districts that allowed patient choice to some degree.
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A13: Robustness Test: Excluding Four Northern 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				
Treated$_h$ × Post$_t$	0.066***	4.545*	0.011	0.030**
	(0.018)	(2.438)	(0.021)	(0.012)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.048***	1.723	0.043**	0.013
	(0.017)	(1.904)	(0.021)	(0.011)
mean(y_{imht}|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				
Treated$_h$ × Post$_t$	0.015*	2.101**	0.021	0.010*
	(0.008)	(1.064)	(0.015)	(0.006)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 288$). Excludes patients who lived in the four western hospital districts that allowed patient choice to some degree.
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

Table A14: Robustness Test: Excluding Four Northern Hospital Districts With Possibilities 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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 288$). Excludes patients who lived in the three western hospital districts that allowed patient choice to some degree.
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A15: Robustness Test: Excluding the Reform Area Hospital District Which Implemented DRG pricing in 2005 (Choice Outcomes)

	Teaching hospital[a] (1)	Distance (km)[b] (2)	Nearest hospital[c] (3)	Different hospital district[d] (4)
Panel A. Hip replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.053***	3.813	0.023	0.019
	(0.019)	(2.673)	(0.021)	(0.013)
$\text{mean}(y_{imht}|\text{Post}_t = 0)$	0.477	30.336	0.861	0.037
N	28,565	28,565	28,565	28,565
Panel B. Knee replacement surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.037**	0.880	0.058***	0.005
	(0.017)	(1.943)	(0.022)	(0.012)
$\text{mean}(y_{imht}|\text{Post}_t = 0)$	0.449	29.346	0.867	0.034
N	34,642	34,642	34,642	34,642
Panel C. All orthopedic surgeries				
$\text{Treated}_h \times \text{Post}_t$	0.013	1.702*	0.032*	0.005
	(0.009)	(1.016)	(0.019)	(0.005)
$\text{mean}(y_{imht}|\text{Post}_t = 0)$	0.449	28.595	0.833	0.043
N	402,497	402,497	402,497	402,497
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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$). Excludes patients who were treated in the hospital district's hospitals.
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

Table A16: Robustness Test: Excluding the Reform Area Hospital District Which Implemented DRG pricing in 2005 (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.007	-85.847***	0.009
	(0.007)	(9.175)	(0.321)
$\text{mean}(y_{imht}\vert\text{Post}_t = 0)$	0.081	184.920	8.014
N	28,565	22,550	28,565
Panel B. Knee replacement surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.006	-114.849***	-0.181
	(0.010)	(16.103)	(0.284)
$\text{mean}(y_{imht}\vert\text{Post}_t = 0)$	0.103	230.862	7.496
N	34,642	27,169	34,642
Panel C. All orthopedic surgeries			
$\text{Treated}_h \times \text{Post}_t$	-0.000	-17.953*	-0.171***
	(0.003)	(9.487)	(0.056)
$\text{mean}(y_{imht}\vert\text{Post}_t = 0)$	0.063	149.926	2.352
N	402,497	281,338	402,497
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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$). Excludes patients who were treated in the hospital district's hospitals.
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A17: Robustness Test: 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)
$\text{mean}(y_{imht}\vert\text{Post}_t = 0)$	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)
$\text{mean}(y_{imht}\vert\text{Post}_t = 0)$	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)
$\text{mean}(y_{imht}\vert\text{Post}_t = 0)$	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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 318$).
[a] Equals one if patient was treated in a teaching (university) hospital.
[b] Distance from patient's residence to the hospital in kilometers.
[c] Equals one if patient was treated in the geographically nearest hospital.
[d] Equals one if patient was treated in a hospital located in a different hospital district than where they live.

Table A18: Robustness Test: 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			
Treated$_h$ × Post$_t$	0.010	-84.872***	0.130
	(0.007)	(12.937)	(0.345)
mean(y_{imht}|Post$_t$ = 0)	0.083	185.398	7.960
N	19,814	14,941	19,814
Panel B. Knee replacement surgeries			
Treated$_h$ × Post$_t$	0.010	-122.254***	-0.312
	(0.010)	(18.574)	(0.355)
mean(y_{imht}|Post$_t$ = 0)	0.109	233.832	7.585
N	24,330	18,334	24,330
Panel C. All orthopedic surgeries			
Treated$_h$ × Post$_t$	0.001	-32.061***	-0.136**
	(0.003)	(8.841)	(0.058)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 318$).
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A19: Robustness Test: 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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 324$–326 depending on the column). Outcome = waiting time in days.
[a] Including only hospitals from districts in which less than 30% of the waiting time values were missing in 2004–2010.
[b] Including only those surgeries for which less than 30% 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: Effects of the Reform Additional Quality Measures

	Revision[a] (1)	Infection[b] (2)	Complication[c] (3)
Panel A. Hip replacement surgeries			
Treated$_h \times$ Post$_t$	0.007	-0.001	0.004
	(0.005)	(0.004)	(0.006)
mean(y_{imht}|Post$_t = 0$)	0.034	0.012	0.056
N	29,625	29,625	29,625
Panel B. Knee replacement surgeries			
Treated$_h \times$ Post$_t$	0.007*	0.001	-0.008
	(0.004)	(0.003)	(0.005)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$).
[a] Revision surgery within 2 years of the initial surgery.
[b] Infection or inflammation in the prosthesis within 2 years of the initial surgery.
[c] Mechanical complication in the prosthesis within 2 years of the initial surgery.

Table A21: 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			
Treated$_h \times$ Post$_t$	0.010	-0.007	-0.200
	(0.008)	(0.010)	(0.591)
mean(y_{imht}|Post$_t = 0$)	0.072	0.179	8.724
N	32,107	32,107	32,107
Panel B. Stroke			
Treated$_h \times$ Post$_t$	0.004	-0.044***	-0.615
	(0.007)	(0.012)	(0.783)
mean(y_{imht}|Post$_t = 0$)	0.082	0.199	16.231
N	48,495	48,495	48,495
Panel C. Hip fracture			
Treated$_h \times$ Post$_t$	-0.007	-0.025	-1.697
	(0.007)	(0.019)	(1.480)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$ depending on the sample).
[a] Death (before or after discharge) within 30 days of admission.
[b] Emergency readmission (to any hospital) within 30 days of departing from the last hospital of the treatment spell.
[c] Number of days.

Table A22: Effect of the Reform on Hospital-level Waiting Times After the 6-month Medical Treatment Guarantee

	Whole time period		After treatment guarantee	
	DiD (1)	Heterogeneity (2)	DiD (3)	Heterogeneity (4)
Panel A. Hip replacement surgeries				
Treated$_h$ × Post$_t$	-83.110**	-68.900	-35.524*	-22.548
	(35.522)	(44.454)	(17.338)	(14.790)
Treated$_h$ × Post$_t$ × Teaching$_h$		-48.217		-49.730*
		(46.002)		(24.405)
mean(y_{ht}|Post$_t$ = 0)	174.557	174.557	141.217	141.217
N	668	668	401	401
Panel B. Knee replacement surgeries				
Treated$_h$ × Post$_t$	-111.100**	-98.275	-48.931**	-43.824*
	(42.234)	(56.985)	(17.263)	(23.820)
Treated$_h$ × Post$_t$ × Teaching$_h$		-40.523		-20.868
		(58.399)		(31.406)
mean(y_{ht}|Post$_t$ = 0)	215.895	215.895	163.569	163.569
N	664	664	397	397
Panel C. All orthopedic surgeries				
Treated$_h$ × Post$_t$	-14.575	-8.785	-19.068*	-15.152
	(11.235)	(18.590)	(10.588)	(16.273)
Treated$_h$ × Post$_t$ × Teaching$_h$		-33.458*		-21.266
		(18.274)		(17.630)
mean(y_{ht}|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 = 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 hospital's total patient volume. Baseline = share of 60–69-year-old male patients.
[b] Incidence of different procedure codes among hospital's patients.

Table A23: 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 level of hospital district ($N = 20$).
[a] Mean age of patients at the time of admission (18–74).
[b] Share of females out of all patients.
[c] Mean number of emergency admissions hospital's patients had within 1 year before their surgery.

Table A24: Effects on Hospitals' Surgical Expenditure

	Total expenditure (millions of €)[a]		Expenditure per treated patient (€)[b]	
	DiD (1)	Heterogeneity (2)	DiD (3)	Heterogeneity (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)
$\text{mean}(y_{ht}\vert\text{Post}_t=0)$	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 treated surgical patients.

Table A25: Marginal Effects of Concentration and Reform on Surgical Care Quality, Waiting Time, and Length of Stay

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (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]
$\text{mean}(y_{imht}\vert\text{Post}_t=0)$	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]
$\text{mean}(y_{imht}\vert\text{Post}_t=0)$	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]
$\text{mean}(y_{imht}\vert\text{Post}_t=0)$	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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 74$). HHI measured on a 0–1 scale, where higher value indicates more market concentration.
[a] Emergency readmission (to any hospital) within 30 days of departing from the last hospital in the treatment spell.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A26: Back-of-the-Envelope Calculation

Variable	Description	Hip replacement surgeries		Knee replacement surgeries		All orthopedic surgeries	
		Source	Value	Source	Value	Source	Value
Panel A. Benefits of the reform							
h	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
$h \times (T - w_0) \times y_0$	Total health benefit per year, pre-reform		79,385,171.94		60,216,705.50		823,015,201.20
$h \times (T - w_1) \times y_1$	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							
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 estimates of the quality of life (EQ-5D index) gains from hip and knee replacements and orthopedic surgeries (the 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 the discount factor of 3 percent and expected death at 80 years of age.
[c] Total volume in the pre-reform period is approximated by multiplying the average hospital volume per quarter in that period by the number of reform area hospitals (9) and quarters (4).
[d] Total volume in the post-reform period is approximated by multiplying the sum of the pre-reform volume and the coefficient estimate of $\text{Treated}_h \times \text{Post}_t$ (column 1 of Table 6) by the number of reform area hospitals (9) and quarters (4).
[e] The average cost for orthopedic surgery is approximated by taking a weighted average of the costs in Osnes-Ringen et al. (2011), using observation shares as weights.
[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 (2.34 days).
[f] Average costs in the post-reform period, taking into account the savings from shorter stays $c_1^{LOS} - c_0^{LOS}$, are calculated as $c_1 = c_0 + (c_1^{LOS} - c_0^{LOS})$.

Table A27: Robustness Test: Effect of the Reform when Controlling First-Stage Residuals (Hospital Performance Outcomes)

	Readmission[a] (1)	Waiting time[b] (2)	Length of stay[c] (3)
Panel A. Hip replacement surgeries			
Treated$_h$ × Post$_t$	-0.003	-100.662***	-1.692***
	(0.005)	(11.834)	(0.264)
mean(y_{imht}|Post$_t$ = 0)	0.080	183.757	8.044
N	29,625	23,481	29,625
Panel B. Knee replacement surgeries			
Treated$_h$ × Post$_t$	0.016**	-140.146***	-1.584***
	(0.007)	(15.667)	(0.275)
mean(y_{imht}|Post$_t$ = 0)	0.103	229.671	7.528
N	35,884	28,269	35,884
Panel C. All orthopedic surgeries			
Treated$_h$ × Post$_t$	0.000	-56.324***	-0.596***
	(0.002)	(6.769)	(0.041)
mean(y_{imht}|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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 326$).
[a] Emergency readmission (to any hospital) within 30 days of departing from the last hospital in the treatment spell.
[b] Waiting time in days. Some of the values are missing, which results in lower N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A28: Marginal Effects of Concentration Without Controlling First-Stage Residuals

	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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 74$). HHI measured on a 0–1 scale, where higher value indicates more market concentration.
[a] Emergency readmission (to any hospital) within 30 days of discharge.
[b] Number of days. Some of the values are missing, which results in smaller N compared to other columns (see online Appendix Section A1.6 for more details).
[c] Number of days.

Table A29: 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). Includes 18–74-year-old patients in Q1/2004–Q4/2010. Standard errors clustered at the level of patient's home municipality ($N = 74$).
[a] Death (before or after discharge) within 30 days of admission.
[b] Emergency readmission (to any hospital) within 30 days of discharge.
[c] Number of days.